And then you hit play:
Investigating players' responses to wayfinding cues in 3D action-adventure games

by

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Abstract

This research is concerned with wayfinding, one of the most basic interactions of 3D action-adventure games. Even though players are required to move from point A to point B to progress in games, there is little research on the difficulties, needs, and preferences of players regarding wayfinding in 3D game worlds. It is well known that to alleviate wayfinding issues, designers add wayfinding cues to the game world. However, little is known about how those cues affect players' in-game behavior and, more importantly, the player experience. This research addresses those issues by investigating players' responses to a variety of wayfinding cues. To this end, I developed two research tools resembling commercial 3D action-adventure games. Both games (i.e., The Lost Island and A Warrior's Story) presented several wayfinding cues and tasks, purposefully designed to make players move from one space to the next. I investigate the player experience through mixed method and user-centered approaches, collecting and analysing quantitative and qualitative data.

In the first study, all participants played the same version of The Lost Island, and I emphasized the differences between the experiences of more and less skilled players. For the second study, I categorized wayfinding cues into three groups that worked as my independent variables. Participants played one of the three versions of the game (i.e., experimental conditions) and reported on their experiences.

Through concrete examples, this work demonstrated how wayfinding cues had an impact on players' wayfinding behavior and attitude towards the games. Design implications are also discussed. I hope this work will assist wayfinding researchers in their future investigations, and assist wayfinding system designers in creating and ameliorating their systems for a more profound user experience.

Keywords: wayfinding cues; navigation; player experience; engagement; user-centered design; design-oriented research

Dedication

To Helder

Acknowledgements

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List of Acronyms

ESA   Entertainment Software Association

FPS   First person shooter game

IEQ   Immersive Experience Questionnaire

NPC   Non-player character; an agent with scripted behavior that players do not control in the game

RPG   Role-playing game

SFU   Simon Fraser University

SIAT   School of Interactive Art and Technology

Glossary

Cognitive absorption   Deep involvement with a software that is "exhibited through the following five dimensions: temporal dissociation, attention focus, heightened enjoyment, control and curiosity" (Jennett et al., 2008).

Engagement   Involvement with something (e.g. a digital system); a lower degree of immersion.

Engrossment   Further degree of involvement (usually emotional), going beyond engagement, and the second level of immersion.

Flow   "The state in which people are so involved in an activity that nothing else seems to matter" (Csikszentmihalyi, 1990). It is often followed by a sense of enjoyment and personal growth.

Immersion   The graded experience of "being absorbed in a game to the exclusion of all else outside of the game" (Cox, Cairns, Shah, & Carroll, 2012). It is built upon five underlying components: cognitive involvement, emotional involvement, real world dissociation, challenge and control.

Navigation   The decision execution phase during wayfinding; locomotion.

Presence   The perception of being in a different reality.

Wayfinding   "Spatial problem solving comprising the following processes: decision making, decision executing, and information processing." (Arthur & Passini, 1992)

Chapter 1.

Introduction

Video games[1] have become a multibillion dollar industry as the number of consumers has increased. For example, consumers spent around $22 billion on gaming hardware, software and accessories in 2014 in the United States alone (The Entertainment Software Association - ESA, 2015[2]), and game market research company Newzoo[3] predicts that worldwide revenues will surpass $100 billion in 2017. The population of gamers has also become notably diverse. Nowadays, teenagers, adults, and seniors, both male and female, are video game consumers. The ESA and ESA-Canada have reported that 155 million Americans and 19 million Canadians play video games, and that the average game player in those countries is 35 and 33 years old respectively. Undoubtedly, as noted by game scholars, video games have reached a broader audience and turned out to be part of our popular culture (Jenkins, 2006; Turkle, 2003). This creates an interesting challenge to game researchers, theorists and designers trying to understand the reasons why games are so captivating and how game components must be designed, tuned, and combined to enhance the player experience.

According to Zimmerman (2004), a "game is a voluntary interactive activity, in which one or more players follow rules that constrain their behavior, enacting an artificial conflict that ends in a quantifiable outcome" (p.160). Although several authors have proposed their own definition of games, interactivity is recognized as both required and central characteristic of this media (Crawford, 2003; Ermi & Mäyrä, 2005; Juul, 2004; Salen & Zimmerman, 2003; Vorderer & Bryant, 2006; E. Zimmerman, 2004). In fact,

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[1] The terms video games and games are used interchangeably throughout this document, so are the words players and gamers.

[2] http://www.theesa.com/ and http://theesa.ca/

[3] http://www.newzoo.com/

video games are branded as **interactive entertainment**, separated from other forms of entertainment such as books and films; interaction is at the core of the gaming experience. Therefore, one way of exploring what makes video games so attractive to players is to understand how and why players interact with specific game features.

Crawford (2003) compares interaction to a *conversation* between entities, describing interactivity as a "cyclic process in which two active agents alternately (and metaphorically) listen, think, and speak" (p. 76). To expand on Crawford's and other definitions of interactivity, Salen & Zimmerman (2003) propose a Model of Interactivity including: **Cognitive interactivity** (or interpretive participation); **Functional interactivity** (or utilitarian participation); **Explicit interactivity** (or participation with designed choices and procedures); and finally **Beyond-the-object interactivity** (or participation within the culture of the object). To the authors, all modes are interrelated, but explicit interactivity is particularly related to the gaming experience, as it has to do with players making choices in a previously crafted video game. They further explain that explicit interactivity is about **designed interactions** where designers structure a space for play, equip players with relevant information and action possibilities, allow players to express themselves through interactions, and create meaningful game outputs to respond to players' inputs. This **player's input – game output** cycle echoes Crawford's view of interactivity as a conversation between two or more entities – even if preprogrammed utterances take place in the process. Clearly, both designing game interactions and interacting with video games are intricate processes because of the many variables and choices involved in those tasks.

Since their first release in the 1990s, 3D games[4] have rapidly gained popularity across many gaming platforms and game genres. The adoption of three-dimensional graphics was part of a natural and cyclical evolution that drove, and was driven by, a combination of factors such as advances in hardware and software with the addition of game developers' desires to provide a more compelling gaming experience to players (Egenfeldt-Nielsen, Smith, & Tosca, 2012; Wolf, 2007). Moving around 3D game worlds

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[4] To avoid confusion, as pointed out by Egenfeldt-Nielsen *et al.* (2012), I am using the term 3D games to refer to videogames that use three-dimensional graphics, not "3D projection" as in stereoscopic videogames that creates depth perception.

is a shared interaction among 3D action-adventure, first person shooter (FPS), and role-playing (RPG) games, to name just a few. The idea is for players to navigate the game environment in order to encounter and overcome set goals. Accordingly, videogames become unplayable if players cannot find their way through the game world, making wayfinding a central interaction within 3D games. In fact, previous research shown that navigation has a notable effect on the player experience (Bidwell, Lemmon, Roturu, & Lueg, 2007; McGregor, 2008).

Navigating game worlds is not a simple task, however. As game worlds become larger and more complex, perceptual-cognitive demands on players also increase. For example, players need to navigate through spaces that they have never seen before so they cannot rely on their memory to know where to go. In addition, 3D environments are partly occluded and players have limited sight of the game space; they need to slowly make sense of the spatial layout to understand how different locations are linked. Particularly in 3D action-adventure games, wayfinding is an intended challenge where designers create environmental puzzles to defy and amuse players. In this game genre, players can explore and manipulate the game world through their avatars by walking, jumping, picking up objects, swimming, pulling switches, grabbing onto ledges and ropes, climbing, and so on. The possibilities are many and, while interacting with the game, players need to gather and interpret information in order to take appropriate in-game actions.

To alleviate exploration and navigation, game designers inform players of where to go and how to get there through wayfinding cues. I define wayfinding cues, in the context of video games, as objects added to game worlds by the designers with the explicit intent of indicating players' next steps. When combined, wayfinding cues produce a sophisticated system that communicates paths, interactible items (items that players can interact with), pickups (like health and rewards), destinations, and key characters. Such cues are important for gaming interaction because, frequently, game environments alone are not enough to guide players – although no one can deny the importance of the architectural layout in indicating new routes in games.

Besides the problems wayfinding creates for the users, there are problems faced by designers: how to create and strategically place wayfinding cues into games. And that is not a straightforward task. It requires several iterations to make a game both playable and enjoyable (Fullerton, 2008), so designers spend a great amount of time fine-tuning their creations. And yet, players constantly report problems with wayfinding such as feeling lost and misguided. Feeling lost usually occurs due to improper wayfinding system design (Arthur & Passini, 1992), and it frequently leads to frustration. As pointed out in previous work, frustration "is that which arises when the progress a user is making towards achieving a given goal is impeded" (Gilleade & Dix, 2004, p.229). Wayfinding problems in games may have serious consequences, such as disruption of the gaming experience or even players quitting the game (Virvou & Katsionis, 2008; Virvou, Katsionis, & Manos, 2004). If players cannot navigate a game in a satisfying way, all effort in crafting other aspects of the gaming experience will be in vain, as players will be unwilling or unable to reach the intended locations.

As pointed out by Salen & Zimmerman (2003) and Crawford (2003), creating video games requires designing an experience that emerges through player-game interaction. My research focuses on the basic interaction of wayfinding, looking at how wayfinding cues shape the gaming experience in 3D action-adventure games.

1.1. Research purpose and motivation

The purpose of this dissertation is to investigate, from a pragmatist view, how players respond to different wayfinding cues in 3D action-adventure games. That is, I seek to find out how changes in visual wayfinding cues affect players' in-game behavior and their involvement with a game: How do wayfinding cues improve or disrupt the gaming experience? I have chosen action-adventure games because they inherently provide a variety of wayfinding tasks for players such as exploration, searching, and planning routes. Accordingly, wayfinding cues are already part of the visual language of that game genre.

It is well known that high-budget games on the market already allow players to customize their games by turning wayfinding cues on and off. However, it is still unclear

exactly how those cues affect gameplay and the user experience. Game researchers and designers are faced with the problem of not knowing how players systematically navigate through games and what visual features are used in the process. For example, when a player chooses **path A** over **path B**, is it because of any specific feature in the environment? Or is it because of a personal motivation? In addition, it is also known that games' building blocks alter the degree of involvement one has with a game (Brown & Cairns, 2004). Thus, the paths one chooses in a given game, and more specifically the reasons why those paths are chosen, will likely affect the player experience.

However, despite the fact that wayfinding is a basic interaction in 3D games, it is yet to be known how wayfinding cues influence the way players react to those cues during gameplay. Exploring these issues will allow designers to make informed decisions, tailoring wayfinding cues to specific game contexts, improving player-game interactions and, consequently, giving rise to richer, more compelling experiences. To tackle these issues, I ask the following research questions:

1.1.1. Research questions

1. How do different types of wayfinding cues affect players' wayfinding behavior in 3D action-adventure games?
2. How do different types of wayfinding cues affect players' involvement with 3D action-adventure games?

To explore these questions, I have designed two research tools that resemble commercial action-adventure games in terms of graphics, tasks, environmental layout, cues, and so on. Each game was used in a different study and both introduced a variety of wayfinding tasks and wayfinding cues. The main purpose was to make players advance through the game world, interacting with objects, finding paths, collecting items, and fighting enemies, while I investigated how long it took players to finish the tasks, how easily the cues were seen, how players interpreted the cues, and what wayfinding decisions were made based on those interpretations. I also explored how the wayfinding cues affected the player experience, paying attention to when the wayfinding cues improved or disrupted the gaming experience and why.

The first study was exploratory, and included several wayfinding cues through six major spaces. All participants played the same version of the game and reported on their experience post-interactions. Based on results from the first study, a second game and study were designed. Wayfinding cues were grouped into three major categories: Attentional cues, Representational cues, and Textual cues. Wayfinding cue types were then used as independent variables where the environmental layout was kept the same and only the cues varied, resulting in three different conditions. Participants were assigned to one of those conditions and subsequently reported on their experiences.

Taking a mixed methods multiphase approach, I collected quantitative and qualitative data mainly through system logs, questionnaires, and cued recall debrief. The rationale for choosing this approach is that the nature of my research question asked for both broad numeric trends and contextual factors provided by the players. In that way, players could explain how wayfinding cues affected their wayfinding in-game behaviors and attitude towards the game they played. Hence, this research fits in the user-centered design and human-computer interaction domain.

1.2. Contributions of this work

Through this research I hope to have contributed to the fields of game research and wayfinding system design in the following ways:

1.2.1. Effects of wayfinding cues on the gaming experience

Previous work identified several wayfinding cues used in video games (Davies, 2009; Lemarchand, 2012; Moura, 2007; Nerurkar, 2009; Rogers, 2009). Others tested how some wayfinding cues affected player performance in more restrict virtual worlds (Samarinas, 2009; Vembar et al., 2004; Wu, Zhang, Hu, & Zhang, 2007). However, none of those works have tested how players respond to wayfinding cues in complex, visually rich game worlds. This research begins to explore that path by giving concrete examples of how players responded to different wayfinding cues based on a variety of contexts.

1.2.2. Methodological approach

This research also demonstrated the benefits of collecting players' reports to better understand the wayfinding experience in video games. While quantitative studies have investigated wayfinding though a series of performance metrics, this work agrees with previous research (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Murray, Bowers, West, Pettifer, & Gibson, 2000) highlighting the importance of understanding participants' experiences from a qualitative or mixed methods perspective, as investigators will know not only what participants did but also why they behaved and felt that way.

In addition, this work documented the design process of the prototype of two different action-adventure games as well as detailed how players reacted to each wayfinding cue depending on the context where cues were applied. Game researchers and designers may find it useful to rely on user-based knowledge at the starting phase of their works.

1.2.3. Design implications

I derived a set of guiding questions (Table 8.1) in hopes of assisting game designers and researchers to design, investigate, and ameliorate wayfinding systems in games. Note that I opted for generating a set of questions because, unlike prescriptive rules that restrict one's work, I believe that by questioning oneself during the crafting process, researchers and designers may achieve richer, more profound results.

1.3. Other contributions

Prior to the research presented in this thesis, I worked on a few other projects related to the breadth and depth of this research.

1.3.1. Visualizing and understanding players' behavior in video games: discovering patterns and supporting aggregation and comparison

This work was published at Siggraph (2011) and co-authored by Magy Seif el-Nasr and Christopher D. Shaw. The goal of this research was to introduce a visualization system that would help designers and analysts to visualize and understand player behavior in video games. While most visualization systems rely on single-metric visualizations and frequently used heat maps, we proposed a new way of visualizing players' actions and the capability of superimposing several players' in-game actions at the same time (Figure 1.1).
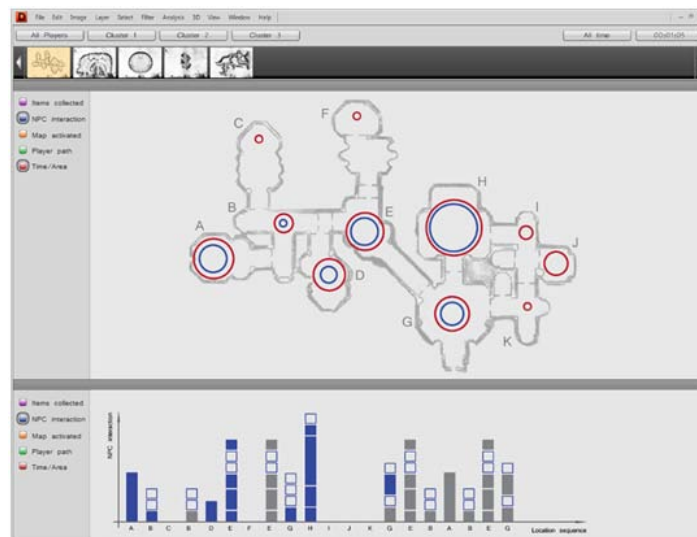
Figure 1.1. **Screenshot of the proposed visualization system: red circles represent how much time players spent in each area; blue circles represent how much time players spent talking to NPCs. Rectangles at the bottom represents the number of NPCs in each room**

In addition, the system would allow analysts to aggregate and compare different player types. All those capabilities would certainly be important if one needed to investigate cause and effect within a game. For example, given that there were two groups of players in a game – those who finish the game and those who quit the game and never return – an analyst may want to identify what actions were taken by those groups and then investigate how the actions differed between groups. The analyst would then be able to infer what caused some players to quit. The system proposed visualizations for the total time players spent in each area, the amount of times each

area was visited, where and how much time players spent interacting with the game map, where and how much time players spent interacting with NPCs, how many items were collected in each area of the game, and players' paths through the game. We used data from five playthroughs of Dragon Age: Origins (BioWare/EA, 2009) as examples.

While visualizing and understanding telemetry data can be highly insightful, such an approach has at least two major limitations. First, as game analytics usually relies on a great amount of user-initiated events, it is more suitable for summative assessments, when a game has been already shipped. That is, designers may not have much data to make decisions based on telemetry data alone while a game is still in production. Second, analysis from telemetry data can show what players do during gameplay, but they cannot explain why players do what they do. For example, an analyst can tell that a players did not collect an item, but that analyst cannot explain if that happened because the player did not see the item on the screen or because the player simply was not interested in that item. Once again, analysts can make inferences, but telemetry data alone cannot answer all questions and further investigation may be necessary.

1.3.2. The effects of ambient motion speed on player performance in video games

This work was published at the International Games Innovation Conference (2012) and co-authored by Lyn Bartram and Magy Seif el-Nasr. It investigated whether the speed of ambient motion (e.g., visual effects like moving water and grass) would affect players' performance in games. The motivation for this research was that, while moving visual effects and animations have been widely applied to interactive video games in order to create the atmosphere of those games and engage users, there is little empirical evidence for the influence of ambient motion on players' performance in 3D games. We designed a game with two levels in the Unity game engine (Figure 1.2). The levels had similar tasks. The first level, our base line, had no motion. The second level presented one of three conditions: frozen particles, with static fireflies; slow motion, where fireflies moved at 1x; and fast motion, where fireflies moved at 15x. Participants played in one of the three different conditions. We collected completion time, number of

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errors, and number of collected items. We compared the performance of novice players and expert players.

Figure 1.2.   Game developed in the Unity game engine to test how the speed of ambient motion affects players' performance in games

Overall, results suggested that experts players were rarely if ever affected by the speed of ambient motion (i.e., fireflies), whereas novice players seemed to have a better performance in the slow motion condition. The speed of ambient motion had no effect on the number of items collected by participants (novice or expert). In addition, the majority of novice players reported that rapid ambient motion was very distracting, whereas expert players seemed to be capable of habituating to motion. Even though this research was not directly related to wayfinding, it showed that some game features have the potential to affect players' in-game behavior. It is also important to remember that several games introduce motion (i.e., visual effects) to guide players through game environments.

1.3.3.   Design techniques for planning navigational systems in 3D video games

This work was published at ACM Computers in Entertainment (2014) and co-authored by Magy Seif el-Nasr. It was an extension of my Master's thesis. The goal was to understand wayfinding better in the context of high budget 3D action-adventure games on the market. To do so, we conducted a detailed analysis of 21 games.

First, we identified a few design considerations that surely affected wayfinding:

- How much exploration the game environment should incite;
- How much access to the game world players have (or how large each level should be);
- How much control over the camera settings players have.

Depending on those decisions, the wayfinding system may be more or less complex and players will have an easier/harder journey.

We also identified several game mechanics closely related to wayfinding and navigation: master character's movements and skills; level up the character, level up tools or vehicles; use of NPC to open doors or solve puzzles; puzzle solving; defeat enemies; racing; and stealth mechanics.

Finally, we presented a series of design techniques (i.e., wayfinding cues) applied into those games. The wayfinding cues were named and categorized according to their function: direct players to specific objects, identify specific objects, or orient players in relation to the game world. Those design techniques are introduced in Table 1.1 (and presented in our paper).

Table 1.1.   Design techniques for aiding wayfinding in games

Wayfinding cues	Definitions
Directional signs	
Guided tour	A cut scene that walks the player through a path in the game environment or shows the after-effects of a player-game interaction.
Map [in the game menu]	This tool is a 2-D representation that shows the 3-D world from a top-down view. Such representation can be accessed through the game menu.
Mission or goal	Missions direct players by explicitly informing them of where to go and/or what to do.
Instructional aid	Instructional aids are a class of tools illustrating the controls that should be used in particular situations. They take on different forms.
Environmental objects representing path	This pattern refers to objects that allude to transportation or connection between two locations. They are unique and, most of the time, easily recognizable in the game environment such as ladders, ropes, chains hanging from the ceiling, distinct textures on the wall, and so on.
Marker	Markers are high-contrast elements within the game used to bring objects and locations to players' attention.
Lever, Gear, and Button	The name of this pattern is self-explanatory. They are levers, gears, and buttons that work as directional signs because they notify the player that a new path will be opened as soon as s/he interacts with them.
Direction from Characters	This means directions or instructions that come from an NPC, who tells the player

	where to go or what to do.
Subtitle Stating Directions	These are sentences that appear on screen to inform players of goals and directions they should take.
Collectible Item Indicating Paths	This is a collection of items spread through the game environment that can be picked up by the player.
Teleport [in game]	This is an element used by the player to travel from one place to another without experiencing the entire game environment. That is, this tool offers a lower-cost transportation.
NPC that should be followed	This technique is self-explanatory; it is a design technique that uses NPCs to guide players to different locations.
Arrow	It is an artifact that points toward a specific direction. This type of aid notifies players of paths in a pretty straightforward way.
GPS	It is a personal navigation device simulating what we call GPS in the real world. In games, a GPS is not only a simple map on the screen, but it also shows the main character represented by an arrow (instead of a dot) that indicates the direction the player is moving. Also, a GPS shows important landmarks and highlights the location the player should reach.
Compass	A compass is a device that that points the player toward a direction without giving him/her details about the path that should be followed.
Specific Tool Indicating Direction	Similar to Compass, this navigational aid refers to tools that indicate the direction players should follow. The difference is that a specific tool indicating direction should be activated by the player.
Teleports [through the map in the menu]	This teleport is different from the other presented in this paper (i.e., teleport [in game]) only because the player needs to go to the game menu before using it. Other than that, teleports have the same function: transport the player from one location to another without forcing the player to navigate the game world.
Identification signs	
Instructional Aid	As identification signs, instructional aids indicate elements that players can interact with (e.g., doors, levers, gears, NPCs, etc.)
Subtitle Identifying Level/Area	This technique refers to subtitles that appear on the screen, naming a level or area when players reach those locations in the game.
Marker	Brightness and color contrast work as identification signs when they specify interactive objects or locations to the player.
Direction from Characters	identification signs from when the NPC identifies himself or when the NPC says where the player has arrived.
Sign Board	As in the real world, sign boards are visual elements used to identify locations in the game.
GPS	As previously defined in the directional signs section, this navigational tool is a personal navigator device. It works as identification sign only when it "identifies" a specific location.
Orientation signs	
Map [in the menu]	As previously defined, maps are 2-D representations of the 3-D environment (see Map [in the menu] in the directional signs section).
Map [on screen-HUD]	This kind of map provides a partial view of the game environment so a player can situate himself according to what is shown.
GPS	As an orientation sign, a GPS is responsible for providing important landmarks in the

	environment and the player's position and orientation (i.e. the direction the character is facing). See also 'GPS' in the directional signs section.
Directory	Similarly to directories in the real world, this tool is a map fixed in a specific location of the game environment. The environmental layout, and sometimes the character position, is displayed in this tool.

Note.   Transcribed from Moura & Seif El-nasr (2014).

In addition to defining each wayfinding cue, we provided examples of how each cue was applied into several games. We also explained the benefits and drawbacks of using each one of those cues. However, as already mentioned, research findings were derived from the analysis of 21 action-adventure games, where only one of the researchers played all games. Hence, there was still a need for empirical evidence that could confirm or refute the findings suggested in this previous work. I hope to start such investigation with this thesis.

1.4. Document organization

This thesis is organized into 8 chapters:

- **Chapter 1** highlights the research problem and my motivations; it states the two central research questions and the methodological perspective guiding this dissertation. I also give an overview of the contribution of this research and contributions of previous work.

- **Chapter 2** introduces key concepts on wayfinding in video games and the gaming experience, expanding on the context and importance of this work based on previous research and gaps in the literature.

- In **Chapter 3**, I introduce the pragmatist worldview and further explain and justify my methodological approach. In addition, I detail my data collection and analysis as well as comment on validity and reliability concerns in this thesis.

- **Chapter 4** presents my first study in detail: the design rationale and game design process of the first game created for this research (i.e., The Lost Island).

- In **Chapter 5**, I further detail my methodological approach in Study 1, describing procedures and apparatus, participants, data collection and analysis, and findings of my first study.

- I start **Chapter 6** by describing lessons learned from my previous study and then I detail the design rationale and game design process of my second game (i.e., A Warrior's Story). I also present how the wayfinding cues used as independent variables in Study 2 were categorized into three distinct groups.

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- **Chapter 7** further details my methodological approach in Study 2, describing procedures and apparatus, participants, data collection and analysis, and results.

- Finally, **Chapter 8** summarizes my findings and conclusions. I also highlight the contributions of this work, discuss limitations of this research, and propose future work.

Chapter 2.

Literature Review

My research is devoted to the wayfinding process in 3D action-adventure games, a fundamental player-game interaction, and hence a subset within the domain of human-computer interaction. In this chapter, I refer to relevant wayfinding theories to introduce three agents that take active roles in the process of wayfinding – environments, wayfinding tasks, and wayfinding cues. A considerable part of the research presented here is about our current understanding of wayfinding processes in the **real world**. To complement that knowledge, I introduce design lessons on wayfinding cues coming from experienced game designers working in the game industry.

Subsequently, I shift my focus away from the product (i.e., games) to the gaming experience, looking at concepts such as immersion and flow to better understand what it is to be involved with a video game. Those phenomena are also theoretical constructs shaping my dissertation.

It is important to note that, because this work falls into the research through design category, I also analyzed a variety of action-adventure games that inspired the design of my research tools. It was an iterative process where I constantly alternated between game analysis and literature review. I borrowed from several fields such as game design research and best practices, wayfinding and attention theories, and human-computer interaction, collecting design lessons and theories to guide and inspire my studies and conclusions.

2.1. The wayfinding process

Wayfinding is spatial problem solving, involving information processing, decision making, and decision execution[5] (Arthur & Passini, 1992); and, according to Golledge (1999), it "is a purposive, directed, and motivated activity" (p. 6). During the wayfinding process, users traverse the environment, searching, gathering, and interpreting relevant information to make and execute wayfinding decisions until they reach their final destination. Wayfinding in familiar environments has become so ordinary that it is almost taken for granted; users move from **point A** to **point B** oblivious to the sensorimotor and cognitive processes in action at specific decision points in an environment. It is only when one either visits an unfamiliar space such as a new city or experiences a game for the very first time that they become aware of the challenges and necessary skills accompanying their journey.

2.1.1. Wayfinding tasks, environments and visual cues

My research is concerned with visual wayfinding cues in 3D action-adventure games and how they affect players' involvement with a game; however, it is necessary to introduce other elements related to wayfinding to better situate my research. There are three major components embedded in the wayfinding process in 3D game worlds: the environments where interactions take place, the wayfinding tasks players should accomplish in order to advance in the game, and the wayfinding cues added into the environment to inform players of where to go. The ease with which one traverses a space will depend on the quality of those three components (Moura & Seif El-nasr, 2014).

Game environments

The primary function of architectural design in games is to support gameplay by providing challenges and suggesting actions to be executed by players (Adams, 2003;

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[5] Decision execution is here defined as **locomotion** or **navigation** (Arthur & Passini, 1992; J. L. Chen & Stanney, 1999). It involves steering and obstacle avoidance. Note that the relationship between wayfinding and navigation presented by those authors differs from Wiener et al.'s (2009), as the latter defines wayfinding and locomotion as subsets of navigation.

S. Chen & Brown, 2001; Güttler & Johansson, 2003; Hullett & Whitehead, 2010; Licht, 2003; McGregor, 2007; Nitsche, 2009; Schell, 2008). Adams (2003), for example, indicates four ways a game environment can assist gameplay; all four are related to navigation in my opinion: (1) limiting the player's freedom and, at the same time, guiding the player to specific locations; (2) hiding objects such as enemies, traps, and pickups, and hence challenging the player to find such objects; (3) providing obstacles such as climbable walls, charms to be transposed and traps to be avoided, letting the player show off their skills and "beat" the environment while navigating; and (4) providing space for exploration, challenging players to understand spatial relationships between locations in the game. McGregor (2007) explicitly connects game space design and wayfinding when she emphasizes that the architectural design defines what a player should do in the environment as well as the navigable areas of the game. As in real world environments, moving around game spaces involves a series of subtasks such as deciding where to go, planning a sequence of locations that should be visited in the process, and taking action at those locations (e.g., turning left or going up). To do so, users use information available in the environment. J. L. Chen & Stanney (1999) explain how spatial information is classified based on Downs & Stea's and Passini's works:

- **Locational information** is about "where" an event occurs and it encompasses distance information (e.g., five miles, three-hour flight, after the bridge) and direction information (e.g., west, uptown).

- **Attribute information** is related to the "what" (descriptive attributes) and "why" (evaluative attributes) about a space. It is subdivided into descriptive attributes, which cover "sensory features that identify a place" (p.674) (e.g., a blue house, a log cabin), and evaluative attributes, which assess a space and explain why it is significant or not (e.g., great food, vibrant atmosphere).

- **Time** is also related to spaces as it tells "when" and "how" an event occurs.

Establishing links between space structure and players' actions, and navigation more specifically, is an important step in understanding how wayfinding works in games. However, knowing the function of game spaces does not say much about how to design those spaces (and wayfinding systems) to create desirable gaming experiences. For example, what type of affordances and wayfinding cues should be used in spaces designed for exploration? And what is the "best way" of guiding players to specific locations?

Undoubtedly, the spatial structure of games influences the player's in-game behavior. As in the real world and virtual environments, users may be steered through the environment based on its paths and barriers and landmarks (J. L. Chen & Stanney, 1999; Gibson, 1979; Lynch, 1960; Rogers, 2009; Vinson, 1999). As Lynch (1960) points out, the legibility and readability of a setting is improved by an appropriate arrangement of paths, edges, nodes, districts and landmarks. For example, if players recognize a doorway, they will interpret that as their way of getting out and advancing through the game (S. Chen & Brown, 2001; Moura, Breyer, & Neves, 2006). Similarly, if a spatial layout limits the players' actions by giving them a single route to follow, players will not make a great effort to decide where to go; they will take the only available option. However, wayfinding decisions become more intricate as game environments become less linear, offering a variety of decision points, locations, and goals to the player.

On design lessons for appropriate wayfinding in **real world environments**, Arthur & Passini (1992) explain that spaces should be designed in a way that all necessary information for navigation should be visible when one quickly scans a scene, allowing for the acquisition, understanding, and manipulation of information. In video games, however, there are objects and locations purposefully hidden by designers in order to make players explore the environment, searching for those objects. The authors also comment on the importance of cognitively mapping spaces, which is the process of developing a rough map of the environment in our brain while we get familiar with it. Although this is true in circumstances where users navigate the same space several times, players may never develop such cognitive maps because, depending on the game they are playing, they may never navigate a path twice.

It is clear that not all design guidelines coming from conventional wayfinding system design will work when one designs action-adventure games. In fact, there are many games of that genre that break the rules of conventional architecture design to challenge players and create unique experiences for them. The complexity added to game environments will create wayfinding problems of different nature, and it is exactly when a space is no longer easy to "read" that designers need to include wayfinding cues to help players move around and make sense of those novel game worlds while executing a series of wayfinding tasks.

Wayfinding tasks

Researches on wayfinding in **real and virtual worlds** have proposed several wayfinding tasks: path planning, following routes, backtracking, and search and exploration, to name a few (Arthur & Passini, 1992; J. L. Chen & Stanney, 1999; Wiener, Büchner, & Hölscher, 2009). Those tasks are also presented in action-adventure games as micro (or local) and macro (or global) goals. For example, in **Shadow of the Colossus** (Sony, 2005), players need to search for specific locations in order to fight a Colossus; and, after they find and start to climb that Colossus, players search for a specific spot that needs to be hit by the player's sword. As players search for that specific spot, they carefully plan their next steps (path planning) based on elements players can grasp tightly. In **Don't Starve** (Klei Entertainment, 2013), one of the major goals is to explore the environment to find resources that will keep players alive. Players walk uncharted lands searching for food, wood, rocks, and many other elements, in order to build a base camp and survive nightly and seasonal monsters that try to kill them. The **Tomb Raider** (Square Enix) and **Prince of Persia** (Ubisoft) game series provide several environmental puzzles where players cautiously plan and follow routes to reach their final goals.

Although real and game worlds share the same types of wayfinding tasks, the way users execute those tasks can be very different. Wayfinding in real spaces is meant to be quite efficient and transparent. Playing video games, on the other hand, is a "voluntary attempt to overcome unnecessary obstacles" (Suits, 2005). Wayfinding tasks are not always meant to be clear and straightforward. Game designers need to create tasks that are simultaneously pleasurable and puzzling, difficult and rewarding, sometimes even frustrating, but always engaging. As such, designing wayfinding systems for action-adventure games can be challenging, as game designers should push players' perceptual-cognitive limits, and yet make the game both playable and fun.

Previous research identified several wayfinding tasks and cognitive processes related to those tasks (Arthur & Passini, 1992; Wiener et al., 2009). For example, Arthur & Passini (1992) presented a variety of basic wayfinding tasks and their relative spatial-cognitive manipulation:

Table 2.1.   The basic wayfinding tasks and the corresponding spatial-cognitive manipulations

Basic wayfinding task	Corresponding spatio-cognitive manipulation
Learning a new route	Recording a decision plan and/or developing a cognitive map
Returning to the point of origin (retracing one's steps)	Inverting a decision plan or the mapped route
Linking known routes to the new configurations	Combining decision plans or sections of the mapped routes into new combinations
Learning a route from a small display and making the journey	Making a transfer of scale
Pointing to directions of locations visited on a journey	Making a triangulation
Learning a route from a non-aligned display	Making a mental rotation
Understanding the overall layout of a visited setting	Identify the underlying principle of spatial organization

Note.   Transcribed from (Arthur & Passini, 1992).

The list of wayfinding tasks provided by the authors is useful to make one aware of the complexity of the wayfinding process; but, given the focus on the real world and breadth of their work, it might be difficult for young game designers to extract straightforward design guidelines to help them create better wayfinding systems.

Wiener and colleagues took a different approach and proposed a **wayfinding taxonomy** focusing on **unaided wayfinding tasks**. Their classification was based on the absence or presence of a specific destination during wayfinding, and the type of spatial knowledge a user acquired prior to performing the task (Wiener et al., 2009). The authors reason that users' behavior and cognitive processes significantly change depending on how much of the environment is known by the users. Spatial knowledge can be divided into:

- Destination knowledge: when users know a landmark or a destination.
- Route knowledge: when users have already memorized a sequence of destinations or steps to follow during navigation.
- Survey knowledge: when a user knows great portion of the environment. In this case, users know the spatial relation between several locations and landmarks in the environment.

Wiener et al. (2009) explain that there are two major categories of wayfinding tasks: undirected or directed wayfinding. **Undirected wayfinding** occurs if users do not have a specific destination in mind. In this case, they will either be **exploring** the space

when the area is unknown, or **cruising**, when survey knowledge is available. On the other hand, **directed wayfinding** occurs if users want to reach a specific destination. Directed wayfinding tasks can be divided into **search** and **target approximation** based on the absence or presence of destination knowledge respectively. Users will perform a **uniformed search,** if they have neither destination knowledge nor survey knowledge, and they will perform an **informed search** if they do not have destination knowledge but have survey knowledge. An example of uninformed search can be a person looking for a specific product in a store that person is visiting for the first time: the user knows neither the layout of the store nor where the item is located. An informed search happens if users do not know where their destination exactly is, but they know the area quite well: a user looking for a restaurant in a well-known neighborhood.

Finally, **target approximation** occurs when users have destination knowledge. It can be further divided into **path following** (if a user has route knowledge and only needs to follow a memorized path) and **path finding** (if a user does not have route knowledge and needs to learn a sequence of actions to reach the destination). Wiener and colleagues explain that **path following** requires less perceptual-cognitive effort from users because it is about a user monitoring a path that has been visited before and "almost no reasoning" (p. 160) is necessary. **Path finding**, on the other hand, is more complex. It can be subdivided into **path planning** (if survey knowledge is available) and **path search** (if users do not know the environment). In **path planning**, users make inferences about the relationship among several points in the space to plan a route to their destination. To conclude, Wiener et al. point out that **path search** occurs when users have neither route nor survey knowledge, but they can see the target destination from far away. As an example, the authors talk about a visitor that sees the Eiffel Tower in Paris but doesn't know how to get there. That user will need to search for that path.

Although the authors argue that such taxonomy is about unaided wayfinding, one can also argue that their example about a user navigating with the Eiffel Tower in sight is already an example of aided wayfinding where navigation is aided by a landmark. In fact, navigable environments are full of cues and/or constraints guiding the users, the so called affordances (Gibson, 1979) or, especially in the case of video games, perceived

affordances (Hartson, 2003; D. A. Norman, 1999). One of the unknowns is how environments and cues affect the quality of the wayfinding experience.

Wayfinding cues in 3D action-adventure games

In this section, I shift my attention to visual wayfinding cues: sensory information placed in game space by the designers to guide players when the environment becomes too convoluted to be navigated through its architectural features alone.

Previous research categorized wayfinding cues (also referred to as signage or navigational signs) into three groups based on their role on wayfinding in real world settings: directional signs; identification signs; and orientation signs (Arthur & Passini, 1992). In addition, several tools used to aid navigation in virtual environments were proposed (J. L. Chen & Stanney, 1999): tools that shows a participant's location, orientation and surrounds, and tools such as a global-positional system (GPS) and autopilot systems.

With such classification and tools in mind, I analyzed various console games and identified design techniques affecting wayfinding in 3D action-adventure games[6] (Moura, 2007; Moura & Seif El-nasr, 2014). I was mainly concerned with *visual* wayfinding cues, as I was interested in how video game designers communicate where players should go in such a visually rich media. In those works, I played each game from beginning to end at least once, pausing the games and taking notes about elements guiding me through the environments. Results from those qualitative analyses showed that although wayfinding cues in video games fall into the same categories as wayfinding cues in the real world, they take a variety of forms or shapes that cannot be found in real environments (please refer to Table 1.1 for a complete list of the identified wayfinding cues). Also, while wayfinding cues in the real world are meant to be standardized and easily discernible within a space (i.e., legible), wayfinding cues in games are more creative and playful, and not always consistent or standardized. It is important to note

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[6] This research is extensive and in the paper I provide definitions for each wayfinding cue, explanations of how they are applied to game spaces, benefits and drawbacks of all the cues, and concrete examples. A complete list of the design techniques and their definitions is presented in Table 1.1.

that some wayfinding cues in games may have two or three functions at the same time. Thus, a said cue may, for example, work as both a directional and identification sign. Wayfinding cues were grouped as follows:

- **Directional cues** are design techniques pointing players towards exact locations and/or interactions with objects or non-player characters (NPCs). They inform players of where to go and how to get there.

- **Identification cues** identify or distinguish locations, objects and NPCs within the game world. Those cues make clear that players have reached their destinations. They also inform players of interactive elements within the game.

- **Orientation cues** give players survey knowledge; that is players can understand spatial relationships among objects and the spatial relationship between objects and themselves. Orienting players is especially important when they have to navigate back and forth through the game world.

From an industry perspective, game designers have also listed wayfinding cues applied in 3D games. Examples of cues are compasses, maps, spoken directions, written objectives and missions, motion and lighting effects, landmarks, and non-player characters (NPCs) (Davies, 2009; Nerurkar, 2009; Rogers, 2009).

Rogers (2009) argues that navigational aids 'invite' players to keep moving through the game world and bad wayfinding design can prevent players from progressing. He identifies landmarks and lighting as elements that can be used to attract and guide players through the game.

Davies (2009) unpacks some of the elements that constitute game pace. To the author, the four key aspects of game pace are: movement impetus, threat, tension, and tempo. **Movement impetus** is the "desire of a player to move forwards through a level." According to Davies, some elements can be used in the game to increase impetus to move such as: introduce a threat from behind, present an objective ahead, impose a time limit, narrow physical options, draw the eye, architectural pressure, snatch desired objects, and NPC leads the way. On the other hand, some elements decrease impetus to move such as: wow moments, obstacles, altered movement, introducing a threat ahead, increased tension, multiple routes/open world, NPC halts player, taking stock of inventory (collecting items), dialog/roleplay, and story exposition. **Threat (actual danger)** will change game pace when a player feels that something can go wrong. It can

be an external threat (e.g. enemy – fast pace), or a mistake that the player can perform (e.g. fall from a platform – slow pace). **Tension (perceived danger)** is related to the atmosphere of the game and immersion. Horror games are good examples of how tension can influence game pacing. Finally, **Tempo** is "the level of actual action currently being experienced by the player" and is related to "how much concentration" the player needs to accomplish his/her goal. Low tempo gameplay, like puzzles, requires thought and observation. High tempo gameplay requires "fast reactions and split-second decisions."

As pointed out, wayfinding cues in games take different forms, and they, every so often, offer users new ways of moving around the world such as teleporting from one place to another through maps and other objects. Game wayfinding cues allow for different interaction patterns or different gaming experiences. For example, **Markers** make use of basic visual attention principles such as lighting and motion techniques to highlight objects in the game, attracting players' attention and making players move towards them. Other cues force players to interact with them if they want to know where to go. For example, a **specific tool indicating direction** can be found in **Shadow of the Colossus** (Sony, 2005): players need to press a button making the character raise his sword and, as players turn the character towards different directions, the sword gives players feedback, letting them know whether they are moving on the right path or not. Even though several wayfinding cues in games have been identified, they have not been empirically tested.

Seeking to understand user behavior in digital worlds, researchers have analyzed players' interactions through visualizations (Drachen & Canossa, 2009; Hoobler, Humphreys, & Agrawala, 2004; Moura, el-Nasr, & Shaw, 2011) and players' behavioral patterns in the context of games (Hoeg, 2008; Hullett & Whitehead, 2010; Si, Pisan, Tan, & Shen, 2017) or virtual environments (Booth, Fisher, Page, Ware, & Widen, 2000; de Castell, Larios, Jenson, & Smith, 2015; Liszio & Masuch, 2016; Murray et al., 2000; Vembar et al., 2004; Wu et al., 2007).

For example, Murray et al. (2000) conducted a qualitative study with eight participants to investigate how people navigate virtual environments. Participants

followed the think aloud protocol and asked questions to the researchers while exploring a virtual city. In this work, the authors identified implications for the design of virtual environments: for instance, they found that participants transferred their real world expectations to the virtual city (e.g., they expected the to see more avatars, birds, and detailed building making the virtual city more realistic/alive); difficulties with controlling their avatar and issues with spatial orientation affected how participants navigated the virtual space; and they also expected to see more landmarks and have a map to help them to navigate the space. The authors highlight the importance of qualitative and descriptive research for a better understanding of how people navigate virtual worlds.

To test the effectiveness of different maps in virtual world navigation, Vembar et al. (2004) presented one of three different maps on the screen while players navigated a maze in a virtual reality system. They found that the more helpful the map was the more players fixated on it during navigation, ignoring the 3D world. In addition, de Castell et al. (2015) tested the performance of novice and experts players during a series trials in a Morris Water Maze. They hypothesized that, since expert players show higher spatial ability, they would perform better than novice players (e.g., traveling shorter paths) in different test scenarios (e.g., with and without proximal cues). Among other results, the authors found the "differences in spatial learning and memory between novices and experts were essentially eliminated with the addition of proximal cues" (p.34). This result shows the importance of adding wayfinding cues in virtual worlds like video games.

Another study (Hoeg, 2008) was conducted where players were exposed to different cues in a FPS: light contrast, dynamic light, rhythm, sound, narrow vs. wide spaces, movement of objects or characters, resistance (i.e. a path that has obstacles), and color (associated with textures or lighting). Each decision point presented one of those elements guiding players toward a main and/or a side path (e.g. color attracting toward side path). The author found that participants visited spaces in the same sequence, regardless of the navigational cues presented, because of the influence of the architectural layout (the closest rooms were visited first). His findings suggest that designing cues that effectively manipulate players' interactions can be significantly complex due to other variables such as the game environment. In the next chapter, I describe how I approached this research topic. To validate a few design techniques

intended to guide players in virtual environments (i.e., landmarks or NPCs, paths, and centering), Liszio & Masuch (2016) "created three simple test scenarios, which implemented these patterns" (p.3) in a virtual reality game. They recorded several metrics such as players' position and paths, distance travelled, viewing directions, and player-object interactions. They concluded that all those elements were effective. They also implications for the design or virtual reality games: the visual design of paths can make them more or less inviting to users, and centering the field of view onto important objects (e.g., doors) will influence user behavior. As future research, the authors intend to "investigate the interplay of multiple patterns in more complex and realistic game scenarios" as proposed in (Moura & Seif El-nasr, 2014).

As discussed above, there are many elements influencing navigation in games, from architecture and narrative to signs and game pacing, which makes it harder for researchers and practitioners to make sense of navigation in games in a systematic way. Even though I have mentioned several studies that propose contributions towards the development of a model for navigational systems and their use in games, a detailed analysis of those systems and an analysis of how players respond to them are still missing. In addition, as far as I am aware, no previous research has systematically tested and described how specific cues affect the gaming experience. It is important to investigate how players would like to be guided in video games.

2.2. Wayfinding and the player experience

As with any other entertainment product such as books, movies and TV shows, users can walk away from video games that do not satisfy them. Therefore, games need to be engaging enough not only to attract players' attention but also to keep the users playing. It is only through sustained interaction that players are exposed to all experiences emerging from game mechanics crafted by designers. It has been pointed out that the elements (or objects) contained within a game affect the player experience (Hunicke, Leblanc, & Zubek, 2004; Salen & Zimmerman, 2003) as they give rise to specific interactions. Together, such interactions and experiences influence players' attitude toward a game. Attitudes "are a psychological construct defined as 'a sustained internal disposition that underlies favorable or unfavorable individual responses towards

an object or a class of objects'" (Lemay & Maheux-Lessard, 2010, p. 90). If wayfinding system designers seek to induce a positive attitude toward their games, they need to first understand how different players react to wayfinding cues in a variety of game contexts (Moura & Bartram, 2014). From this perspective, one may ask the following questions: What kind of wayfinding problems do players encounter? What are the challenges and needs during wayfinding in games? How do players react to getting lost in video games? Do they react in a manner similar to getting lost in the real world? What kind of wayfinding guidance do players expect? How do wayfinding cues shape players' wayfinding experiences? If questions like these are not addressed, certain players may experience frustration and simply quit the game; that is, a player will experience a **breakdown** (Ryan & Siegel, 2009).

Building upon past research (Heidegger, 1962; Marsh, Wright, & Smith, 2001; Winograd & Flores, 1987), Ryan & Siegel (2009) proposed a set of heuristics to inform the design of video games in a way in which breakdowns are avoided and **immersion** is supported. Those heuristics fall into four major classes: **Perceiving Environment** (or sensing/noticing the elements in the game environment); **Meaning Making**; **Developing Strategy**; and **Taking Action**. The authors explain that any element that breaks players' immersion will disrupt the experience, as players will switch their attention from solving problems within the game world to solving problems with the game itself (Ryan & Siegel, 2009). Therefore, in order to keep players immersed in a game, designers need to pay attention as to how players detect and interpret game elements, how those elements support players' strategies, and how they let players implement their strategies as they play. Interestingly, there is a parallel between those four classes and the wayfinding phases previously presented: **information processing**, **decision making** and **decision execution.** Such classes of heuristics are also aligned with communication theories proposed by semiotic engineering (de Souza, 2005; de Souza & Leitão, 2009) and Norma's seven-stage model of user-centered HCI (D. Norman, 1988). They all propose that users should **notice** and **appropriately interpret** the available information in order to plan and successfully execute their tasks.

As players spend a great amount of time walking around the game world, it is fundamental to investigate how wayfinding, and particularly wayfinding cues, interfere

with the degree of user engagement with games. Players' engagement is particularly important to the gaming experience because players need to concentrate on the game tasks to be able to progress in the game. If players are not engaged enough with a game, they will move away from the experience.

Game-user researchers discuss player involvement in experiential terms of **immersion**, **flow**, and **presence**. These are frequently mentioned in the literature as a characteristic phenomenon of finest gaming experiences (Brown & Cairns, 2004; Calleja, 2007; J. Chen, 2007; Cox et al., 2012; Csikszentmihalyi, 1990; Ermi & Mäyrä, 2005; Takatalo, Hakkinen, Kaistine, Nyman, & Bernhaupt, 2010; Vorderer, 2011; Vorderer & Bryant, 2006). Many authors have dedicated their research to measuring, analyzing, and improving the player experience based on those phenomena (Brockmyer et al., 2009; Ijsselsteijn, de Kort, Poels, Jurgelionis, & Bellotti, 2007; Isbister & Schaffer, 2008; Jennett et al., 2008; Nacke & Lindley, 2008; Qin, Patrick Rau, & Salvendy, 2009; Sharp, Rogers, & Preece, 2007; Sweetser & Wyeth, 2005). Despite the amount of research, there are still some disagreements on the definitions and boundaries of those terms, likely due to the complexity of those experiences. For example, some researchers liken deep immersion to presence (Brown & Cairns, 2004). Others compare the state of deep immersion to the flow state (Cox et al., 2012; Seah & Cairns, 2008).

From an industry perspective, game designer Lemarchand (2012) argues that the term **immersion** is poorly defined and usually associated with the common definition of presence, which suggests that players would believe they were "inside" the game world, taking a second identity. Lemarchand disagrees with this view and prefers to talk about **attention**, rather than immersion, when describing the core of the experience of players deeply involved with a game. Researchers in the field, however, identify attention (or cognitive/psychological absorption) as part of immersive experiences and the flow state, and not as a substitute for those phenomena (Brockmyer et al., 2009; Brown & Cairns, 2004; Csikszentmihalyi, 1990; Ermi & Mäyrä, 2005; Jennett et al., 2008; Seah & Cairns, 2008).

Despite those disagreements, most researchers seem to agree that engagement and immersion are graded experiences; thus, it makes sense to say that a player is

more or less immersed within a game. Researchers also agree that it does not make sense to say that there are different degrees of flow. In fact, Cox and colleagues emphasize that one can either be in the flow state or not (Cox et al., 2012). This goes in line with the **Flow Theory** proposed by Csikszentmihalyi (1990). In addition, several academics also agree that engagement and immersion are vital to successful gaming experiences. Therefore, in my research I want to investigate how wayfinding cues affect players' engagement and immersion within action-adventure games.

2.2.1.   Player involvement: from engagement to immersion

Brockmyer et al. (2009) define **engagement** as a "generic indicator of game **involvement**" (p.624). Cox et al. (2012) complements their view, describing **immersion** as "the sense of being absorbed in a game to the exclusion of all else outside of the game." To the authors, players become less aware of their surroundings and lose the sense of time when they are completely immersed within a game. As pointed out by Lemarchand (2012), "good video games hold our attention." As players become more and more deeply engaged, they reach the highest level of immersion (i.e., total immersion) (Brown & Cairns, 2004), which is similar to the flow state (Cox et al., 2012; Seah & Cairns, 2008) (note that some authors believe that flow and immersion "are not the same construct in the gaming domain" – see Procci & Bowers, 2011, p.2186).

This view that immersion is a graded experience that grows from engagement to engrossment to total immersion is proposed by Brown & Cairns (2004). To understand the meaning and intricacies of immersion in games, the authors interviewed expert gamers to find out what they really meant when recognized themselves as immersed during gameplay. Through ground theory, the authors identified three levels of immersion and the experiences around them as follows:

- **Engagement**: is defined as the lowest level of involvement with a game. Players become engaged with a game if they invest time, effort and attention. The game needs to match players' preferences and present clear and learnable controls to allow engagement to occur.

- **Engrossment**: is the second level of immersion, and a further degree of involvement. As players have invested time, effort and attention, they also become emotionally involved with the game and less aware of the real world. Game construction is the main barrier for engrossment.

- **Total immersion**: is defined as the highest level of involvement; it is rare and hard to sustain. As described by Brown and Cairns, in total immersion "the game is the only thing that impacts the gamer's thoughts and feelings." Barriers to total immersion are empathy and atmosphere. Atmosphere is related to aesthetics and how game elements work together to create a whole that makes sense.

Note that the experience described by Brown & Cairns does not assume that players see themselves in a different reality, as usually suggested in researches about **presence**. In the virtual reality domain, presence is usually defined as a sense of "being there." In a review on immersion, engagement, and presence, for example, McMahan (2003) introduces Lombard and Ditton's definition of presence: "the artificial sense that a user has in a virtual environment that the environment is unmediated." That is, users experience presence when they believe they are no longer in the real world, but in a different world. According to McMaham, six factors contribute to presence: quality of social interaction; the effect of "transportation"; realism in the environment (graphics, sound, etc.); the degree of immersiveness generated by the interface; the user's ability to impact the environment and the social impact of what occurs in the environment; and users responding to the computer as an intelligent social agent. As such factors become more like the real world, users become more capable of experiencing presence, and this is what is called the "perceptual illusion of nonmediation" (McMahan, 2003).

Getting into a debate on whether a virtual environment can or cannot perfectly mimic the real world is not concern here. In regard to games, Lemarchand (2012) points out that it is unlikely that players would want to forget where they are and believe that they are actually facing the risks of the main characters in video games. In addition, I argue that even if players could experience "presence" while playing a game, imagining that they are in a new world, that experience would not be analogous to the immersive experience as previously suggested (Brown & Cairns, 2004). Being immersed in a game has more to do with being cognitively and emotionally captivated by a game than it has to do with being transported to somewhere else. What I want to clarify is that, in my dissertation, I see the phenomena of presence and immersion as separate phenomena. For example, I believe that performing a boring task in a well-designed virtual world could result in perceptual presence, but not necessarily in engagement or immersion. By

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the same token, games with poor graphics or abstract worlds (e.g. Tetris) may not elicit presence, and yet be engaging (Jennett et al., 2008).

As pointed out, some researchers compare **total immersion** to the **flow state** (Cox et al., 2012). Flow is described as an optimal experience, a state in which someone is involved in an activity to the extent that nothing else matters (Csikszentmihalyi, 1990). It is usually followed by a sense of enjoyment and personal growth, although such "experiences are not necessarily pleasant at the time they occur" (Csikszentmihalyi, p.3). As defined by Csikszentmihalyi, the flow experience (or the "phenomenology of enjoyment") is built upon eight factors:

- **A doable task**: a given activity should be challenging, but the person performing the activity should have enough skills to complete the task.

- **Concentration**: attention is completely focused on the activity, which becomes spontaneous (but not necessarily effortless). Person and activity become one.

- **Goals**: usually set by the activity (clear goals), but sometimes by the person (internal guidelines). Someone may start a game without knowing its goals, but "develop a strong personal sense of what she intends to do" (ibid., p.55)

- **Feedback**: should be immediate and related to the goals.

- **Loss of awareness of everyday life**: because attention is on the task, no spare attention is left for other thoughts or activities. The surroundings also "disappear."

- **Control over actions**: defined "more precisely, as lacking the sense of worry about losing control" (Csikszentmihalyi, p.59). This factor is related to the "possibility, rather than the actuality, of control" (Csikszentmihalyi, p.60).

- **Lack of self-consciousness**: the person stops preoccupying with him/herself and deeply engages in the activity. There is a "loss of consciousness of the self" (Csikszentmihalyi, p.60).

- **Distortion of time**: the sense of time differs from that we normally perceive in ordinary activities.

A fundamental idea of flow is that if a task is too challenging, the person will become anxious; and, if challenge is low for someone's skills, the person will become bored. Therefore, one reaches flow when in a perfect state: the offered challenge matches one's skills. As noticed, flow and immersion have similar characteristics and

some researchers suggest that **flow** and **total immersion** are comparable experiences. A major difference is that flow is not seen as a graded experience and immersion is.

As engagement and immersion are so important to the success of a game, one of the goals of game designers is to create engaging products that both attract and hold players' attention until they are totally immersed. Lemarchand (2012), for example, proposes that games do so through three fundamental elements: aesthetics, narrative (or social aspects), and gameplay (or game systems). According to his assumptions, game aesthetics is the best way to attract players' attention, but it is gameplay that does a better job on holding players' attention for long periods of time. Similarly, Ermi & Mäyrä (2005) see "immersion is a many-faceted phenomenon with different aspects that can appear and be emphasized differently in the individual cases of different games and players" (p.7). According to their gameplay experience model, the SCI-model, games immerse players through audiovisual features (sensory immersion), interactions (challenge-based immersion related to physical/motor and mental challenges), and characters, stories and worlds in which the game takes place (imaginative immersion).

Lemarchand's and Ermi & Mäyrä's works aptly describe game design areas that affect immersion in games. However, more research is needed to elucidate how the manipulation of specific objects in a game affects players' immersion. Immersion, as previously argued, can be disrupted if the game building blocks do not allow players to smoothly interact with the game. Wayfinding (or navigation) plays an important role in keeping players immersed for two main reasons: first, navigation is a basic interaction in itself, so it should be well planned; second, navigation is what is in between players and the accomplishment of their next goal (e.g., players need to navigate from A to B in order to collect a key). Wayfinding cues should successfully guide players through the game world, but also challenge them. If wayfinding is too easy, players will get bored. If wayfinding is too hard, players will get frustrated. But how do players respond to cues? Do they enjoy being guided through the game? Do they like the way the information is presented? Exploring these is fundamental to help designers make informed design decisions, better shaping game interactions and experiences.

Chapter 3.

Research design

I am aware that many AAA games on the market already allow players to customize their games by turning wayfinding cues on and off. However, it is still unclear exactly how those cues affect gameplay and the user experience. More investigation is needed on what players' difficulties and preferences are, so game designers can make informed decisions in the design phase. The focus of my work is to investigate how changes in visual wayfinding cues affect players' in-game behavior and their subjective experience. Therefore, my research is not only grounded on what players do during gameplay but also on what they disclose in interviews and questionnaires. My goal is to develop an understanding of how to design wayfinding systems that improve game interactions and the gaming experience. I started with the following research questions:

1. How do different types of wayfinding cues affect players' wayfinding behavior in 3D action-adventure games? (RQ1)
2. How do different types of wayfinding cues affect players' involvement with 3D action-adventure games? (RQ2)

The rationale behind my choice of looking at both angles is that I believe a single perspective would provide a limited view of the effects of wayfinding cues on the gaming experience. From a theoretical and practical understanding of game-user interaction, it is reasonable to expect that players will alter their in-game behavior (interactions) and consequently their attitude towards a given game depending on how effortlessly or strenuously it is for them to notice and interpret wayfinding cues. That is, one may expect that different wayfinding cues have the potential to change the difficulty level of wayfinding tasks, as those cues will require more or less cognitive effort from players. As a result, both players' in-game behavior and players' attitude towards said game will be affected.

To explore those assumptions and research questions, I made two fundamental decisions in my research. First, I opted for a **mixed method approach** (Figure 3.1) where both quantitative and qualitative data informed my conclusions. The pragmatist perspective is appropriate here as mixed methods "is both practical and intuitive in that it helps offer multiple ways of viewing problems – something found in everyday living" (Creswell & Clark, 2010, p.17).

Second, I opted for a **research through design** (Forlizzi, DiSalvo, Bardzell, Koskinen, & Wensveen, 2011; Gaver, 2012; J. Zimmerman, Forlizzi, & Evenson, 2007; J. Zimmerman, Stolterman, & Forlizzi, 2010) where I designed my own research tools (i.e., games) to investigate player wayfinding behavior and the player experience.

I decided to design my own research tools because I needed both a controlled environment that would allow me to properly investigate my research topic (thus addressing concerns with internal validity) and game environments that were complex enough to mimic commercial games (thus addressing concerns with ecological validity). Although designing my own games made this research more complex, complexity is usually necessary in design research (Forlizzi et al., 2011; Gaver, 2012), and especially games research. That is not to say that this work focused on design lessons alone. In fact, I greatly focused on the user. Nonetheless, I sought to better understand users through their interactions with specific artifacts.

I relied on several sources to design my research tools. For example, from my previous analysis of video games, I developed an understanding of how wayfinding cues are applied in games (i.e., game context) and how other important game building blocks (e.g., game spatial layout, puzzles, enemies) can be combined in video games. Also, my analysis allowed me to extend my previous work (Moura, 2007) by identifying advantages and drawbacks of adding specific wayfinding cues into action-adventure games (Moura & Seif El-nasr, 2014). This phase was important because it helped me to conjecture about players' reactions to wayfinding cues. In parallel, I reviewed the literature searching for design lessons, user models, and theories that could both guide me during the game design process, and help me define operational variables for my studies. In addition, that phase allowed me to make conjectures on how wayfinding cues

affect gameplay and players' involvement within games. In short, my experience as a researcher and as a gamer enabled me to design and develop the research tools for Studies 1 and 2.

In the next sections I further explain my research approach and decisions.

3.1. Strategy of inquiry

As illustrated in Figure 3.1, due to the practical nature of my problem, and most research problems in human-computer interaction, I opted for a mixed methods multiphase design.
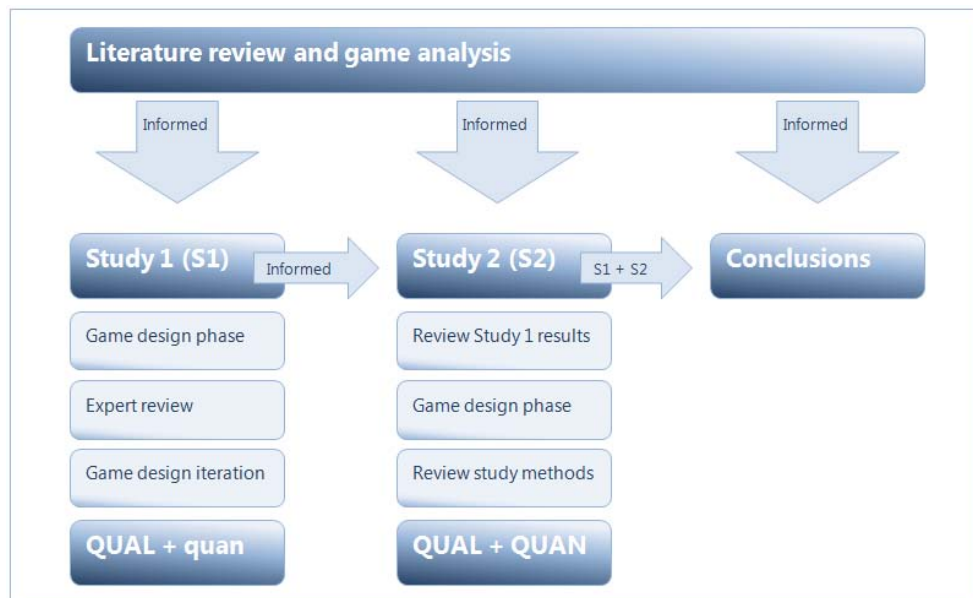
Figure 3.1.   Multiphase mixed method design diagram

The mixed methods approach leans towards the pragmatist paradigm and grants a better understanding of the phenomenon under investigation. According to Creswell (2009), pragmatists "do not see the world as an absolute unity" and they believe that "truth is what works at the time" (p.11), making them free to choose the most suitable methods for tackling their research problems. In this sense, mixed methods researchers draw from quantitative and qualitative approaches for collecting, analyzing, and interpreting data as soon as those approaches meet their needs and purposes. They

believe all methods have strengths and limitations and converging or triangulating data coming from different assumptions is the best way to account for potential biases of those methods while taking advantage of their strengths; quantitative and qualitative methods thus complement each other.

The pragmatist perspective is suitable for research through design, as design is by nature "a discipline that approaches problems holistically, simultaneously and iteratively discovering and intervening upon interconnected material, social, experiential, and technical phenomena" (Forlizzi, DiSalvo, Bardzell, Koskinen, & Wensveen, 2011, p.824). Thus, relying on both quantitative and qualitative strands can certainly help researchers to better understand complex phenomena. In addition, that pragmatist view allows researchers to rely on less traditional methods than the ones applied in the game industry (Isbister & Schaffer, 2008) and adopted in this research.

The mixed methods multiphase design consisted of two distinct studies where I used concurrent mixed methods strategies, collecting and analyzing quantitative and qualitative data in both studies. As explained by Creswell (2009), "the quantitative data addresses the outcomes expected from the treatment while the qualitative data explores the processes experienced by individuals in the treatment groups."

I employed a multiphase design because a single study would not be enough to unpack the intricacies of my research questions, especially because there is a lack of theories explaining many of the variables involved in wayfinding in video games. Thus, the first study was exploratory and I investigated how players responded to a variety of wayfinding cues in an action-adventure game. The second study followed the between-groups design procedures. It had three conditions with different wayfinding cues applied to each condition.

3.2. Procedures

The overall procedures of both studies were roughly the same where participants were welcomed by the researcher, filled out a demographics questionnaire, and were left alone in the experimental room to play the game and fill out the Immersive Experience

Questionnaire after they finished the gaming session. The researcher then met the players in the experimental room for the cued recall debrief. Participants talked about their experiences playing the game. Chapters 5 and 7 detail the procedures and apparatus in Studies 1 and 2 respectively.

3.3. Data collection

3.3.1. Questionnaires

Demographic information questionnaire

The pre-interaction questionnaire was adapted from Joorabchi & El-Nasr (2011) and can be found in Appendix A. It asked basic demographic questions, players' gaming preferences and gaming habits.

Immersive experience questionnaire (IEQ)

The Immersive Experience Questionnaire (Appendix B) (Jennett et al., 2008) gathers quantitative data about players' experience with games. Based on the theory of immersion proposed by Brown & Cairns (2004), Jennett et al. (2008) envisioned that immersion could be quantified in a systematic way because it is a graded experience, noticeably affected by several game-related and player-related factors. With this goal in mind, they developed and validated the Immersive Experience Questionnaire (IEQ), borrowing not only from Brown and Cairns' work but also from previous work on flow, presence, and cognitive absorption.

They developed the questionnaire through a series of experiments, proposing that game immersion covers five factors: cognitive involvement, emotional involvement, real world dissociation, challenge and control. The first three factors are related to the players, while the two last factors are offered by the game, but will be affected by players' skills. The final version of the IEQ consists of 31 items distributed across these five themes. Items are presented to players as a seven-point Likert scale. Moreover, a final question is added at the end so participants can rate on a 1-10 scale how immersed they were at the end of a game. Such final score can be correlated against the IEQ

immersive score for reliability. One of the reasons why the IEQ is suitable for this research is that, unlike previous studies in presence, flow and cognitive absorption, the IEQ exclusively focuses on the gameplay experience, whereas other questionnaires deal with more generic experiences (Jennett et al., 2008).

3.3.2. Cued recall debrief

Subjective data was collected through cued-recall debrief (Bentley, Johnston, & von Baggo, 2005) where participants explained what disrupted and/or improved their gaming experience while relying on visual stimuli.

Note that I used screenshots of each level as visual stimuli in Study 1, but I switched to video recordings in Study 2, as videos are richer visual stimuli and players could follow the sequence of actions in the game. It is also important to note that players did not watch the video in its entirety, as I skipped to the next level as soon as enough information had been provided. I needed to do so because of time constraints.

Debriefing sessions were audio recorded and transcribed for analysis. Transcripts were coded based on the essence of partial or full sentences, or even paragraphs. Any meaningful information related to each research question was seen as a potential code. After being defined, codes were revisited and grouped into major themes. This was done by hand for Study 1. As a higher number of participants took part in the second study, I used the qualitative data analysis software NVivo.

3.3.3. Observation and video recording

I observed all the play sessions (from a second monitor outside the study room) and took unsystematic notes on players' in-game behavior. Observation notes were not fully analyzed but visited when I wanted to cross-check subjective data from participants to what I observed in a given play session. Note that this research would benefit from a more systematic note taking procedure. In addition, I video recorded all play sessions. Again, I did not intend to do video analysis, due to the number of participants; however, video recordings were available to debug the process if necessary.

3.3.4. Time on task

Time on task was calculated either through videos (Study 1) or through telemetry data (Study 2) – see Chapters 5 and 7 for details on task completion time was collected in Studies 1 and 2 respectively.

3.4. Data analysis

3.4.1. Questionnaires

Demographic information questionnaire

The pre-interaction questionnaire was mostly used to verify whether participants would fit the profile: action-adventure gamers, knowledgeable about games. I looked at distributions for several metrics.

Immersive experience questionnaire (IEQ)

I analyzed the data from the IEQ using descriptive and inferential statistics. Note that I only used inferential statistics in Study 2, as that was a between-group design. Study 1 was an exploratory study, and I only used the IEQ to find out whether The Lost Island was thought to be engaging since it was the foundation of my second study.

3.4.2. Cued recall debrief

I did a thematic analysis (Braun & Clarke, 2006) on transcripts of post-experimental cued-recall debrief data to understand how the wayfinding cues (and other factors raised by players) affected players' wayfinding decisions. To do so, I followed the steps suggested by Braun and Clarke (2006).

Table 3.1   Phases of thematic analysis

Phases	Description of the process
1. Familiarizing yourself with your data	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.

Phases	Description of the process
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic "map" of the analysis.
5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the reports	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Note. Extracted from (Braun & Clarke, 2006).

Due to the complexity of Study 2, I used NVivo to analyze data from the cued-recall debrief. Also, a second coder worked on the data for inter-rater reliability.

3.4.3. Time on task

I reported the total gameplay time in Study 1 just to give the reader an idea of how players performed based on their level of expertise. In Study 2, I analyzed time on task using descriptive and inferential statistics.

3.5. Validity and reliability

I discuss procedures to enforce and verify validity differences in quantitative and qualitative research (Creswell, 2009; Creswell & Clark, 2011). To the authors, there is an ongoing debate on how validity and reliability should be addressed in mixed methods research because researchers usually need to reconcile quantitative and qualitative strands while staying true to the pragmatist paradigm – and not biased towards the post-positivist or constructivist worldview.

According to Creswell & Clark (2011), validity is concerned with the quality of the collected data, the results, and the researcher's interpretation. There are several

procedures that researchers should take to ensure validity and reliability in their work as discussed below.

3.5.1. Construct validity

According to Evans & Rooney (2011), construct validity refers to a "measure that truly reflects the theoretical construct" (p.391). In their discussion on games research validity, Ravaja & Kivikangas (2009) point out that some constructs "(e.g., emotion or attention), must be differentiated from their measures or ways to identify them. Unlike measures, constructs are always hypothetical and not directly observable" (p.407). The authors also borrow from Campbell & Fiske's work and explain that "(e)valuation of construct validity requires examining the correlation of the target measure with variables that are known to be correlated to the construct purportedly measured by the target measure or for which there are theoretical grounds for expecting it to be related" (p.407).

Given the state of the art in game research, one may argue that it is difficult to "measure" constructs like "fun" or the "player experience." Nonetheless, it is possible to collect information from different sources for deeper investigation around those constructs. I collected data from multiple sources (surveys, observation, telemetry, videos, and cue recall debrief) to be able to triangulate and compare data from those sources thus addressing concerns with construct validity and reliability in my research. Also, the questionnaires used in this research (demographics and the IEQ) were validated in previous research, as already pointed out. Finally, the cued recall debrief also offered construct validity evidence, as participants either watched their own play sessions or looked at screenshots for each level to be able to explain what happened in the game. As Creswell & Clark (2011) explain, convergent design (my research approach) "is used when the researcher wants to triangulate the methods by directly comparing and contrasting quantitative statistical results with qualitative findings for corroboration and validation purposes" (p.77).

3.5.2. Internal validity

Internal validity is concerned with the researchers' ability to establish a causal relationship between variables. I took the following steps to minimize threats to internal validity in this study. First, I designed my own research tools or games to only manipulate the variables of interest, trying to avoid cofounding variables. In addition, I was able to design games that emphasized my area of investigation by reducing the number of activities unrelated to wayfinding. In addition, participants were left alone to both play the game and fill out the questionnaires in order to avoid that my presence in the room influenced participants' gaming experience (Hawthorne effect). While I am aware that one cannot truly mitigate the Hawthorne effect in lab studies, I believe that staying in the room and "looking over one's shoulder" would have greater impact on their experiences than observing them from a second monitor – especially because I was observing their in-game behavior, but not the participants themselves. Finally, in Study 2, participants were assigned to each condition in a way that I tried to have the same number of female players and more/less experienced players in each condition.

3.5.3. External validity

There is a debate on what generalizability means, or should mean, in the context of games research. For example, Shapiro & Peña (2009) define generalizability as "the ability to say something that goes beyond the particular" (p.389). The authors defend that external validity in the field of games should not be as strict as it is in post-positivist research. They continue by explaining that "parameter estimation is not critical to every investigation of digital games, and focusing on a statistical definition of generalizability is problematic and may lead to lost opportunities for understanding digital game phenomena in at least a couple of ways" (p.390).

Ravaja & Kivikangas (2009), on the other hand, define external validity as the extent to which a finding can be "generalized across different experimental settings, procedures, participants, or time" (p.405). To the authors, external validity should be a fundamental concern in applied research in games, as a researcher "certainly wishes to apply the results to the other persons and to other games" (p.406).

Ravaja & Kivikangas' concerns are legitimate and I agree that one must always consider how game research can inform game researchers and designers; however, I tend to agree with Shapiro & Peña when they explain that the standard post-positivist view of generalizability may be harmful to games research. The design community has also questioned whether generalizability should be used as a metric for measuring research quality (Forlizzi et al., 2011; Gaver, 2012). Gaver, for example, tends to choose plurality over consensus. And, as Fulton (2002) explains, "[t]heory may help designers begin to ask the more pertinent questions, but no theory will tell you exactly how often a player should level up in three hours of play in a particular RPG game."

This research values quantitative and qualitative data, but it does not aim for statistical generalizability for two main reasons: first, time on task and the immersive experience questionnaire data are not considered in isolation, as they could be in post-positivist approaches. My quantitative measures complement my qualitative findings and vice versa. Second, as research on wayfinding and players' involvement is a new and intricate topic, there are many factors that have not been fully understood yet. Therefore, overall, I am taking a more exploratory approach thus aligning my research to a broader definition of external validity as proposed by Shapiro & Peña (2009).

To address concerns with external validity, I took the following steps: first, I designed research tools that resembled commercial games in terms of quality of graphics, music, and, more importantly, wayfinding tasks and wayfinding cues. That is, the tasks and cues included in the game are frequently seen in other commercial games. Second, I recruited action-adventure gamers to make sure that the participants were actually part of the intended audience of that type of game. Finally, as already explained, I left participants to play alone in the gaming room not to influence their experience. These steps address concerns with both external and ecological validity.

3.5.4. Reliability

Once again, reliability is more of a concern for quantitative researches than for qualitative works. As Creswell & Clark (2011) explain, "Reliability plays a minor role in

qualitative research and relates primarily to the reliability of multiple coders on a team to reach agreement on coders for passages in text" (p.211).

To address reliability, I describe, in great detail, my design choices and research procedures to allow other researchers to repeat the steps followed in this research. In addition, in my results, I frequently cite the raw data to explain my findings in the hope that I am providing detailed evidence of how I drew my conclusions.

Also, in my second study, I had a second coder working on cued recall debrief data to verify whether we would reach agreement on research findings.

3.6. Prototypes

As pointed out, I designed an action-adventure game for each study. They encompassed a variety of game spaces and wayfinding tasks supported by one or several wayfinding cues added to those spaces. I chose to design my own research tools, instead of using commercial games, because, as a researcher, I wanted to have control over the tool being tested by participants. For example, I had control over the size and layout of each space, the number and quality of the proposed wayfinding tasks, the wayfinding cues added to each space, the number of cut scenes in the game, and the complexity of the controls (i.e., button combination during gameplay), just to name a few. Such design decisions are particularly important in lab studies when a researcher needs to deal with time constraints and scope of the research. In addition, had I used a game previously released on the marked as a research tool, I would not have been able to modify the wayfinding cues, creating the different conditions seen in my second study.

Although those games were specifically designed for my research, they were inspired by commercial titles and crafted to resemble those in terms of graphics, visual effects, wayfinding tasks, wayfinding cues, and so on. I was particularly concerned with creating an appropriate research tool for this work because many game studies lack ecological validity as games used in experimental settings are usually simplified versions of games found on the market. The final versions of my research tools were sufficiently complex and thus suitable for my investigation.

As pointed out, my first study was exploratory given that there were few similar studies that could inform this research. Most works on the topic focus on either design practices purely based on design lore and thus lacking empirical evidence or experimental studies lacking ecological validity (as already discussed). To conduct this study, I designed an action-adventure game (The Lost Island) on Game Globe, an online game engine developed by Square Enix, in order to manipulate and control wayfinding tasks and wayfinding cues for in my study.

Based on the results of my first study, I designed a second game/research tool (A Warrior's Story) on Project Spark, a game engine developed by Microsoft. I switched to Project Spark for two main reasons: 1. Game Globe's developers shut down the service and all users lost access to their games, and 2. Project Spark had even more flexibility in terms of what you can control in a game (e.g., sound and visual effects, enemy behavior, and game logic). Unlikely the first study, which was heavily exploratory, this second study was more experimental in nature. Wayfinding cues were grouped into three different categories: Attentional cues, Representational cues, and Textual cues. These categories worked as my independent variables and they were applied into the action-adventure game designed on Project Spark.

As a result of Study 1, I also slightly changed my methodological procedures by adjusting the way participants were selected, including a cued recall debrief at the end of the study to collect qualitative data (see Chapter 6), and changing game controllers from mouse and keyboard to an Xbox controller.

Chapters 4 and 6 describe the design rationale, design process, and wayfinding cues applied to both games (The Lost Island and A Warrior's story).

Methodological details of both studies can be found in Chapters 5 and 7: specific research questions and expectation guiding the studies, participants, materials and apparatus, procedures, data collection, and data analysis.

Chapter 4.

Prototype 1: The Lost Island

This chapter describes the motivations and design process of The Lost Island, the game (i.e., research tool) created for my first study. As explained in the previous chapter, this was an exploratory study, which started with many open questions and hardy any predictions on how players would respond to the wayfinding cues in the game. This study was crucial to create a baseline for what to expect in my second study, a more controlled and extensive study than the first one. On a high level, my first study was led by the following research questions:

- How do wayfinding cues affect players' in-game behavior in 3D action-adventure games?
- How do wayfinding cues affect players' attitude towards 3D action-adventure games?

I sought to find out whether – and if so, how – wayfinding cues would affect players' decisions of where to go and what to do in specific areas of the game. Also, I wanted to find out whether those cues would change what players thought of their experiences. For example, would players perceive a game as more or less enjoyable based on the wayfinding cues guiding them from a space to another? With those motivation and questions in mind, I designed The Lost Island.

4.1. Design goals and requirements

One of the first challenges of this research was to find the appropriate 3D action-adventure game that would allow me to investigate my research question without jeopardizing the quality of my results. The said game needed to contain a great variety of wayfinding cue types (e.g., Markers, Guided tours) and representative wayfinding

tasks. At the same time, the game needed to be shorter than AAA games (even though it needed to be complex enough) to allow participants to finish the game in a reasonable amount of time. The solution was to design my own research tool.

4.2. Target audience

The game was designed for action-adventure players of any expertise. The idea was to find out how players with different levels of expertise would respond to wayfinding cues, given that they typically enjoyed action-adventure games.

4.3. The design of The Lost Island

4.3.1.   Concept phase

I started by listing common wayfinding cues and tasks found in action-adventure games. Those games usually use strategies to push and pull players from place to place to collect objects and/or interact with other characters (friend or foe). I was mostly inspired by games like the Prince of Persia (Ubisoft) and Tomb Raider (Eidos/Square Enix) series. Games like Kya (Eden Game) and Maximo vs. Army of Zin (Capcom) also greatly influenced my work.

As tasks and cued were defined, I also sketched an overview of the map. Then I started to actually develop the game using a web engine called GameGlobe (Square Enix). I chose that platform because of its flexibility; users have access to high quality graphics and specific building blocks to create 3D spaces that resemble commercial AAA games (Figure 4.1). As I developed the game, I made a few changes on the map, tasks, and cues. It was an iterative process in which I frequently tested and modified the game up until the game played well (purely based on my experience as a gamer).
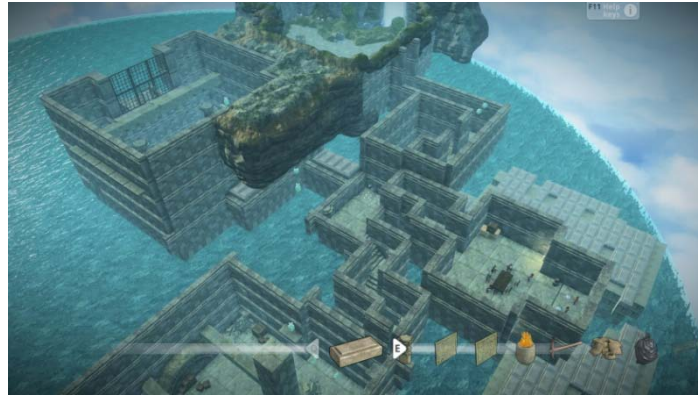
Figure 4.1 **GameGlobe editor: The Lost Island in development; some building blocks at the bottom right**

When the game was ready, two game designers and two expert gamers tested it and reviewed my design. The reviewers played the game separately: one at a time. I modified the game after each participant gave feedback on it. That is, the second reviewer played a slightly different version of the game than the version the first reviewer played, and so on. The game was only considered ready for the study after the last tester reported that it was easy for him to know where to go. That was confirmed by comparing testers' performances, comparing where the first participants took considerably longer to finish the game than the last one.

Figure 4.2 **Schematic view of the first three levels of The Lost Island. The bottom left side of the image shows the starting point. Players then go to the Maze (right) and backtrack. Then, players go to the Climbing space (top left). Key objects and cues are highlighted**

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The game had a variety of wayfinding challenges in six major spaces: Starting point, Maze, Climbing space, Waterfall area, Exit room, and Outdoors. To finish the game, players needed to explore the environment, jump onto platforms to solve environmental puzzles, defeat pirates, find hidden keys and levers, and explore the environment. The next sections detail each level of The Lost Island.

4.3.2.   Starting point

The game started with the main character waking up and noticing that he was locked in a small room with a friend. Pirates had hijacked a Caribbean cruise, enslaving all the people in that island. The player was then instructed to escape from the island and save all his friends. More specifically they were informed they needed to find a lever to open that first door. Those **instructions** were the main cues in this space.

Players started the game in a dungeon and needed to open a locked door (Figure 4.3b) in order to escape. To do so, they needed to overcome a Maze.

(a)   (b)

Figure 4.3   (a) Top view of the Starting space seen from the editor. (b) Screenshot of actual gameplay: the player needs to find a way of opening a locked door at the start of the game

4.3.3.   Maze

The main goal for the Maze was to find the lever that would open the locked door at the Starting point. It was located at the very end of the Maze. To help players find their way, torches illuminated the path from the Maze's entrance to the lever. In addition, as players switched the lever a subtitle informed them they had accomplished their goal.

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Players then needed to backtrack to the starting point. Note that chests were placed at specific locations and players could explore the space to collect rewards. Those collectibles, however, were not necessary for player progress; they were purely cosmetic. Both the **torches** and the feedback through the **Guided Tour** were the main wayfinding cues in the Maze.

(a)

(b)

(c)
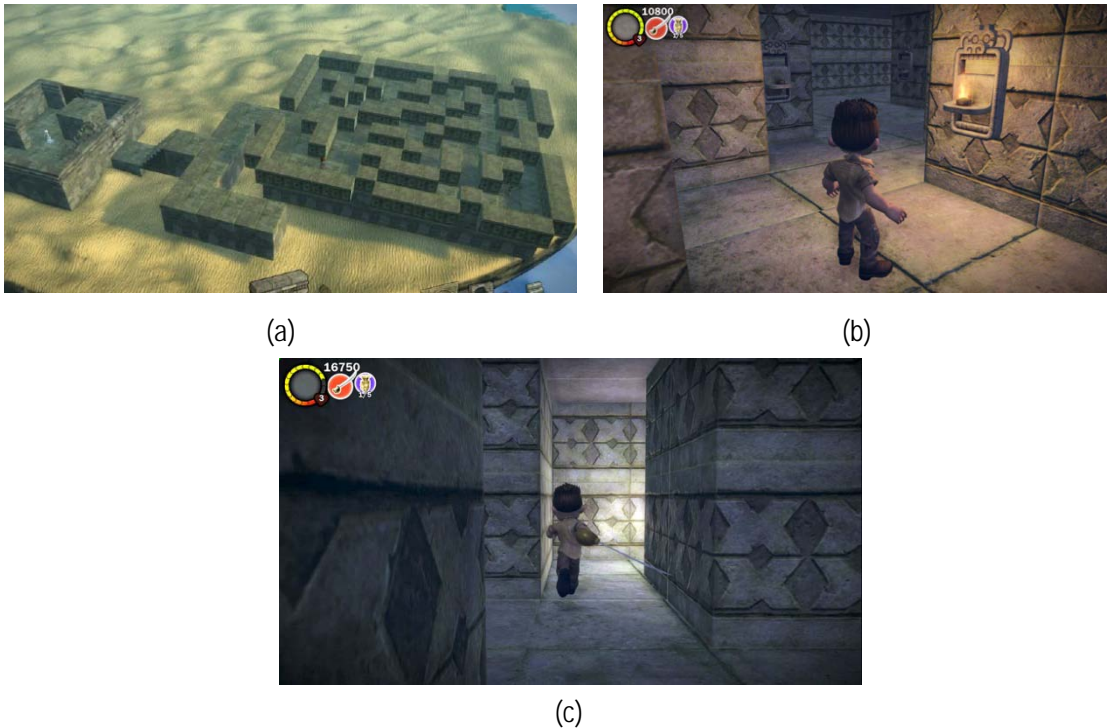
Figure 4.4   **(a) Top view of the Maze seen from the editor. (b) Screenshot of actual gameplay: torches illuminate the path towards the lever. (c) A corridor illuminated by a torch – contrast between darker and brighter areas in the Maze**

Upon reaching the Starting point again, players found the door unlocked and proceeded to the Climbing space.

4.3.4.   Climbing space

This space was a vertical puzzle where players started at the bottom and needed to find their way out by jumping onto platforms and reaching a small door. Shiny pickup items were placed on some platforms to draw players' attention to those paths.

However, to increase the challenge, no wayfinding cues were placed on the very first platform, a small platform located on the side of a pillar (Figure 4.5a).

Players also needed to find a lever to that would bring in a platform, allowing players to reach the final step to the exit. After switching the lever, a Guided Tour (cut scene) showed players the platform coming out, revealing where they needed to go. **Pickup items**, the **Guided Tour** and the **Lever** itself were key wayfinding cues in this area. Other than that, players needed to pay close attention to the environmental layout since most objects had similar colors and textures.

(a)   (b)

(c)

Figure 4.5   **(a) Climbing space in development seen from the editor. (b) Top view of the Climbing space; pickup items were placed on platforms. (c) Players got in through the door at the bottom right and needed to get out through the door at the upper right. To do so, they needed to climb up and switch a lever (center)**

Upon reaching the Climbing space's exit, players could choose between three doors as shown in Figure 4.6: the door on the right would take them to a dead end, with only enemies and a collectible in that room. The door at the center led players to a

garden-like area with no ceiling, quite a few plants, and a waterfall. Finally, the door on the left side took players to a second vertical puzzle (i.e., Exit room).
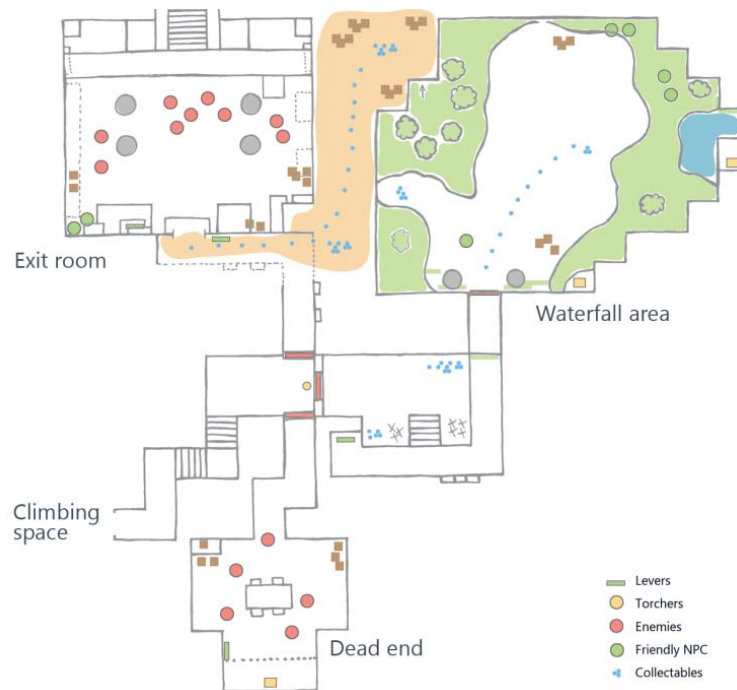
Figure 4.6   Schematic view of the dead end (bottom), Waterfall area (top right) and Exit space (top left). Note that the Waterfall area and Exit space are linked through a secret passage (peach-orange area on the map)

4.3.5.   Waterfall area

This space was meant to be comforting and peaceful:

- No enemies were added to this area; instead, players found friendly NPCs.

- Players could see a bright sunny sky for the first time in the game.

- The space also had a lot of vegetation, a pool and a waterfall.

The main goal in this room was to find a key located behind the waterfall. Players needed the key because it opened the gate that would free players from the dungeon, letting them go outside. Four major wayfinding cues were added to this space:

- An NPC was placed near the entrance and, if approached, he would let players know that there was a key in the space. Players had a view of the player as soon as they reached the door (Figure 4.7a/b).

- Shiny pickup items drew a path from the entrance to near the waterfall.

- Vines were attached to the wall around the waterfall area. Those vines were similar to the ones players had already been taught how to climb when they were finding their way to this space (tutorial in Figure 4.7a).

- A visual effect, similar to fireflies, was added around the vines to attract players' attention to those vines (Figure 4.7c).

(a)

(b)

(c)

(d)

Figure 4.7   **(a) Tutorial just before the Waterfall area, teaching players they could climb vines. (b) Top view of the Waterfall area showing the entrance, NPC near the door, and pickup items leading to the waterfall (editor view). (c) Fireflies around the vines near the waterfall (key is behind the waterfall). (d) Vegetation hiding the entrance to the secret passage in the back of the room**

In addition to the key, players could find a secret passage to the Exit room (i.e., the final space in the dungeon). The advantage of finding that passage was that players start halfway through the vertical puzzle in the Exit room (instead of starting the puzzle from the very bottom). Vegetation was added around the entrance to block the view of the secret passage so players would need to explore the space to find that path. Note that players could still finish the dungeon even if they could not find the passage.

Upon finishing the Waterfall area, players were ready to move on to the final room of the dungeon.

4.3.6.   Exit room

The idea of this space was to create a vertical puzzle where players needed to, once again, find the right platforms to climb all the way up (similar to what they had done in the Climbing space). However, this puzzle was more difficult than the Climbing space, as platforms blended in with the environment, jumps were more challenging, and some platforms were very narrow.

(a)   (b)

(c)   (d)
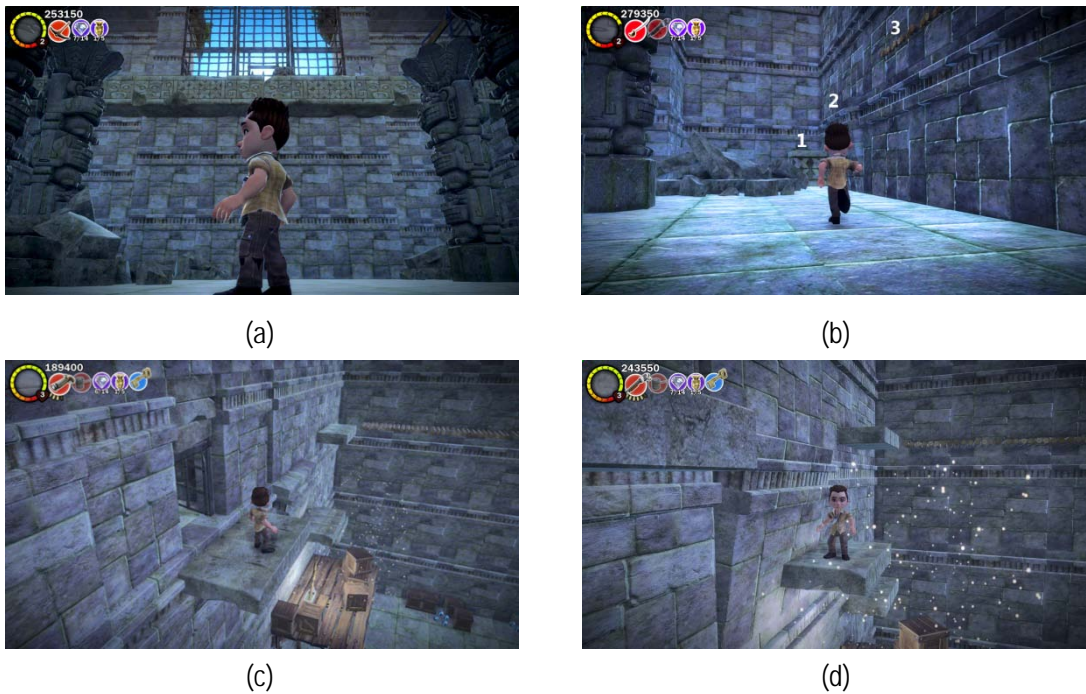
Figure 4.8   (a) Players needed to escape from the Exit room through a gate in the upper area. (b) At the start, players needed to jump on several platforms around the room. This image highlights the first three platforms. (c) Players then needed to go down one level to switch a lever. On the left side of the character is the exit from the secret passage. (d) A visual effect, similar to fireflies, was added around the lever to attract players' attention to that area. The lever activated a last set of platforms (background) connecting the player to the exit

Upon reaching this room, players saw a Guided Tour (cut scene) showing the exit of the room (highest platform in the space, Figure 4.8a). Players then needed to

figure out how to climb up to that area. Players needed to do the following: turn right and jump on a small platform in the back of the room and then onto a second platform close by. A new set of platforms would show up and players needed to use them to keep climbing (Figure 4.8b). At some point, players needed to actually notice a lever on a platform one level below them. That lever would activate the last set of platforms, leading to the exit of the space.

Note that if players entered the Exit room through the secret path, they would appear right above the lever. They would only skip the part of the puzzle described in Figure 4.8b. That part of the puzzle was tricky because there was no wayfinding cue indicating that players needed to jump on the first platform. In addition, entering through the secret path would make players avoid viewing the Guided Tour showing the exit and fighting enemies in that room. The cues in this space were the **Guided Tour**, the **fireflies** and **lighting** effects around the lever, and **instructions** from NPCs that let players know that they needed to start from "across the room." I made this hint vague to let players explore the environment by themselves.

Finally, if players reached the gate that gave access to the outside area without the key from the Waterfall area, they would see a note informing them they needed to find a key (Figure 4.9). Players could take an elevator down (and up again) to avoid the vertical puzzle.

Figure 4.9   **Note informing players they needed a key. The elevator is on the right side**

If the player had the key, however, they could leave the dungeon and explore the outside area.

4.3.7.   Outdoors

Players needed to find two keys in order to open a final gate, meet their friends by the beach, and finish the game. The area was jungle-like, full of trees and other plants. Some enemies were in the environment as well, to increase the challenge of the game.

The outdoor area did not have many cues attracting players to far away locations. My goal for that space was to find out what players would do in completely open environments. Nonetheless, a few cues could be seen once players got closer to the keys:

- **Fireflies** highlighted the entrance to an underground area where the first key was located (Figure 4.11c).
- After finding the way to climb a mountain, players could find a **note** informing them that a second key was nearby (Figure 4.11d).
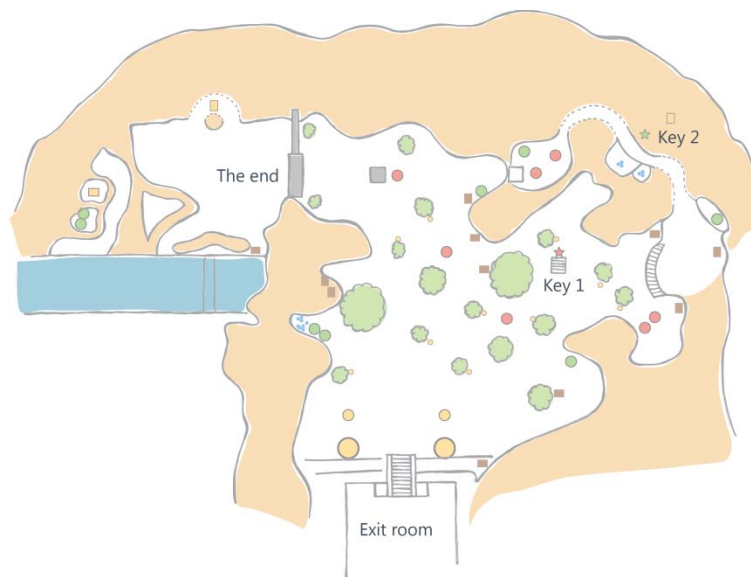
Figure 4.10   Schematic view of the outdoor area. Players needed to locate two keys. The first one was in a small room underground. The second one was in a mountain on the right side of the area. The end of the game is on the left side of the map

(a)

(b)

(c)

(d)

Figure 4.11   **(a) Players had a lot to explore in the outdoor area. (b) View of the outside area as soon as players left the dungeon. (c) Entrance to the underground area leading to the first key. Note that the entrance is hidden around the vegetation. The fireflies effect is very subtle. (d) A visual effect, similar to fireflies was added around the lever to attract players' attention to that area. The lever activated a last set of platforms (background) connecting the player to the exit**

Chapter 5.

Study 1: The Lost Island

5.1. Methodology

The focus of this exploratory study was to investigate how players responded to wayfinding cues in an action-adventure game. Since I wanted to identify players' needs and expectations on wayfinding cues, I prioritized qualitative over quantitative data, mostly relying on data from the cued recall debrief. Nonetheless, quantitative data contextualized my findings and helped to explain participants'' observations. Such findings were then used to inform my second study.

This study was partially published at CHI 2014, Extended Abstract: Investigating players' responses to wayfinding cues in 3D video games (Moura & Bartram, 2014).

5.2. Participants

Participants were recruited through email to professors from the School of Interactive Art and Technology (SIAT) and word of mouth. The main criterion was that participants needed to be active gamers and enjoy action-adventure games. Participants directly contacted the researcher, who manually assigned participants to specific timeslots.

Twelve players (seven female), naïve to the purpose of this research, took part in the study. However, one participant's results were removed because he did not feel well during the play session and had to stop playing the game. Seven gamers were frequent game players (age range: 20-25 years) and four were occasional game players (age range: 21-25). All played computer games (ten also played console games).

5.3. Procedures and apparatus

I welcomed each participant and clarified the purpose of the study (without giving too much detail). After signing a consent form, the player filled out a questionnaire on demographics and was taken to a separate room to play the game. I then explained the game controls (also available on a poster attached to the wall, see Appendix C) and left the participant alone when s/he felt ready to start playing. I left the room in order to lessen the effects that the researcher's presence could have on participants. All participants played the same version of the game.

The participant sat in front of a 23" computer monitor, wearing headphones. The environment was well lit, silent, and seating was adjusted to make the participant comfortable. The participant then played the game for either one hour or until s/he reached all essential areas in the game (whichever came first). Upon reaching the last major area (which is not exactly the end of the game), a message was displayed on the screen, reminding the participant to fill out a questionnaire. Otherwise, the researcher entered the room and reminded the participant that it was time to answer the questionnaire (for those who had not reached the message after one hour of gameplay). Participants were again left alone to answer the questions. The questionnaire was displayed on a second monitor near the player; it was turned off during the play session to avoid distraction. I watched the play session by duplicating the game screen on another monitor outside the gaming room. There was also a narrow glass window in the experimental room, so I could see the participant from the outside of the room.

Lastly, I conducted a ~20-minute cued recall debrief with each player where I showed printed screenshots of The Lost Island's environments (Appendix D) to remind the participant of wayfinding tasks and challenges in the game. Then, the participant received a gift certificate and was thanked for participating.

The procedure of letting participants interact with a game and provide feedback on it is quite common in user-centered design and in the game industry specifically (Isbister & Schaffer, 2008). In traditional usability studies, five to eight participants play a game and a moderator asks questions about their playthrough. Meanwhile, an observer takes notes of specific in-game behaviors and utterances that will help researchers

identify potential interaction problems users may face with the system. Findings are used to compare designers' intents against the actual user experience. Then, designers iterate on the system (or game) based on users' feedback, and a new version of the system is tested again. I followed this user-centered design perspective in this first study. However, as explained, to avoid bias and lessen the effects of my presence in the room, I left participants to play alone while I observed them from a second monitor, outside the testing room. Questions about participants' experiences were asked afterwards. In addition, I increased the number of participants to twelve in order to gather more data, making patterns more evident and findings stronger.

5.4. Data collection and analysis

5.4.1. Questionnaires

Demographic information questionnaire

Players filled out a pre-interaction questionnaire asking basic demographic questions, players' gaming preferences, and gaming habits.

Immersive experience questionnaire (IEQ)

Participants also filled out an Immersive Experience Questionnaire (IEQ), which gathered quantitative data about their experience with the games. Note that this data was only collected because I wanted to verify the extent to which the game was considered engaging by participants.

5.4.2. Cued recall debrief

Subjective data was collected through a cued recall debrief (see Chapter 3). Screenshots of each game space (Appendix D) were shown to participants and they were encouraged to explain what disrupted or facilitated their wayfinding experiences and their expectations on wayfinding in games. When necessary, I also asked participants the reasons why they visited a place more than once, disentangling straightforward exploration from navigational issues. I also asked players to choose the

most and least difficult to navigate spaces in the game, and also about examples of games that they found pleasant (and unpleasant) to navigate through. Those sessions were audio recorded and transcribed for analysis.

5.4.3.   Observation and video recording

I observed all the play sessions (from a second monitor outside the study room) and took unsystematic notes on players' in-game behavior. Observation notes were not fully analyzed, as explained in Chapter 3. In addition, I video recorded all play sessions so video recordings were available to debug the process if necessary. Time on task was collected through video recordings.

5.5. Data analysis

In this section, I explain how the collected data was analyzed based on my research questions and the study purpose. Table 5.1 presents an outline of data collected and analysis methods based on my research questions.

Table 5.1   Summary of research questions, data collection and data analysis

Research question	Data collection	Data analysis
RQ1: How do different types of wayfinding cues affect players' performance in games?	Completion time	Descriptive statistics
• How do different types of wayfinding cues affect players' decisions of where to go and when to proceed in action-adventure games?	Cued-recall debrief	Thematic analysis
RQ2: How do different types of wayfinding cues affect players' attitude towards games?		
• How do different types of wayfinding cues improve or disrupt the player experience, making a game more or less enjoyable?	Semi-structured interview and cued-recall debrief	Thematic analysis

5.5.1.   RQ1: How do different types of wayfinding cues affect players' wayfinding behavior in 3D action-adventure games?

I documented, from video recordings, the amount of time players spent to finish the game. Also, I verified how many environments/spaces participants were able to

complete. My intent was to give some context to the qualitative portion of the collected data (participants' reports), showing how less experienced and frequent players performed in the game. To identify those players' skill level, I looked at both players' performance and answers from the demographic questionnaire.

I did a thematic analysis on transcripts of post-experimental cued-recall debrief data to understand how the wayfinding cues (and other factors raised by players) affected players' wayfinding decisions and the gaming experience. In this study, I separated comments from novice and expert players to understand the difficulties and expectations of each group.

5.5.2. How do different types of wayfinding cues affect players' attitude towards games?

To answer to this question, I mostly used cued recall debrief data. In my qualitative analysis, I focused on the following question: RQ2.a How do different types of wayfinding cues improve or disrupt the player experience, making a game more or less enjoyable? As previously mentioned, based on the exploratory nature of this first study, I gave more emphasis to the qualitative data (i.e., narrative descriptions). As before, I performed a thematic analysis (refer to Chapter 3) on transcripts of audio recordings, extracting familiar patterns or general themes based on my research questions.

I read through participants' narratives focusing on what made their experiences more positive or negative. I tried to identify specific elements that influenced participants' opinions about the game, paying attention to the context (i.e., the dynamics) in which that element improved or disrupted players' experiences.

It is important to mention that, even though players filled out the Immersive Experience Questionnaire, I only used that data to verify whether the game had been considered engaging overall, not to compare participants' scores. Had the game been poorly rated by all participants, I would have needed to consider using a commercial games to move forward with my research.

5.6. Validity and reliability

As pointed out, this first study was exploratory, mostly relying on qualitative data. Validity and reliability are extremely relevant to quantitative research, where researchers seek to establish a cause-effect relationship between variables in experimental setups, but are less of a concern in qualitative studies. Nonetheless, I took some measures to address overall concerns with the validity and reliability of this study:

- I designed my own research tool to ensure that a variety of wayfinding cues and tasks would be included in the game.
- I used a game engine that allowed the research tool to mimic the quality of commercial games.
- I described my design process in detail in case other researchers wanted to trace my steps and replicate this study.
- Participants were gamers who had experience with several gaming platforms.
- Participants were left alone to play the game thus lessening any effect my presence would have had on the participants.
- When presenting my results, I constantly cite the raw data so the reader has evidence of my findings and can better understand how I reached my conclusions.

Finally, it is important to point out that, even though all those steps were taken to improve the quality of this research, my findings and conclusions are not free of bias (as in any other qualitative research). My own experiences, as researcher, gamer, and designer, certainly shaped my analysis and results as qualitative research is subjective by nature.

5.7. Results

As mentioned, even though twelve participants played the game, one participant did not feel well during the study and I removed her/his data. The results presented here came from the remaining eleven participants. From those, six were novice to mid-experienced gamers (P01, P02, P05, P07, P08, P09) and five were experienced gamers (P03, P04, P06, P10, P11).

5.7.1. Overall performance and completion time

Play sessions last from 28'30" to 1 hour, and not all participants visited all areas of the game:

- Three players decided to stop playing the game after getting frustrated because they either died many times falling from platforms (P01–48', P08-42'26") or got lost and backtracked to the starting point (P05-46').
- Three players were stopped after 1 hour of gameplay (P02, P07, P09) and none of them had left the dungeon, so they never saw the outdoor space.
- Five participants reached all major spaces (P03-31', P04-58'50", P06-38'20", P10-28'30", P11-58'50").

5.7.2. Players responses to wayfinding and the overall game

As mentioned above, several themes were raised from the thematic analysis, as I focused on most features improving or disrupting the wayfinding experience. Since this was my first study, I found it important to understand and report on players' wayfinding experiences from a more holist perspective. Thus, while I gave priority to comments around wayfinding cues, I also identified other factors affecting players' experiences with the game and wayfinding in general. Those major factors were: player expertise, players' general expectations about games, and players' general expectation about wayfinding in general and wayfinding cues more specifically. Findings are discussed in the next sections, organized by the above mentioned topics, from broader to more specific themes.

In addition to freely reporting on their experiences with the game, participants were asked to choose the most and least difficult spaces to navigate; i.e., where they had wayfinding issues and where wayfinding was a straightforward process. I introduce more details about those spaces through the next sections, but a breakdown of those results is presented below. Note that only five players reached the outdoor area so not all players could choose that space as the easiest/hardest in the game. Also, not all players wanted to choose a second easiest/hardest space to navigate.

Table 5.2   Breakdown of spaces where wayfinding was considered easy or difficult: spaces are listed as they appeared in the game

	Maze	Climbing	Waterfall	Exit	Outdoors
Easiest space	0	3	6	0	2
2nd easiest	4	1	1	1	2
Hardest space	5	2	0	3	1
2nd hardest	2	1	1	4	0

Expertise

As expected, players' level of expertise influenced how they navigated the game and how they reacted to wayfinding cues. Frequent players reported that the cues in the game were clear and they could easily find their way and finish all spaces. For example, while the Maze was considered one of the most difficult spaces by many participants, some expert gamers were able to apply successful strategies to get in and out of the Maze. In addition, some also commented that they rarely if ever felt disoriented in that space – they had a better sense of direction than less experienced gamers:

> So this maze was easier to get into. I didn't have trouble coming back because most of the major paths you take to get back, the paths were wide and well lit for what it seems, so... it wasn't as hard. And the sense of direction, the game itself, control wise, it doesn't disorient you. [P10]

> It was easy because there is enough lights there... when I saw that there were two openings, I had to go to both of them. I just usually choose the one on the right first to see what's inside and then if there is a blockage and just return and go back, and go to the other side and pretty much check what is in the other side as well. I went there and I saw those boxes there and I opened pretty much all the boxes everywhere I passed so if I pass a second time and there is no boxes I have been there before. If there is a box, then obviously, I haven't been there yet. That's how I keep track. To go back, I just kept on going left and then, if there is a blockage, you just go right. That's pretty much like that. [P11]

Occasional or less experienced players, however, said that the lack of cues through the game affected their performance. They expected the game to have more instructions and wayfinding cues in several circumstances. The Maze was one of those.

At first, I found the maze challenging and fun, but after being in the maze for a long time I found it a little frustrating. I couldn't memorize the path I had been on before so I think I was repeating the same path. In real life I'm good with direction, but I would see the sun, clouds, brightness and other buildings. But in there [in the maze], everything to me is the same. I would suggest an overall map on the bottom to show where the player can go after a certain while. Or maybe like an arrow pointing where the player can go, but that is maybe too visible. [P09]

In addition to wayfinding issues, less experienced gamers had problems with moving around the game world and jumping onto platforms more specifically. That also affected their performance and prevented them from finishing the game.

It's easy to walk around, how to pick things, how to shoot at someone, how to fight with somebody. But I found it difficult to jump from one place to another place. And every time I needed to try several times to achieve my goal. […] Jumping so many times made me feel frustrated and I didn't want to try that again. [P01]

"It was hard because it requires a lot of jumps and my attention was on the jumping. […] It was hard because [even in the right corner] the platform to jump on was so small and a little bit inclined, so I wasn't sure if I could step on it, so I didn't try at first. [P07]

General expectations

As a general rule, not only applied to this study, players expect games to have good controls (character and camera movements). In fact, participants mentioned that they would give up on playing a game if the character or the camera movement did not "feel" right. One of the first things players checked in The Lost Island was the Controls.

Controls and camera strongly affected how players navigated the game and also how immersed they felt about it. For example, players could slightly adjust the camera perspective in the game, and those who had the camera zoomed in too closely to the character missed some cues, got disoriented and lost at times. Controls ended up positively or negatively affecting players' opinions about the game and navigation:

[…] the controls were decent and that made it very immersive for me. […] the controls work very well, and if a game is mildly interesting and it has good controls, I'm gonna play it. [P03]

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The jumping was really hard. And I think also the camera movement affected how I moved as well. [P02]

Maybe because I'm getting familiar with the game, I found that the camera angle is not that great. So I think that the navigation is not that great in that game… you can zoom in and out and the camera moves around and around. [P08]

Final comment would be to fix the controls. It is a pretty nice introduction game to regular games though, other than the controls. [P10]

It was pretty hard. This one was frustrating. It was frustrating because the camera was zooming in too much so the grass was blocking my vision and I was trying hard to zoom out to get a better view, but I couldn't do that. It's really hard to have a look at the whole picture because I notice it is really focused on the guy and I couldn't see anything around. [P11]

Game mechanics also dictate whether a game will be played or not. Through players' reports, it became clear that players mostly seek games aligned with their motivations. Also, they usually do not play games if they dislike the core mechanics of in the first place. This finding is corroborated by previous work (Yee, 2016).

The game story also plays a major role in whether a gamer will keep interacting with a game or not. Most players mentioned they expect games to have an interesting, gripping story to go along. Interestingly, I found that if the game story is appealing enough, players work around wayfinding problems to see how the story unfolds. Players mentioned they would be willing to endure obvious cues that could potentially spoil exploration or look for walkthroughs on websites to progress through areas where wayfinding cues were not available.

Regarding navigation, when I don't know where to go I just go to the internet and look for spoilers. I think that after a while I just think it's so frustrating that I don't want to deal with that anymore and I just want to move on with the story. So, for example, with the temple room [climbing room] I would just go and look for a spoiler. The reason why it was so frustrating is because I knew where I was supposed to go, but I just couldn't get there. [P02]

What some games try to do is that if you get close enough things will glow, but yeah, if you are across the room and it's glowing I guess it feels too easy. In those cases the story would motivate me to play or not. [P06]

[In Yakuza 4,] [t]here is a story mode and you follow the story and it pretty much guides you through the game. […] They tell you to get some stuff to progress in the story but, I guess it was in Japanese and I don't know Japanese, so that's problem why it was so difficult. Then I got the game in English. Even in the English version, they still had all those Japanese names and you have to go find [someone], but I had forgotten which character was that one. So I couldn't find the character to know if he needed something. […] The hardest part were the names, some of those street names I don't really know, so I have to Google that. [P11]

Expectations on wayfinding and wayfinding cues

Some players mentioned they usually expect games to provide comprehensible goals, clearly informing players of where they need to go (top-down processing) in the game. Most players mentioned that they were disappointed that the game did not provide more specific and meaningful goals, especially at the very beginning of the game. In other words, players would prefer to start a new game with a specific task in mind, instead of blindly exploring the game environment. Overall, specific directions from characters in The Lost Island (i.e., subtitles) worked better than environmental cues alone (e.g. shining objects and pickups – bottom-up processing). Even though players were successful at accomplishing tasks using top-down and bottom-up cues, players seemed to have a more positive attitude toward the tasks when they were informed of what needed to be done (top-down).

In the beginning of the game, I would like to have a more clear idea of what is going to happen, in general. There are only a few sentences in the conversation and then a few hints. [P01]

I have played these kinds of games before, so, for beginners who are not familiar to these games, it would be better to have a little bit more detailed instructions at the beginning of the game telling that following the candles would lead to the path, because I didn't see that at the beginning. [P09]

There's no storyline... you just have to explore, you do this task and you reach a destination, and that's pretty much it, right? I wasn't like fighting around, there is no preference... You just have to explore and pull a lever and reach a destination. It was a little bit challenging, but boring. Sometimes I didn't even know where I was going, I was just pulling levers and collecting those metallic balls. What was the point of this game? [P08]

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Although players did not directly state this belief, it seems reasonable to say that players also expected to be presented with easier wayfinding tasks at the very beginning of the game. As previously mentioned, the Maze was an overly challenging wayfinding task for many players, which made them unable to progress for a long period, even before they were completely familiar with the game, environments, controls, story, etc. Players found it difficult to navigate through the maze mostly due to the lack of landmarks and other cues.

Players' reports suggested that players expected not to be stuck for a long time, independently of whether they were in the beginning of the game or not. When they got stuck, they felt frustrated, bored, and discouraged. As I mentioned, a few players even gave up on playing the game. They explained that being lost distracts them from the story and disrupt the gaming experience, as they need to stop playing and seek help in walkthroughs posted online.

> Regarding navigation, when I don't know where to go I just go to the internet and look for spoilers. I think that after a while I just think it's so frustrating that I don't want to deal with that anymore and I just want to move on with the story. [P02]

> But every time I don't know where to go in a game, I just search online for walkthroughs. [P08]

In general, participants reported that they expect to see subtle wayfinding cues in games. Even less experienced gamers agreed that navigation can be challenging and fun at the same time. For example, some players suggested that the games should let players try tasks on their own and only add a cue if players are lost for a certain period of times. The cue should then disappear again. This, of course, still raises the question of what makes cues more or less subtle. P09, for example, talked about a game the player enjoyed navigating and reported:

> [...] if I stay in a place for a long time, the game shows me an arrow telling me where to go. I found that really helpful. [P09]

P02 and P06 also reported:

Regarding navigation, I like that there are subtle hints some places. So the vine climbing, I eventually got that after a while. And when you walk to check points, they show you places you want to. […] The hints were good. They were subtle enough that I understood and I think that the items that I could pick up they were usually shining, and I think that they were subtle enough and they were not too obvious in your face. [P02]

[…] if it's too obvious, then it's too easy. What some games try to do is that if you get close enough things will glow, but yeah, if you are across the room and it's glowing I guess it feels too easy. [P06]

Finally, as expected, more experienced players would prefer game tutorials tailored to their level of expertise so they would not need to learn basic controls (e.g. "learn how to jump") when starting a new game.

Players responses to wayfinding cues and tasks in The Lost Island

While analyzing players' performance and perceived experiences, it seemed that some wayfinding cues were more effective than others. In addition, the data suggested that wayfinding cues played a major role in the player experience. They were, at many times, seen as a necessity, even considering that most of the game was quite linear.

Maze: the most difficult wayfinding task in The Lost Island

For example, as many players mentioned, the Maze was one of the most difficult spaces, so it seems reasonable to assume that the lights/candles connecting the entrance of the Maze to the lever were not as helpful as I had expected in the design phase. A few players mentioned that the space was well lit, but none of the players mentioned they had noticed a connection between the lights and the path they needed to follow. Another major complaint about the Maze was that it felt quite claustrophobic; hence players wanted to get out of there as soon as possible. That increased players' frustration when they noticed they were disoriented and could not find their way out.

These results suggest that dark or narrow spaces like the Maze should have clearer cues and landmarks. In addition, the size of the space should also be taken into account when one thinks about the player experience. Players found it really hard to stay in the Maze for a long time. Tomb Raider (Square Enix, 2013), for example, presented a

series of claustrophobic caves with extremely low ceilings, creating an intense sense of dread. Those sections, however, were usually quite short and straight corridors so players could not get lost. Those were good examples of how to include claustrophobic and dark environments into games.

Waterfall: the easiest space in The Lost Island

In contrast to the players experience in the Maze, several participants considered the Waterfall room one of the easiest and most relaxing spaces, matching design intentions. The area was bright and open; it had some vegetation and no ceiling. Players seemed to be willing to explore and stay there longer than in other spaces, even though some players took a while to accomplish the task in that space (i.e., find the key).

> Here [waterfall room], the scenery itself makes me a better… better emotionally, so I feel a little more encouraged about the scene itself maybe because it is brighter and has some nature in it. [P01]

> The graphics were pretty nice and felt really engaged so I wanted to explore more. It was exciting. The room is pretty bright and the graphics look really nice, and it is an open environment. I felt like I could see everything very clearly. [P09]

Surprisingly, most players took a while to spot the vines leading to the key, despite the fact that players had just learned they could climb vines and the vines had good contrast against walls. Instead, some players thought that the key was underwater so they promptly jumped into the pool. They reported that they "somehow" thought the key was there (i.e., they followed their preconceptions or expectations). Note that a particle effect was added in front of the vines to attract the players' attention (see the previous chapter), but players focused on the water instead. Conversely, the same particle effect proved to be efficient to attract players' attention in still scenes (e.g., close to levers, see in the next section).

> So, for the waterfall room, I thought that the key was in the water. I didn't notice those vines until I was climbing around on the other vines and just looked around [from a higher place] and I notice that that was the only other place that the vines were there so I decided to go there. I quite enjoyed being in the water, I liked the experience of it, but it was really difficult to see maybe because of the camera movement. [P02]

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> This one was frustrating. Because I just didn't see the thing [vines for the key] so I just went on circles. I went to the waterfall because I was expecting something behind the waterfall because that's kind of the usual trick and yeah, I didn't see the vines at first. And then I thought "that's gonna be the stuff here above the door." There is a piece of a ledge sticking out so I thought "it might be possible to climb there", but I didn't manage, so I gave up. [After seeing the vines], it is visible, I think I just didn't look around, I guess. [P03]

Opinions about the efficacy of the textual hints in the Waterfall area were split: some players understood the hints right away, but others only fully understood the message when they could not get out of the Exit room and read the second message about a key. Regarding the secret passage, however, all players eventually found that hidden path. They also commented that they understood the advantage of entering the Exit room through the secret path, as they could avoid the enemies and half of the environmental puzzle.

Vertical puzzles: testing different gaming skills

There were two platform puzzles in the game: the Climbing space and the Exit room. Players were split in their opinions about how easy/difficult the Climbing space was, with four and three players considering that space one of the easiest and hardest respectively. Seven players considered the Exit room one of the most difficult space of the game, while only one player mentioned that that space was one of the easiest spaces. These results are aligned with the design intent, as the Exit room was the last indoors space and was purposefully designed to challenge the player. That said, the Exit room was mostly found to be difficult because it required a higher degree of jumping skill. Whereas the Climbing space was a relatively small space, the Exit room was massive, and players could easily die from falling from platforms.

Regarding wayfinding in vertical spaces, players found it easier to start from the top, as they had a better view of the entire space (i.e., starting half way through the vertical puzzle in the Exit room when coming from the secret passage).

> This one was pretty exciting. When I just got in this room, I could look down and I had an entire view of the room, then I knew where to go. That was different from the maze and the other room [Climbing space] that I had to jump up to see where to go. [P05]

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Players faced different challenges when starting the Climbing and Exit spaces from very bottom, as discussed in the next paragraphs.

Climbing space: Some players had trouble noticing the exit at the top of this room. However, the pickup items were very effective at communicating to players that they needed to find a way to jump on the platforms. Besides the difficulty of looking up and noticing the doorway, players had trouble finding the lever. Note that no extra cues were added to the lever to attract players' attention to it.

> The lever was hard to find because it doesn't stand out. It's like a camouflage on the map. [P08]

> What made this room easy to navigate was spotting the notches on the pillars. Then I was just "okay, what if I climb those notches?" I found a different color on the wall, and then I figured that that was the doorway. But it was hard to spot the lever because I couldn't see that from where I was standing. [P10]

Exit room: Those players who started this room from the bottom mentioned that the Guided Tour (cut scene) showing the exit at the top was quite helpful because it gave players a specific goal. However, players did not know where to start climbing as no wayfinding cues indicated exactly where players needed to jump onto.

> I got stuck at [the exit room], but I knew that I had to go to the other side, I just didn't know how for, I guess, 10 minutes or 5 minutes. I didn't look up, so I didn't see the panels. [P06]

As expected, players found it counterintuitive to be jumping up and then need to jump down to switch the lever. However, the visual effects (lighting and particle effects) helped players notice the platform with the lever. As mentioned before, the particle effect worked quite well in more static scenes like in the Exit room, while it did not work as well when the effect was near the waterfall – two motion effects competed for players' attention.

Finally, also as expected, not all participants noticed the new set of platforms coming out from the wall after they pulled the lever. While there was a Guided Tour giving feedback to the players in the Climbing space, there was no feedback in the Exit

room. Consequently, many players needed to switch the lever several times in order to figure out the effect of the lever in the environment. Note that players still liked the challenges of the Exit room and, surprisingly, they did not complain as much as I expected about the lack of feedback.

> Regarding the lever, I had to pull it twice because I didn't know what was going on, and then I left that alone. Then I tried that again and looked around and pulled again, and turned around and pulled again. That was not clear to me. [P02]

Outdoors

The outdoor area was visited by only five players. Overall, they found that space easy to navigate. However, one player found it quite difficult to find her/his way and mentioned that s/he needed to go "everywhere" and explore "everything." That player talked about the lack of more specific hints for the goals in that area.

Unfortunately, players could not say much about their strategies in the open space. When observing the players, I also did not notice any particular strategy. During the cued recall debrief, players mentioned that they kept walking around the area until they found "something": one player mentioned seeing the fireflies (i.e., particle effect) close to the entrance leading to one of the keys; and all players mentioned that as soon as they noticed the stairs to the mountain, they understood that there would be something in that upper area. This last comment shows that environmental objects like stairs can be effective wayfinding cues. Based on the responses here, I changed the structure of the open space in my second study to try to improve the analysis.

5.8. Discussion and intermediate conclusions

In this study, I found several factors interfering with navigation (beyond wayfinding cues alone). That highlighted the complexity of the topic and the need for more research. A tricky aspect of designing wayfinding systems for games is that cues are not meant to be as clear as directions found in the real world. Designers may want to purposefully hide objects or paths to have players explore the environment to progress.

However, through this study, I learned that, even when in exploration mode, players need some sort of feedback to at least know that they are going in the right direction.

Based on the cued recall debrief, I found that players effortlessly reported on cues they expected to see in the game (e.g. a "map for the maze"). In some cases, however, it was difficult for them to mention what cues helped them navigate through the game. For this reason, I found it very productive to have designed my own game (instead of having participants playing a commercial one) because I knew what features had been applied to it. That helped me better interpret the findings.

One issue with this first study, however, was that I could not verify whether players would behave differently had different cues been applied to each space. In this sense, I could not assertively declare that a wayfinding cue – and not the environmental layout alone – evoked certain behavior or attitude from players. Nonetheless, there were several lessons learned from this study, and those were applied to my second game and study as explained in the next chapters.

Chapter 6.

Prototype 2: A Warrior's Story

This chapter details the design process of my second research tool (A Warrior's Story), and methods and procedures employed in the study. For this second study, I designed a game on Project Spark (Microsoft). Project Spark was appropriate for my research goals because it was an easy to learn tool and offered more control over the design features I wanted to implement. In addition, it allowed me to record event-related data, which was not possible on Game Globe, and offered an intuitive visual programming language (Figure 6.1).

Figure 6.1   Screenshot of Project Spark's development environment

The following research questions and sub-questions guided this study:

1. How do different types of wayfinding cues affect players' wayfinding behavior in 3D action-adventure games?

   o How do different types of wayfinding cues affect the amount of time players take to progress and finish action-adventure games?

   o How do different types of wayfinding cues affect players' decisions of when and where to go in action-adventure games?

2. How do different types of wayfinding cues affect players' involvement with 3D action-adventure games?

   ○ How do different types of wayfinding cues improve or disrupt the player experience, making a game more or less enjoyable?

6.1. Design Goals and Requirements

The primary goal for A Warrior's Story was to design a tool that would allow me to investigate how different wayfinding cues affect players' in-game behavior and involvement within an action-adventure game that was consistent with my previous study. To achieve that goal and apply the design lessons learned from the previous study, I followed these design requirements:

- **The game needed to work well with different wayfinding cues**: to be able to design my different condition, I needed to design spaces and wayfinding tasks that would make sense with different cues.

- **The game needed wayfinding tasks similar to those found in The Lost Island**: for the sake of comparison, I wanted to test similar wayfinding tasks. One of the first challenges I encountered was to replicate a game using assets from a second game engine.

- **The sequence of spaces/tasks needed to be rearranged (e.g., moving the Maze from the beginning to the middle of the game)**: in the previous study, players reported that the Maze was one of the most difficult tasks in the game. To avoid players spending too much time to solve a task right in the beginning of the game, I moved the Maze so it appeared later in game map.

- **The Maze needed landmarks**: players also complained about the lack of landmarks in the Maze. I added a few landmarks and collectibles in the space.

- **More objects needed to be included in the game**: players also mentioned that some parts of the previous game seemed a little empty; they look unfinished. To avoid that being a barrier to players' involvement, I added more objects to The Warrior's Story.

- **The story needed improvements**: players needed a story to go along with the tasks. I included more narrative beats through The Warrior's Story.

- **Previously visited spaces needed to be blocked**: one major problem in the previous study was that players would backtrack all the way to the starting point of the game when they were lost. Blocking the spaces would help players to push forward and not be distracted by previously visited areas

- **The outdoor area needed to be more structured**: one issue with data from the outdoor area is that players did not have much to say about their experience in the outdoor. That was likely because of the lack of landmarks in

the area. In addition, the game did not require any specific strategy from the players, so, it seems, players just randomly walked around the space until they found "something."

- **The game needed to be a little easier than The Lost Island**: I wanted players to finish the game faster than they did in Study 1. That was important because of time constraints as the number of participants increased from 12 in the first study to 42 participants in the second.

6.1.1. Attentional cues, Representational cues, and Textual cues

Given the number of wayfinding cues used in games, I wouldn't be able to test and compare all unique cues in an experimental setting. At the same time, I didn't want to jeopardize the ecological validity of my work by using a limited number of cues in the game because the game would not be as complex as commercial games. My strategy was to group the wayfinding cues into categories and apply as many cues as possible into my games while still being able to compare the those cues and categories.

A common method for guiding players through games is to use what is called Markers through the environment. Those are visual effects that highlight important objects through the use of particle effects (motion), brightness, and color contrast. They are supposed to make a game easier to navigate, as players have a clear indication of where to go and what objects they can interact with. I have named those **Attentional cues**. Designers also take advantage of players' prior knowledge, creating games with familiar objects so players can infer where to go and what to do with those elements. Examples are doors, ladders, buttons, and switches (perceived affordances). The ease with which players navigate games with those objects (without any Attentional cue) is difficult to foresee, as there are many factors that might influence the wayfinding process like the intricacies of the settings and the lighting in the game world. I named those objects **Representational cues**, as they depict known objects. Finally, designers sometimes completely break conventions when they invent their own objects, rules, and fantasy worlds. In doing so, designers need to communicate or teach the meaning of those fabricated elements: what they are and how they work. A common way of communicating how to use these elements, is through dialogues (written or voice-over) and written instructions, which are another type of cue, as players learn to rely on characters to get the information they need to proceed in the game. I named those

written cues **Textual cues**. The name of each category was not meant to be definitive or comprehensive. Categories were named by me for convenience.

Each condition contained cue types from each category, although there were sometimes overlapping between conditions (e.g., the Attentional cue used the same objects seen in the Representational condition, as the visual effects were the main difference between those two conditions).

6.2. Target audience

The game was designed for mid-core action-adventure players: somewhat skilled gamers who typically enjoy the type of tasks and challenges offered by action-adventure games, especially searching tasks and environmental puzzles.

6.3. The design of A Warrior's Story

As explained, a design requirement was to create a game environment and wayfinding tasks that would work with the different types of cues. I first defined the basic mechanics of the game: searching for and collecting objects in a space to unlock the next space. With those mechanics in mind, I defined core objects in the game, starting with the Representational condition because of the real world reference. Simply put, players needed to search for a key and unlock the door to the next space.

The Attentional and Representational versions of the game were basically the same. The major difference between them was that I added visual effects highlighting those important objects in the Attentional condition. For the Textual condition, I needed to use unfamiliar objects so that the players would need instructions to know what to do. I replace the key for a purple gem (Figure 6.2) and the doors for teleports that looked like green pyramids (Figure 6.3).

Attentional   Representational
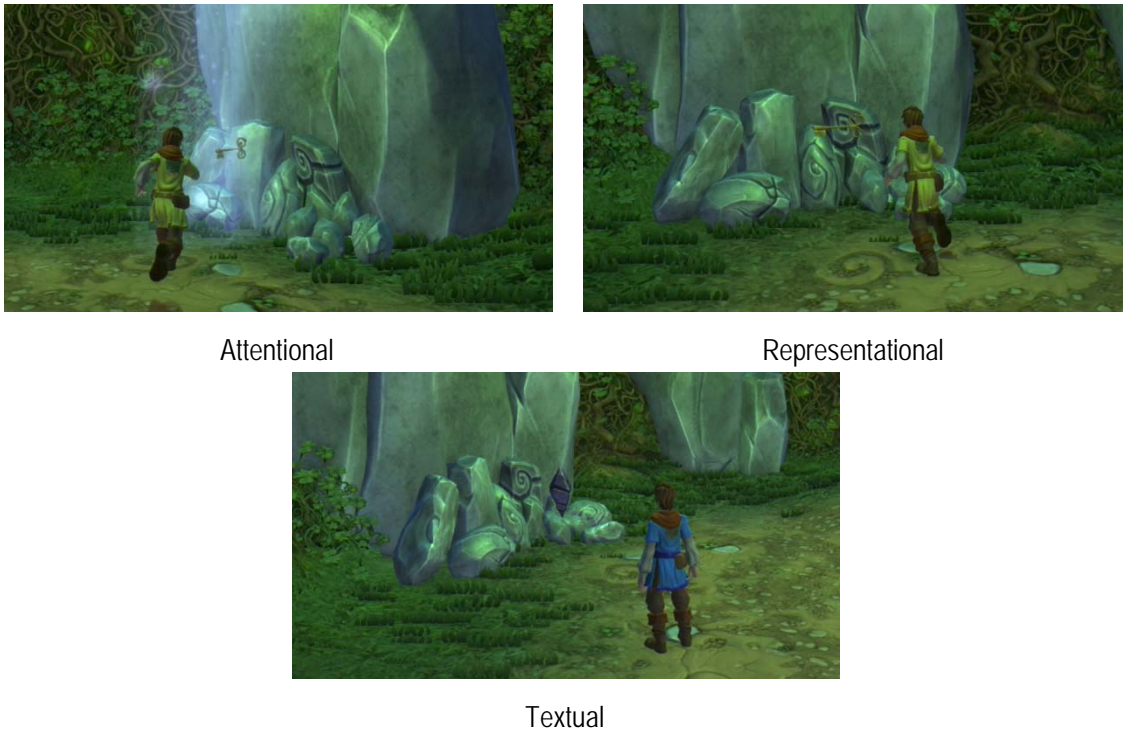
Textual

Figure 6.2   Zoom on the Activator (key or gem) in the Starting space for Attentional, Representational, and Textual conditions

Another example of wayfinding cues used in the game was the Guides that helped players to navigate through non-linear spaces: the Maze and the Village. The Guides in the Representational condition were NPCs and the Guides in the Attentional condition were a blue orb (Maze) and a trail effect (Village). I also added NPCs to guide players in the Textual condition. Contrary to the NPCs in the Representational condition, those in the Textual condition "talked" to the players (through written instructions or hints). Besides those mechanics, I included some environmental puzzles and platform levels where players needed to figure out where to go next. Finally, I also included some combat encounters, and weapons and coins that players could pick up through the game. Pickup items were not used as wayfinding cues in this game (even though they were used in The Lost Island). I present details about each level and cue through the next sections.

In addition to those wayfinding cues, the main goal for each distinct area always appeared on the HUD. They were the same for all conditions. The eight areas included

tasks and cues that mimicked those found in commercial games as described in the following sections. Figure 6.3 shows a schematic map of the game.
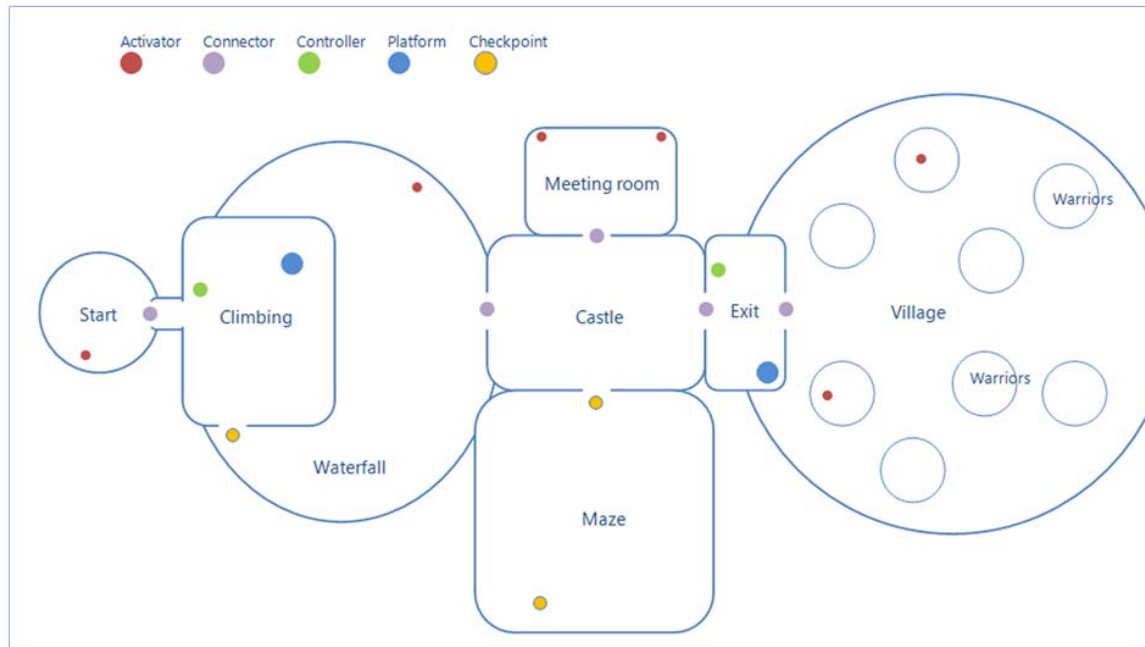
Figure 6.3   Schematic view of A Warrior's Story. Players start on the left side, following this sequence: Start, Climbing, Waterfall, Castle, Maze, Meeting room, Exit, and Village. Core wayfinding cues are highlighted on the map

Once the three versions of the games were ready, for convenience and for the sake of consistency, I gave codenames to the wayfinding cues applied to the game. For example, key and gem were named Activators – because they were used to activate doors and teleports. Doors and teleports were referred to as Connectors – because they connected two spaces. The idea was to keep consistency in my analysis by using the same nomenclature for the objects and referring to specific spaces and experimental conditions when necessary. Table 6.1 shows the list of the main wayfinding cues applied to the game and their respective codenames:

Table 6.1   List of the main wayfinding cues for each condition and their codenames

Codename	Attentional cues	Representational cues	Textual cues
Activator	Key + Visual effect	Key	Gem
Connector	Door + Visual effect	Door	Teleport (+ NPC + Text)
Controller	Lever + Visual effect	Lever	Breakable rock + NPC + Text

Codename	Attentional cues	Representational cues	Textual cues
Platform	Wooded platform + Visual effect	Wooded platform	Mushrooms / Platform + NPC + Text
Guide	Orb (FX) / Trail (FX)	NPC	NPC + Text
Feedback	Orb flying towards the path	-	Guided tour showing the path (camera effect)

Table 6.2 summarizes the wayfinding cues applied to each area per condition.

Table 6.2   List of wayfinding cues applied to each area/level per condition

Level	Attentional condition	Representational condition	Textual condition
Start	Key + Visual effect	Key	Gem
	Door + Visual effect	Door	Teleport + NPC + Text
Climbing	Wooded platform + Visual effect	Wooded platform	Mushrooms
	Lever + Visual effect	Lever	Breakable rock + NPC + Text
	Orb flying towards the path	-	Guided tour showing the path (camera effect)
Waterfall	Wooden platform + Visual effect	Wooden platform	Platform + NPC + Text
	Key + Visual effect	Key	Gem
	Door + Visual effect	Door	Teleport + NPC + Text
Castle	Orb (FX)	NPC	NPC + Text
Maze	Orb (FX)	NPC	NPC + Text
	Torches + Visual effect	Torches	Torches + NPC + Text
	Door + Visual effect	Door	Teleport
Meeting room	Stairs	Stairs	Local teleport
	Key + Visual effect	Key	Gem
	Door + Visual effect	Door	Teleport
	-	-	Breakable rock
Exit	Platform + Visual effect	Platform	Platform
	Lever + Visual effect	Lever	Breakable rock
	Orb flying towards the path	-	Guided tour showing the path (camera effect)
	Door + Visual effect	Door	Teleport + NPC + Text
Village	Trail (FX)	NPC	NPC + Text
	Key + Visual effect	Key	Gem
	Door + Visual effect	Door	Door

6.3.1. Starting point

The game started with a small text with a narrative that gave players some context about the game world and the tasks that unfolded. To summarize, the Waya Village was invaded and its people enslaved, including the League of Warriors that was meant to protect the Village. Players needed to escape, defeat the enemies, and save the people.

The game started in a very constrained space to allow players to learn basic game mechanics such as movements, collecting Activators and using Connectors in the game. There was also a spawn point (a rock on the ground) that triggered a visual effect every time a player would step on it.

Attentional   Representational
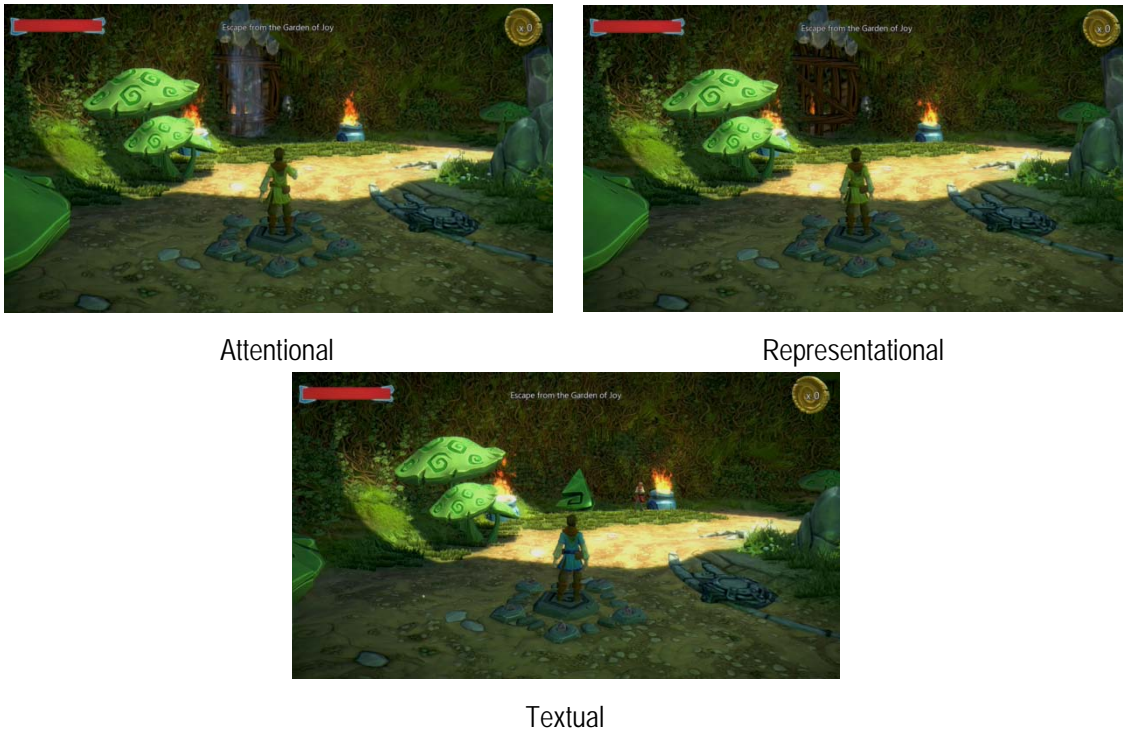
Textual

Figure 6.4   Players facing the Connector at the very start of the game in the Attentional, Representational, and Textual conditions

Players started facing a Connector as shown in Figure 6.4. The goal in this area was to find and pick up an Activator (Figure 6.2) to use the Connector and progress to the next room. Note that the player's character needed to touch the Activators in order to pick it up. As explained, the Attentional condition contained visual effects highlighting the

Connector and the Activator. The Representational condition only had the Connector and the Activator with no extra cue. The Textual condition had a NPC near the Connector (seen in Figure 6.4) that gave instructions to the player, as soon as players got near it: "You need to find something to activate this magic rock."

After finding and collecting the Activator, players needed to use the Connector to move on the next space.

6.3.2. Climbing space

Once players entered the Climbing area, they saw a gate blocked by tree logs. Only those players in the Textual condition saw instructions to "Find another way" when they were near the logs. Participants could explore and collect objects in the lower area.

Attentional   Representational

Textual

Figure 6.5   Platforms in the Climbing space in each condition

The main goal for this area was escaping. The local goals for this space were:

• Notice platforms (Figure 6.5) and climb to a higher area

• Interact with a Controller (lever or breakable rock, Figure 6.6) to create a new path from the upper area to the exit

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- Notice and navigate the new path (Figure 6.6) to reach the next checkpoint.

Attentional   Representational

Textual
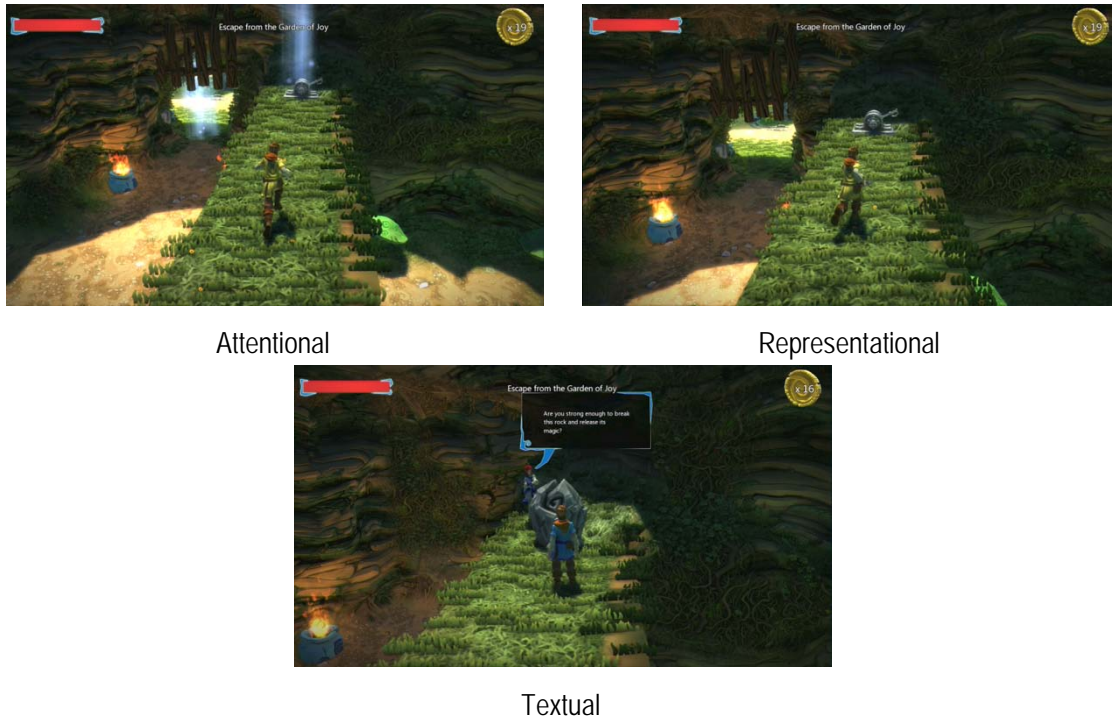
Figure 6.6   Controller in the Climbing space in each condition

After interacting with the Controller, new platforms (pillars) rose from the ground, making it possible for the players to navigate to the exit gate. However, to do so, participants first needed to notice those pillars. Participants in the Attentional and Textual conditions had different visual feedback to help them notice the platforms (Figure 6.7), whereas those in the Representational condition had no feedback.

Attentional   Textual

Figure 6.7   Visual effect moving from the lever to the pillars on the left in the Attentional condition. Final frame from the Guided tour (cut scene) showing the pillars rising from the ground in the Textual condition

6.3.3. Waterfall area

Once participants reached the Waterfall area, enemies spawned and walked towards the players to attack them. Players did not necessarily need to defeat those enemies in order to progress (although the enemies would keep following the participants if not defeated). The main goal for this area was to find a way to enter the Castle. The local goals in this area were:

- Notice the platforms near the waterfall (Figure 6.8)
- Find and collect the Activator (which was behind the waterfall)
- Activate the Connector to the Castle

(a)   (b)

Figure 6.8   Platforms near the waterfall in the Attentional and Representational conditions: platforms were the same for all conditions, but a visual effect was added in the Attentional condition

Attentional   Representational

Figure 6.9   A NPC gave players instructions in the waterfall area

Players needed to notice and jump onto platforms to have access to the Activator. The platforms looked the same in all conditions. However, a visual effect was added to the platforms in Attentional condition with the purpose of attracting players'

attention to the platforms. Participants in the Textual condition had a NPC giving them extra hints as shown in Figure 6.9: the NPC informs players that there is a magic rock in that area and asks players to follow her. The NPC stops closer to the waterfall and informs players the magic rock is around that area.

After finding the Activator, participants needed to use that on the Connector to enter the castle.

6.3.4.   Castle

Once participants entered the Castle, a NPC approached them to give them some background story and instructed them to go to the Maze. Those instructions were given to players in all conditions.

Attentional   Representational

Textual

Figure 6.10   Wayfinding cues (NPCs and visual effects) in the Castle for the Attentional, Representational, and Textual conditions. Also note that doors (background) were replaced by teleports (pyramids) in the Textual condition

To go to the Maze, participants in the Attentional condition also saw a Guide (orb) near the entrance of the Maze. A NPC replaced the orb for participants in the Representational condition. The NPC waved to participants, but did not say anything. Finally, in the Textual condition, the same NPC that instructed players to go to the Maze also said "This way" and went straight to the Maze. Figure 6.10 shows the Wayfinding cues in the Castle in all conditions. It is important to note that participants could choose between going to the Maze right away and exploring the Castle first. The Castle gave players access to three different places: the Maze, the Meeting room, and the Exit room.

6.3.5.   Maze

Once players stepped on the first checkpoint in the Maze, the goal shown on the HUD was: "Find the warriors lost in the maze." Once the players reached the checkpoint at the end of the Maze, near the Activator, the goal on the HUD was updated: "Find a way to open the Meeting room and leave the Maze." Finding the warriors was an excuse for players to navigate the Maze. The local goals in the Maze were:

- Find and collect the Activator (near the second checkpoint)
- Leave the Maze and activate the Connector to the Meeting room

Figure 6.11   **Top view of the Maze as seen from the Project Spark editor. The bottom red circle overlaying the map indicates the entrance of the Maze. The top circle indicates the location of the second checkpoint and Activator. The red line indicates the Guide's path**

Players had two options on their way in: either follow their Guide (orb or NPC) directly to the Activator or explore other areas in the Maze and collect some coins. Figure 6.11 shows a top view of the Maze.

On their way to the Activator, the Guide lit some torches to indicate that players could follow those to find a way back to the Castle. In addition, in the Attentional condition, a visual effect similar to the one that highlighted the Activator was added to the torches. Players encountered the three Warriors on the way to the Activator.

(a)   Representational

Textual
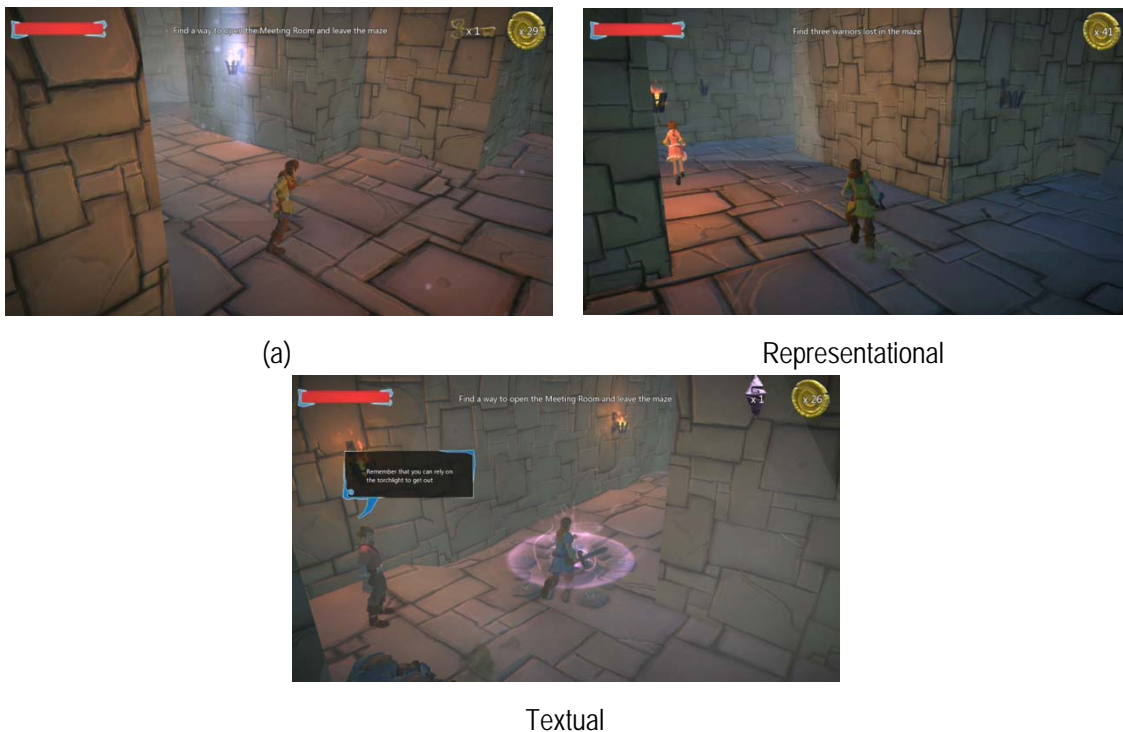
Figure 6.12   (a) A visual effect was added to the torches lit by the orb (i.e. Guide) in the Attentional condition. (b) The NPC lit some of the torches and some paths were left in the dark (screenshot of the Representational condition). (c) The NPC that guided the player in the Textual condition reminded players they could follow the torches to get out

Once participants collected the Activator, they needed to go back to the Meeting room in the Castle, outside the Maze. Only participants in the Textual condition were reminded by the NPC that they could follow the lights/torches to find their way out. With the task of going to the Meeting room in mind, players could choose among the following options: engage in combat, explore the Maze and collect coins, or directly go to the Meeting room.

6.3.6.   Meeting room

Once participants reached the Meeting room, they needed to notice two chests on top of two platforms. Stairs gave access to the platforms in the Attentional and Representational conditions. Players used teleports to have access to the platforms in the Textual condition (Figure 6.13). Each chest contained an Activator: one gave access to the Exit room and the other gave access to the Connector to the Village. Note that since the Meeting room was symmetric, players had an equal chance of going to either side/platform. Even so, there were important questions around how participants would go about collecting Activators and proceeding to the Exit room: how long would participants take to collect the first Activator? Would they easily recognize that they needed to collect a second Activator? Would they get distracted while doing the tasks? Would the wayfinding cues help them to get back to the tasks after being distracted?

Attentional   Representational
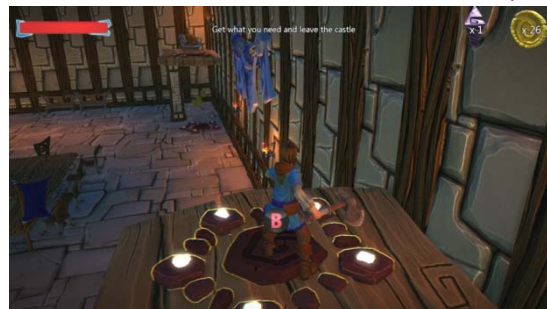
Textual

Figure 6.13   The Meeting room was a symmetric space and contained two chests with Activators. Participants needed to get to the platforms to pick them up. A visual effect highlighted both chests in the Attentional condition. Participants needed to use teleports (brownish rocks on the ground) to reach the platforms in the Textual condition

Besides the Activators, the Meeting room contained several coins. Once players were near the staircases, enemies spawned in the space and attacked the players. Players could choose to move on to the next area as soon as they found the Activators, or stay longer to collect coins and engage in combat.

Finally, after collecting both Activators, participants could move forward to the Exit room (last space inside the Castle).

6.3.7. Exit room

In the Exit room, participants needed to find a way up to be able to reach the Castle's exit and go to the Village. The local goals in the Exit room were:

- Notice and jump on the platforms at the right side of the room (Figure 6.14)
- Interact with the Controller (Figure 6.15)
- Notice the platforms (Figure 6.16) and reach the Connector to the Village

(a)

(b)

(c)

Figure 6.14   (a) A visual effect highlighted important objects in the Attentional condition. (b - Representational condition) Players could see the Connector (higher area). Players needed to turn right and jump onto a small platform (c) to progress in the game.

Once participants jumped onto the small platform, a set of platforms came out from the wall allowing them to jump to the upper area of the space. After interacting with the Controller another set of platforms created a path leading to the final Connector. Local wayfinding tasks in this room followed the same sequence of the Climbing space.

Attentional   Representational

Textual
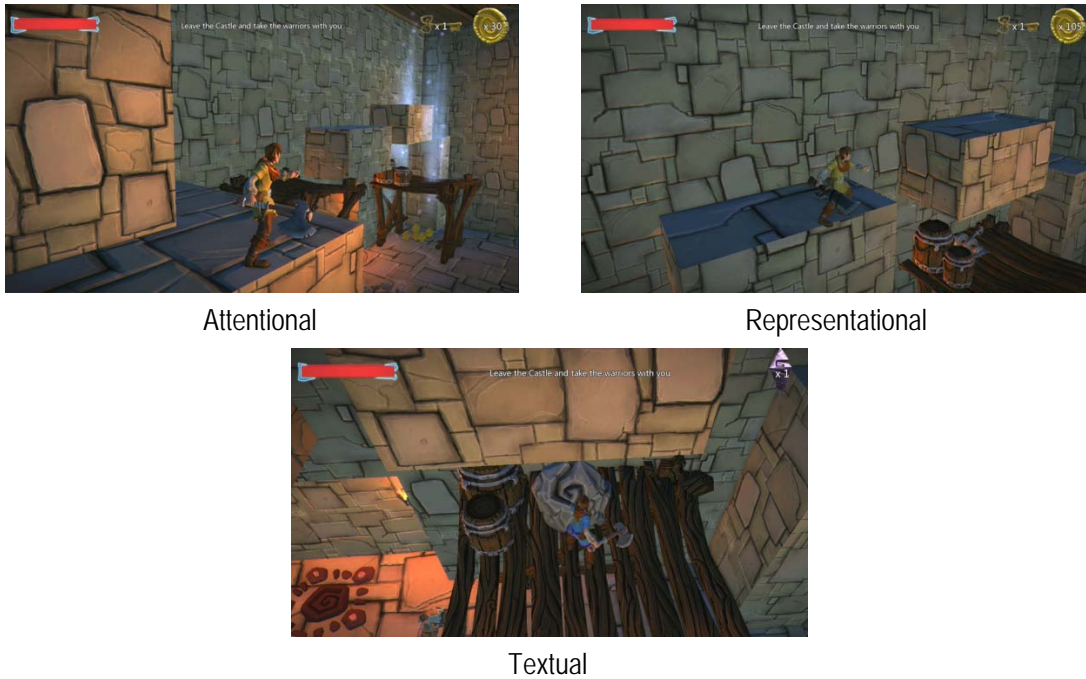
Figure 6.15   Controller in the Exit room for all conditions

Attentional   Textual

Figure 6.16   Visual effect (top) moving from the lever to the platforms in the Attentional condition. Final frame from the Guided tour (camera transition) showing the platforms in the Textual condition

The Representational and Attentional conditions had the same objects but a visual effect was added to key objects in the Attentional condition. Players in the Textual condition had a camera effect indicating that a new set of platforms appeared after they

broke the Controller. Players in this condition could also see a NPC standing beside the Connector in the upper area of the room, indicating that players could reach that area.

6.3.8. Village

Figure 6.17   Top view of the Village from the Project Spark editor. Participants started from the area at the bottom of the image. The Guide went to the house that contained the first key (Key1), then to the house with the first group of warriors (Warriors1). Finally, the Guide went to the last two houses (Key2 and Warriors2)

Upon reaching the Village, players in all conditions were told by a NPC that there were warriors inside some of the houses and they needed to be rescued. There were a total of eight houses in Village. Two houses contained a key that would open two locked houses containing warriors. That is, players needed to visit at least four houses to be able to proceed. Figure 6.17 shows the Village seen from the Project Spark editor.

In the Village, as in the Maze, there was a visual effect that guided players in the Attentional condition and a NPC that guided players in the Representational and Textual conditions. The NPC in the Representational condition talked to players and went to the houses without giving players any further instructions. Players in the Textual condition were asked whether they wanted the NPC to guide them to the houses or not. Figure 6.18 shows the Guides in each condition.

Attentional   Representational

Textual

Figure 6.18   In addition to the Guide, players in the Attentional condition saw a visual effect at all four important doors. The Guide in the Representational condition simply ran off to the first house without warning. Players in the Textual condition could choose whether they wanted the Guide to show the path to the houses or not

Some rewards were added to the other houses in case players wanted to explore more houses: some houses had coins; one house had a new sword and a shield; two houses had some enemies so players needed to fight them before collecting the coins. Note that the Guides never went to those optional houses.

As players had a lot of freedom in the Village (because it was a non-linear space), it was difficult to predict what players would want to do first. The area was vast and there were many objects and places that had the potential to distract participants. My assumption was that it would not make much sense to analyze player performance based on completion time for that space (based on the data collected). For this reason, I did not have any strong expectations around player performance in the Village.

The next chapter describes the methodology and results for my second study: A Warrior's Story.

Chapter 7.

Study 2: A Warrior's Story

7.1. Methodology

In this second study, I equally prioritized quantitative and qualitative strands (data collection, analysis, and interpretation) due to the interdisciplinary nature of my research problem. Performance metrics, survey data, and participants' voices were recorded, analyzed, and triangulated during the interpretation of the results.

7.2. Participants

Participants were recruited through email to SIAT's professors, posters distributed at SIAT (Appendix C) and word of mouth. At times, the researcher also visited classrooms to invite students. Because some participants in the first study didn't have enough skills to complete all the tasks, the criteria for the second study were that participants needed to be active gamers and also know how to use an Xbox controller – this criteria helped to guarantee that only players of a certain skill level would take part in the study. Nonetheless, I still expected to see players at different skill levels in the study – as discussed in the results. Participants used the SONA System to choose timeslots at their convenience.

Forty-two players, naïve to the purpose of this research, took part in the study. Ages ranged between 18 to 28 years old, with the median at 22. Of the forty-two participants, nine were female. Forty-one participants were students coming from different fields of expertise: interactive art and technology, archeology, design, statistics, engineering science, computer science, social science, business, and environmental science. One participant was a software developer.

All participants reported that they played action-adventure, RPG, or puzzle games, which qualified them to the study. Forty participants mentioned that they played on at least two of the following gaming platforms: console, PC, and portable. Two participants mentioned they were more familiar with PC games. Table 7.1 shows a breakdown of the most frequently used gaming platform per condition.

Table 7.1 **Breakdown of gaming platform most frequently used by participants. Comparison by assigned condition**

Condition	Console	PC	Portable
Attentional	2	8	4
Representational	3	7	4
Textual	5	8	1

7.3. Experimental design

This study had three conditions x cue type (Attentional, Representational and Textual cues). It was a between-subject design, with fourteen participants per condition. Level of expertise and sex were balanced between each condition.

7.4. Procedures and apparatus

I welcomed each participant and clarified the general purpose of the study (without giving too much detail). After signing a consent form, the player filled out a questionnaire on demographics, and was taken to a separate room to play the game. I then explained the game controls, which were available on a poster attached to the wall (Appendix C), and left the player alone when s/he felt ready to start playing.

The participant sat in front of a 23" computer monitor, wearing headphones. The environment was well lit, silent, and seating was adjusted to make the participant comfortable. The participant then played the game until s/he triggered a message to fill out the Immersive Experience questionnaire. Participants were not given any time limit to finish the play session. Upon reaching the milestone, a message was displayed on the game screen, reminding the participant to fill out the questionnaire. Participants were left alone to answer the questions. The questionnaire was displayed on a second monitor

near the player. The monitor was turned off during the play session to avoid distraction. I watched the play session by duplicating the game screen on another monitor outside the gaming room. There was also a narrow glass window in the experimental room, so I could see the participant from the outside of the room.

Lastly, I conducted a cued recall debrief with participants, showing a video recording of the play sessions to remind the participant of the game challenges and features. Participants described their play sessions, talking about positive and negative experiences and explaining how they progressed in the game. I also asked questions on the fly to clarify participants' utterances at times. Then, the participant received cash, or extra credit for a class, and was thanked for participating.

7.5. Data collection

7.5.1. Questionnaires

Demographic information questionnaire

Like in Study 1, players filled out a pre-interaction questionnaire (Appendix A) asking basic demographic questions and players' gaming preferences and gaming habits.

Immersive experience questionnaire (IEQ)

Players filled out a post-interaction questionnaire (i.e., Immersive Experience Questionnaire – Appendix B), which gathered quantitative data about their experience with the games.

7.5.2. Cued-recall debrief

Subjective data was collected through cued-recall debrief (see Chapter 3). While watching a video, participants were encouraged to explain what disrupted and facilitated their wayfinding experiences and expectations on wayfinding. When necessary, I also asked participants the reasons why they visited a place more than once, disentangling

straightforward exploration from navigational issues. I opted for video in Study 2 because video was a richer stimulus that allowed me to gather more detailed information about the player experience. Sessions were also audio recorded and transcribed for analysis.

7.5.3. Observation and video recording

I observed all the play sessions (from a second monitor outside the study room) and took unsystematic notes on players' in-game behavior. Observation notes were not fully analyzed, but visited when I wanted to cross-check subjective data from participants to what I observed in a given play session, as explained in Chapter 3. In addition, I video recorded all play sessions so video recordings were available to debug the process if necessary.

7.5.4. Telemetry
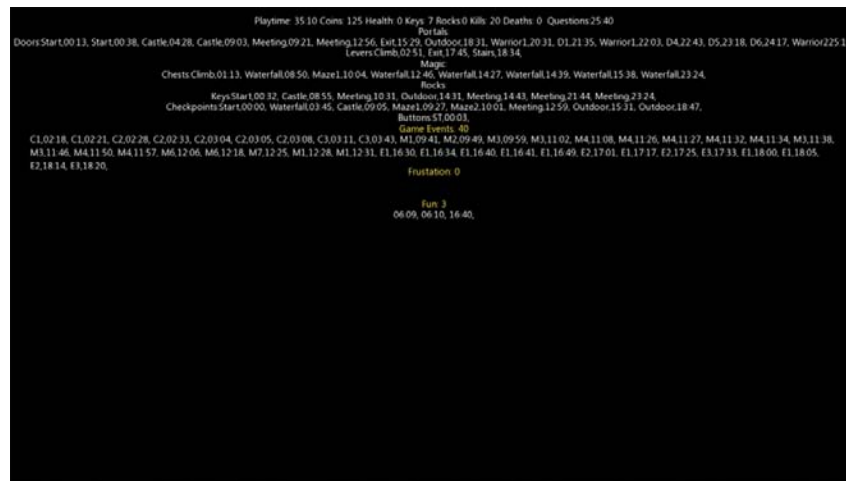
Figure 7.1.   Example of screenshot taken to capture timers and counts from Project Spark in Study 2

Timers and counts were collected in Study 2. Although I was not able to collect system logs directly from Project Spark, its flexibility allowed me to record time to reach specific areas in the game, completion time for each space, counts of number of coins collected, and so on. Also, I recorded how many times players pressed the controller's triggers during the study. Participants were instructed to press the right trigger if

something positively affected their gaming experience ("cool" button), and press the left trigger if something negatively affected their gaming experience ("frustration" button). Unfortunately, that data was not reliable because participants either forgot to press the triggers or pressed them by mistake. Nonetheless, participants referred to those buttons in the cued recall debrief.

After each play session, I took a screenshot of the recorded information (Figure 7.1) and saved it to a file. Telemetry data was extracted from screenshots using Optical Character Recognition (OCR), generating text files that were verified against the screenshots to make sure there were no conversion errors. A custom Java application parsed the text files and converted the text to a Comma Separated Value (CSV) files that were then opened on Microsoft Excel for analysis.

7.6. Data analysis

In this section, I explain how the collected data was analyzed based on my research questions. I used quantitative and qualitative data to answer to both research questions. Table 7.2 presents an outline of data collected and analysis methods based on my research questions.

Table 7.2   Summary of research questions, data collection and data analysis

Research question	Data collection	Data analysis
RQ1: How do different types of wayfinding cues affect players' wayfinding behavior in 3D action-adventure games?		
• How do different types of wayfinding cues affect the amount of time players take to progress and finish action-adventure games?	Timers and counts	Descriptive and inferential statistics
• How do different types of wayfinding cues affect players' decisions of where to go and when to proceed in action-adventure games?	Semi-structured interview and cued-recall debrief	Thematic analysis
RQ2: How do different types of wayfinding cues affect players' involvement with 3D action-adventure games?	Immersive experience questionnaire	Descriptive and inferential statistics
• How do different types of wayfinding cues improve or disrupt the player experience, making a game more or less enjoyable?	Semi-structured interview and cued-recall debrief	Thematic analysis

7.6.1. RQ1: How do different types of wayfinding cues affect players' wayfinding behavior in 3D action-adventure games?

From a quantitative perspective, I was concerned with the following question: RQ1.a How do different wayfinding cue types and wayfinding tasks affect the amount of time players take to progress and finish a game?

I analyzed telemetry data using descriptive and inferential statistics, showing how long it took for players to find elements in the game and how long it took for them to move to different areas in the game based on cues presented in each condition.

The following question guided the qualitative analysis: RQ1.b How do different types of wayfinding cues affect players' decisions of when and where to go in a game?

To answer to RQ1.b, I did a thematic analysis on cued-recall debrief transcripts following the steps suggested by Braun & Clarke (2006) (please refer to Chapter 3 for a description of this process). Some of the identified themes were raised from the data itself, whereas other themes had already been discussed in the literature. For example, previous work (e.g., Ryan &Siegel, 2009) had mentioned how players' abilities to see and interpret game elements impact the gaming experience. In my analysis, I noticed that participants frequently commented on how seeing/interpreting the wayfinding cues affected their decisions of when and where to go in the game. More unique to this research were themes around misleading cues and the number of wayfinding cues in the game. Finally, I also looked for evidence of how the cues positively/negatively impacted the player experience.

After I defined the themes raised from the cued recall debrief transcripts, a second coder worked on the transcripts to verify whether we would reach agreement. First, the second coder was trained on NVivo: qualitative analysis software that helps researchers organize and analyse rich text-based data. Then, I explained the main purpose of the research as well as all the objects in the game, as the second coder needed to familiarize himself with the three conditions of the game to understand why some players talked about a key and others talked about a gem. Finally, I defined and explained all the themes (Table 7.3) to the coder. I also explained that full paragraphs,

full sentences, or even half of a sentence could be associated with a theme, as soon as that highlight contained the core of the essence of theme.

Table 7.3   **List of main categories and themes identified in the cued recall debrief data**

Main category	Theme
Information processing	Difficult to see
Information processing	Easy to see
Information processing	Difficult to understand
Information processing	Easy to understand
Observations on wayfinding	Misleading cues
Observations on wayfinding	Not enough cues
Observations on wayfinding	Too many cues
Quality of the experience	Negative
Quality of the experience	Positive

Note that, due to the great amount of data, the second coder was trained on a single level at a time. In addition, he did not code the Castle and Meeting room levels, as they were more straightforward levels, with significantly less complex reported behavior and feelings to be unpacked than the other levels. NVivo reported a Cohen's kappa score for each of the coded levels (Table 7.4).

Table 7.4   **Kappa scores from inter-rater reliability**

Level	Start	Climbing	Waterfall	Maze	Exit	Village
Kappa	0.90	0.88	0.90	0.91	0.94	0.94

7.6.2. How do different types of wayfinding cues affect players' involvement with 3D action-adventure games?

To answer to this question, I again used both quantitative and qualitative data. Quantitatively, I analyzed the data from the IEQ using descriptive and inferential statistics.

In my qualitative analysis, I focused on the following question: RQ2.a How do different types of wayfinding cues improve or disrupt the player experience, making a game more or less enjoyable? Based on transcripts of audio recordings, I once again did

a thematic analysis, extracting familiar patterns or general themes based on my research question. I focused on comments related to players' wayfinding experiences.

7.7. Validity and reliability

In the next sections, I describe how I employed procedures to ensure validity and reliability in data collection, data analysis and presentation of findings.

7.7.1. Construct validity

As explained in Chapter 3, I collected data from multiple sources (telemetry, questionnaires, observation, and cue recall debrief) to be able to triangulate and compare data thus addressing concerns with construct validity and reliability. I employed previously validated questionnaires (demographics and the IEQ). Also, the cued recall debrief offered construct validity evidence, as participants watched their own play sessions and explained what happened in the game.

7.7.2. Internal validity

I took the following steps to minimize threats to validity in this study. First, I designed my own game to manipulate the variables of interest and avoid cofounding variables. I emphasized my area of investigation by reducing the number of activities unrelated to wayfinding. Second, participants were assigned to each condition so that each group had the same number of female participants (three per group) and roughly the same level of expertise. This step increases the probability of equivalent groups thus increasing the probability that results were due to treatment effects. Finally, I left participants alone in the gaming room to both play the game and fill out the IEQ.

7.7.3. External validity

This study gives equal importance to both quantitative and qualitative data, but it does not aim for statistical generalizability (refer to Chapter 3). This research is more aligned with a broader definition of external validity as proposed by Shapiro & Peña

(2009). I took the following steps to address concerns with external validity: first, as already pointed out, I designed a research tool that resembled commercial games in terms of quality of graphics, music, and, more importantly, wayfinding tasks and wayfinding cues. Second, I recruited action-adventure gamers (the intended audience of that type of game). Finally, I left participants alone to play in the gaming room to avoid influencing their experience. These steps address concerns with both external and ecological validity.

7.7.4. Reliability

To address reliability, I described my design choices and research procedures as much as possible to allow other researchers to repeat the steps followed in this research. In addition, I had a second coder working on the cued recall debrief data to verify whether we would reach agreement on research findings.

7.8. Results

After all the data was collected, I cleaned the quantitative data for analysis and transcribed all audio files from the cued recall debrief sessions. A first pass on the data reviewed that three participants did not fit the profile for the study. The first one was significantly less skilled than other participants and, during the cue recall debrief, he stated that he was not used to playing that type of game. Another participant mentioned that he only plays games to break them. He does not allow himself to be immersed and he was an outlier in the IEQ as he gave significantly lower scores than any other participant in the study. The third participant was also an outlier in the IEQ because he gave significantly higher scores. His comments about the game in cued recall debrief were vague and inconsistent. I disregarded their data from my analysis (one from the Attentional condition and two from the Textual condition). In addition, by looking at the demographic data, I noticed that players in the Attentional condition reported to be slightly less experienced than those in the other conditions. That said, it was previously found that "participants are not good at accurately reporting data such as how often they play, what items they used when playing, or their success at the game" (Amaya et al., 2008, p.53) – note that this is an issue when participants rely on their own memories,

and that is the reason why, in this research, participants watched their own playthroughs to explain what they did in the game and why.

Table 7.5 shows the breakdown of the number of players per group (after those three players were removed), based on their perceived expertise.

Table 7.5   **Breakdown of number of players in each condition, based on their perceived expertise**

Condition	Less experienced players	More experienced players
Attentional	5	8
Representational	3	11
Textual	3	9

In the following sections, I discuss my findings in the context of each research question. For the sake of clarity, I first discuss both quantitative and qualitative data related to participants' performance. I use qualitative data to support and/or explain quantitative results and quantitative data to give context to qualitative findings. Then, I discuss both quantitative and qualitative data related to the player experience within the game.

7.8.1.   How do different types of wayfinding cues affect players' wayfinding behavior?

This research question is divided into two sub-questions. The first one (RQ1.a) looks into players' performance (i.e., quantitative data focusing on task completion time) based on timers collected through the experiment. The second sub-question (RQ2.b) focuses on participants' reports of how they decided when and where to go in the game. This qualitative data came from the cued recall debrief and it tries to explain the reasons why a participant took less or more time to accomplish each task in the game.

How wayfinding cues affected players' performance

I started to investigate wayfinding behavior by analyzing task completion time (RQ1a: How do different types of wayfinding cues affect the amount of time players take to progress and finish action-adventure games?). During the experiment, the game (or system) recorded timestamps of events. To analyze task completion time, however, I

first calculated deltas between timestamps to find out the exact amount of time players spent in each task (instead of dealing with time elapsed since the start of the game).

While calculating the deltas, I noticed an issue with the time stamps of the keys in the Meeting Room. As explained in the previous chapter, the Meeting Room has two keys: one opens the Exit room and the other opens the gate to the Village, allowing players to progress to the last phase of the game. Four participants collected the key to the Exit room but did not realise they needed to pick up a second key. Those four players proceeded to the Exit room, solved the environmental puzzle in that room and only then realised that they could not proceed to the Village because they did not have the key to that door. They needed to go back and keep searching for the key. Therefore, a considerable amount of time passed between the time those four players entered the Meeting Room and the time they found the second key. Using those timestamps would considerably skew the data, so they were reported as missing values instead. Those four time stamps are related to the "Search2ndActivatorMeetingR" analysis. One of the participants was in the Attentional condition, another in the Representational condition, and two in the Textual condition.

Also related to the Exit room, I designed a puzzle where participants would need to jump onto a specific platform to start climbing up to the exit to the Village (please refer to the previous chapter for details on the game design). However, two participants in the Representational condition did not notice that platform and found a way to climb up the space without reaching that first platform. Those two timestamps were reported as missing values in the "ReachPlatformExit" analysis. Also, five participants (one in the Attentional condition and four in the Representational condition) unintentionally activated the Lever in the Exit room (i.e., they were not aware of the existence of the level and activated that while trying to roll, as the same button on the controller was used for both actions). Those timestamps were not considered when I did the "SearchControllerExit" analysis. Because of missing values, I could not calculate the delta for the "UseConnectorVillage" for four participants. Those were reported as missing values as well: one participant in the Attentional condition and three participants in the Representational condition.

After cleaning the data, I first ran a Levene's test for equality of variances on time on task for all tasks (except the Village which is not included in this analysis) and found that the variance between groups was not equal for six of the sixteen tasks (Table 7.6).

Table 7.6   Levene's test for equality of variances on completion time for all tasks. Tasks appear in the same sequence they appear in the game

Level	Factor	F Ratio	DFNum	DFDen	Prob > F
Start	SearchActivatorStart	5.76	2	36	0.006*
Start/Climbing	UseConnectorStart	1.64	2	36	0.206
Climbing	ReachPlatformClimb	2.64	2	36	0.085
Climbing/Waterfall	SearchControllerClimb	2.63	2	36	0.085
Waterfall	ReachCheckpointWater	2.88	2	36	0.069
Waterfall	SearchActivatorWater	4.82	2	36	0.013*
Waterfall/Castle	UseConnectorCastle	6.37	2	36	0.004*
Castle/Maze	Reach1stCheckpointMaze	4.26	2	36	0.021*
Maze	Reach2ndCheckpointMaze	1.82	2	36	0.176
Maze/Meeting Room	UseConnectorMeetingR	5.04	2	36	0.011*
Meeting Room	Search1stActivatorMeetingR	1.54	2	36	0.226
Meeting Room	Search2ndActivatorMeetingR	0.03	2	36	0.963
Meeting Room/Exit	UseConnectorExit	30.82	2	36	0.000*
Exit	ReachPlatformExit	0.04	2	36	0.953
Exit	SearchControllerExit	1.10	2	36	0.343
Exit/Village	UseConnectorVillage	1.23	2	36	0.302

Note. Numbers in bold* indicate that group variances are different.

In addition, based on task time distributions, it was verified that the assumptions of normality were not met. Thus, I carried out a Welch Anova for all the data set, as it is a rigorous test to compare means when assumptions of homogeneity are violated. There were no statistically significant differences among thirteen out of the sixteen group means based on the results as shown in Table 7.7.

Table 7.7   Welch Anova testing whether Score Means are equal for task completion time between conditions, when Standard Deviations are not equal

Level	Factor	F Ratio	DFNum	DFDen	Prob > F
Start	SearchActivatorStart	3.11	2	22.12	0.064
Start/Climbing	UseConnectorStart	1.61	2	19.22	0.224
Climbing	ReachPlatformClimb	3.50	2	21.81	0.048*

Level	Factor	F Ratio	DFNum	DFDen	Prob > F
Climbing/Waterfall	SearchControllerClimb	0.58	2	18.34	0.566
Waterfall	ReachCheckpointWater	2.91	2	18.60	0.079
Waterfall	SearchActivatorWater	2.40	2	21.30	0.114
Waterfall/Castle	UseConnectorCastle	3.31	2	16.07	0.062
Castle/Maze	Reach1stCheckpointMaze	1.17	2	18.24	0.330
Maze	Reach2ndCheckpointMaze	0.19	2	22.32	0.821
Maze/Meeting Room	UseConnectorMeetingR	2.91	2	19.48	0.078
Meeting Room	Search1stActivatorMeetingR	11.87	2	23.36	**0.000***
Meeting Room	Search2ndActivatorMeetingR	1.69	2	20.42	0.208
Meeting Room/Exit	UseConnectorExit	10.62	2	19.89	**0.000***
Exit	ReachPlatformExit	0.19	2	22.61	0.820
Exit	SearchControllerExit	1.28	2	18.25	0.299
Exit/Village	UseConnectorVillage	0.49	2	20.12	0.617

Note. Numbers in bold* indicate that group means are different.

Although group means are not significantly different for most of the tasks, it would be premature to conclude that different wayfinding cues have no effect on players' performance and their decisions of when and where to go in the game (Type II error). For example, a player who took longer than other players to finish a level may have had wayfinding issues or have spent more time appreciating the scenery or searching for secret rewards. It is difficult to pinpoint the elements interfering with wayfinding behavior in games without a more thorough investigation that triangulates completion time with participants' voices and the researcher observations of participants' playthroughs. In fact, the next sections describe how wayfinding cues in each level influenced players' decision of where to go and when. These finding are summarized at the end.

How wayfinding cues affected players' wayfinding behavior

In this section I answer to RQ1b: How do different types of wayfinding cues affect players' decisions of where to go and when to proceed? As pointed out, it is fundamental to understand players' wayfinding decisions and thought processing during wayfinding if one wants to understand how wayfinding cues affect players' wayfinding behavior.

For most tasks, I expected players in the Attentional condition to overall perform better than those in the other condition. There are a few exceptions, however, as

described below. In addition, I did not hypothesize about players' in-game behavior (and performance) in the Village given the non-linear nature of that space.

In the following sections, I present the qualitative analysis of cued recall debrief (supported by observation notes from play sessions when appropriate) to bring in players' explanations of how and when they decided to proceed in the game. Task completion time distributions are presented to give the reader context of how players performed in each task. Levels and tasks are presented in the same sequence as they were seen in the game.

Starting point

Table 7.8   Expectations on players' performance for finding the first Activator

Task	Hypotheses
SearchActivatorStart	Participants in the **Attentional condition** would perform better in the first task than participants in the other two conditions since the lighting effect would attract players to the Activator.
	Participants in the **Representational condition** would take longer than players in the other conditions to find the Activator since the key was rather small and difficult to notice.
	Participants in the **Textual condition** would take more time to find the Activator than those in the Attentional condition, but less time than those in the Representational condition. The players in this group would need time to read and understand the Textual cues, but the gem was visible in the game world so players would not have trouble noticing and picking it up.

Note: Green text indicates the group(s) I expected to have the best performance
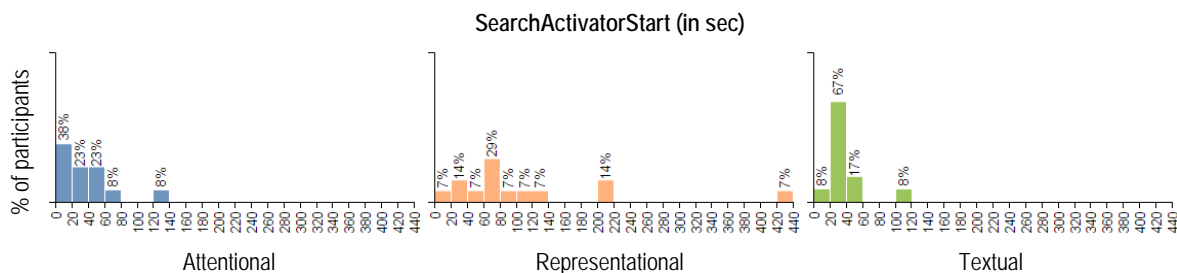
Figure 7.2   Distributions of task completion time for searching/finding the Activator (key or gem) in the Start space for Attentional, Representational, and Textual conditions

Figure 7.2 shows distributions of the amount of time it took participants from each condition to collect the Activator (key or gem) at the start of the game.

Based on these results, participants in the Attentional condition were the fastest, as 38% actually finished within 20 seconds, and most participants (77%) finished the task within 47 seconds. Participants in the Representational condition took longer than those in the other conditions, where 78% finished within ~122 seconds.

Only 8% of the participants in the Textual condition finished the task within the 20 second mark, however, when considering the majority of the participants (75%), those in the Textual condition performed on par with players in the Attentional condition.

Table 7.9   Expectations on players' performance for using the first Connector

Task	Hypotheses
UseConnectorStart	Participants in the **Attentional condition** would perform on par with those in the Representational condition as they would promptly recognize the door and know where to go.
	Participants in the **Representational condition** would perform on par with those in the Attentional condition.
	Participants in the **Textual condition** would take longer to use the Connector because they would need time to interpret the Textual cue, learn that there was a teleport in the space, and find Teleport in the environment.

Note: Green text indicates the group(s) I expected to have the best performance
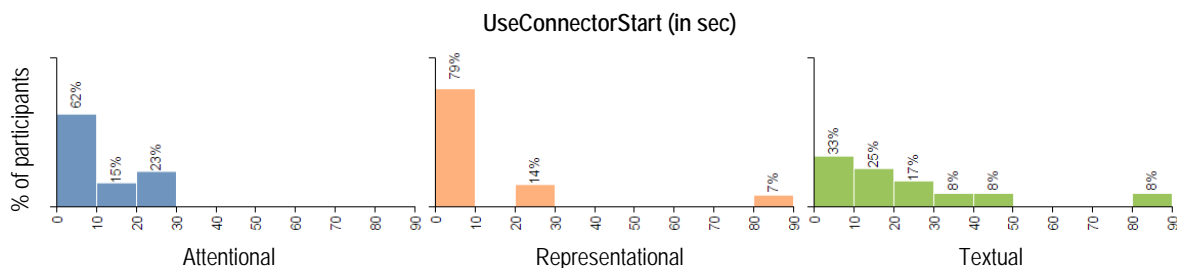
Figure 7.3   Distributions of task completion time for using the Connector after finding the respective Activator in the Start space for Attentional, Representational, and Textual conditions

Figure 7.3 shows distributions of the amount of time it took participants from each condition to use the Connector (door or teleport). Based on these results, participants in the Representational condition were the fastest (79% finished within 10 seconds), followed by those in the Attentional condition (62% finished within 10 seconds) and those in Textual condition (only 33% finished within 10 seconds).

Table 7.10 presents the number of players per condition per themes related to the Start space. For example, four participants in the Attentional condition, fourteen participants in the Representational, and nine in the Textual condition reported that some elements were difficult to see in the Start space.

Table 7.10   Number of participants per condition whose reports of perceived experience fall into the identified themes in the Starting point

Main category	Theme	Attentional	Representational	Textual
Information processing	Difficult to see	4	14	9
Information processing	Easy to see	7	0	4
Information processing	Difficult to understand	4	3	9
Information processing	Easy to understand	6	5	6
Observations on wayfinding	Misleading cues	3	1	4
Observations on wayfinding	Not enough cues	0	3	2
Observations on wayfinding	Too many cues	0	0	0
Quality of the experience	Negative	2	7	2
Quality of the experience	Positive	1	2	0

During the cued recall debrief, many participants in the **Attentional condition** mentioned that the key was easy to notice, mainly because of the lighting effect. That was the reason why participants finished that task faster than participants in the other conditions. A few factors, however, made some participants take a little bit longer in that space. Some players wanted to explore the game and its controls because that is what they were used to doing when starting a new game. Others thought the door was breakable and kept trying to break it. One participant wrongly assumed the checkpoint would open the door because the player did not know what the checkpoint was, and its strong visual effect attracted her/him.

> When I hit the stone there was a purple thing showing up. I noticed that something happened but I didn't see the key in the first time. So I thought that by hitting the stone, the door would open so I went to the door. But I found out that the door was not open, then I went back and I checked around and I saw a key. [P13]

Another player tried to climb up the walls and kept facing up so it took her/him a while to see the lighting effect highlighting the key on the ground.

I first just went to one of the edges and I looked around first to see… I mostly looked upwards to see if I could jump out of here and the door didn't catch my attention because I kept looking upwards. Then, after I was, "oh, I just got a key" and then that was how easy that was. And I was "oh my God." I think that when players start off the game, they don't usually know… especially if there are no tutorials, you don't know how to start… you just look around so that's why that didn't catch my attention. [P12]

Finally, it is worth pointing out that it took a while for a few players to go to the Connector after picking up the Activator because they wanted to spend more time exploring and appreciating the game environment; i.e., those players perceived the Activator before they had the opportunity to look around the area.

All participants in the **Representational condition** confirmed the Key was actually difficult to see. Many participants mentioned that they did not know they needed a key because the door "looked breakable" and there was no keyhole indicating that they would need a key to open the door. Many participants also reported finding the Start space frustrating because they did not know what to do in that space. Thus, they tried random actions like stepping on the checkpoint numerous times, running in circles, breaking rocks, and climbing up the walls. The lack of wayfinding cues hindered players' ability to make informed decisions of where to go and what to do. Also, many players picked up the Activator without being aware that they had done it. Finally, it is worth mentioning that they quickly used the door after picking up the key because, contrary to those in the Attentional condition, participants in this condition had already spent enough time exploring the space.

That was the part where I was learning how to use the controls so I wasn't sure what I was supposed to do. I tried to knock down the gate and I played around with the safe point. I wasn't aware that that was a safe point; I thought there was something I could do with it. It took me quite a while to find the key. In the end I was just navigating around the circle to try to find a key. Then I pressed the frustration button because it's frustrating when it says "escape from the garden of joy" and I don't know what to do. I wasn't aware that I had to find a key. I was just punching everywhere. I pressed the frustration button again when I found the key because I'm not aware that I am supposed to find a key. [P18]

First I tried the movements. Then I saw the instructions so I thought I had to go through the door. Then I attacked [the door], and I saw it

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wasn't breakable. So I was kind of wandering around, thinking that there should be a weapon or some hint. Then I think I just bumped into the key, randomly. Then I saw the [visual] effect and the icon [on the HUD]. I was just exploring the space. [P20]

As predicted, the **Textual condition** required a steeper learning curve, as players needed to read and interpret messages. Although most players correctly understood they needed to find an object (gem) to progress, many could not fully interpret the message, as they did not know what specific object they needed to find. In addition, they did not comprehend what they needed to do once they collected the Activator. There were a few specific factors that delayed players' progression: some did not notice the gem in the space or wrongly believed the gem was a random collectible; some wrongly associated the gem with the checkpoint because the gem was purple and the checkpoint's visual effect was also purple (they kept stepping on the checkpoint for a while); and, as in the other two conditions, some participants took some time to learn all the controls and some tried to climb up the walls.

While in the other conditions participants could quickly associate the Activator and the Connector, those in the Textual condition wrongly assumed that they needed to bring the Activator to the NPC. Many did not even notice the Connector (i.e., teleport) as it blended in with the background. Thus, after picking up the gem, some players kept running around, without any idea as to how to proceed. For those reasons, participants in this condition took longer to use the Connector than those in the other conditions. Several participants left the Start space through pure trial and error.

I hadn't noticed the green rock [teleport] because it is very similar to the mushrooms and the trees so, subconsciously, it just seemed like scenery. And that rock [checkpoint] has a similar texture to the rock [gem] on the ground... They are similar color wise and texture wise so that's why I was constantly walking over there... So at the end I figured out "oh, that's the rock." And then right after that, anytime it told me "you need something to progress", I knew that's the thing I should be going for. [P32]

I didn't know what to do actually because there were no instructions... except when it says that you have to "escape from the garden of joy." They didn't tell me how until I approached the NPC. I read the message that I had to collect something to activate a magic stone. At first I didn't even know what the stone was. It's the green one... So, in

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games, when you don't know what to do you break stuff and things come up. [P41]

Climbing space

Table 7.11   Expectations on players' performance for reaching on the first platforms in the Climbing space

Task	Hypotheses
ReachPlatformClimb	Participants in the **Attentional condition** would be the first noticing the platforms because of the visual effect highlighting those platforms.
	Participants in the **Representation condition** would be the second noticing the wooden platforms. Although the platforms were not highlighted by any visual effect, players were supposed promptly recognize the objects from previous experiences with games (i.e., no learning would be necessary).
	Participants in the **Textual condition** would take longer than players in the other two conditions to notice and climb the platforms (mushrooms in this condition) because the participants would at first assume that the mushrooms were only part of the scenery so they would need to learn what the mushrooms were for.

Note: Green text indicates the group(s) I expected to have the best performance
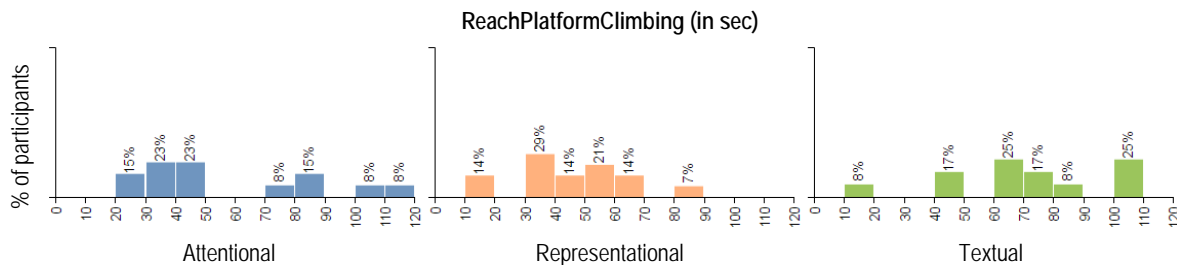
Figure 7.4   Distributions of task completion time for participants finding and jumping on the first platform in the Climbing space for Attentional, Representational, and Textual conditions

Figure 7.4 shows distributions of the amount of time it took participants from each condition to climb on the platforms/mushrooms and go to the upper area.

Overall, contrary to my expectations, participants in the Representational condition performed this task faster than participants in the Attentional condition. Their completion time ranged from 15 to 82 seconds, and 78% of the players jumped on the platform within ~60 seconds. For those in the Attentional condition, completion time ranged from 21 to 110 seconds, and 75% of them finished the task within ~87 seconds. Finally, those in the Textual condition had a completion time ranging from 14 to 109 seconds and 75% of them finished the task within ~90 seconds. The difference between

participants in the Attentional and Textual conditions can be seen based on the shape of the distributions. This, although completion time ranges were basically the same for both conditions, the Attentional condition's distribution for this task is slightly positively skewed and the Textual condition's distribution is slightly negatively skewed, with most players in the Textual condition taking longer to finish the task.

Table 7.12   Expectations on players' performance for triggering the Controller in the Climbing space

Task	Hypotheses
SearchControllerClimb	Participants in the **Attentional condition** would be the first noticing and thus interacting with the Controller because of the visual effect.
	Participants in the **Representation condition** would be the second group interacting with the Controller.
	Participants in the **Textual condition** would take longer to interact with the Controller (breakable rock) as they would need more time read and interpret the instructions in other to progress in the game.

Note: Green text indicates the group(s) I expected to have the best performance
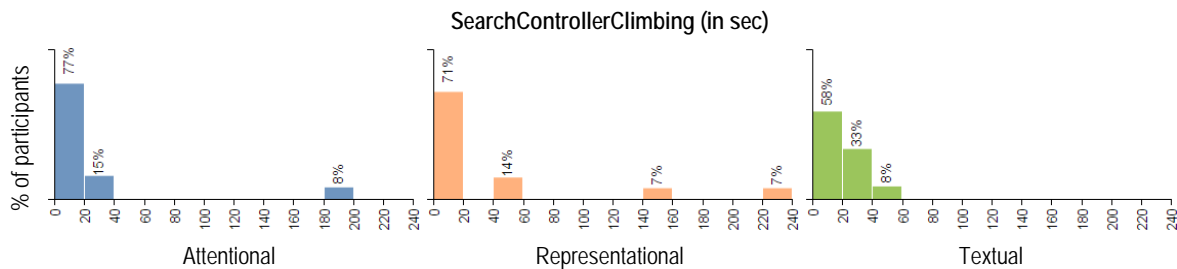
Figure 7.5   Distributions of task completion time for interacting with the Controller (lever or breakable rock) in the Climbing space for Attentional, Representational, and Textual conditions

Figure 7.5 shows distributions of the time between reaching the platform and interacting with the Controller (lever or breakable rock). Most participants in the Attentional and Representational conditions quickly noticed the lever, with those in the Attentional condition performing just slightly better than those in the Representational condition. However, there were outliers in both conditions: a single participant in the Attentional condition accomplished the task in 188 seconds; one participant in the Representational condition finished in 150 seconds and another in 232 seconds. Participants in the Textual condition presented a more consistent performance. There

was one outlier who finished in 47 seconds. As predicted, they took slightly longer to interact with the Controller than the majority of participants in the other conditions.

Table 7.13   Expectations on players' performance for exiting the Climbing space and reaching the checkpoint in the Waterfall area

Task	Hypotheses
ReachCheckpointWater	Participants in the **Attentional condition** would perform better than those in the Representational condition, but worse than those in the Textual condition.
	Participants in the **Representation condition** would perform worse than players in the other two conditions because of the lack of feedback.
	Participants in the **Textual condition** would be the fastest because of the clear feedback indicating the new platforms in the environment.

Note: Green text indicates the group(s) I expected to have the best performance
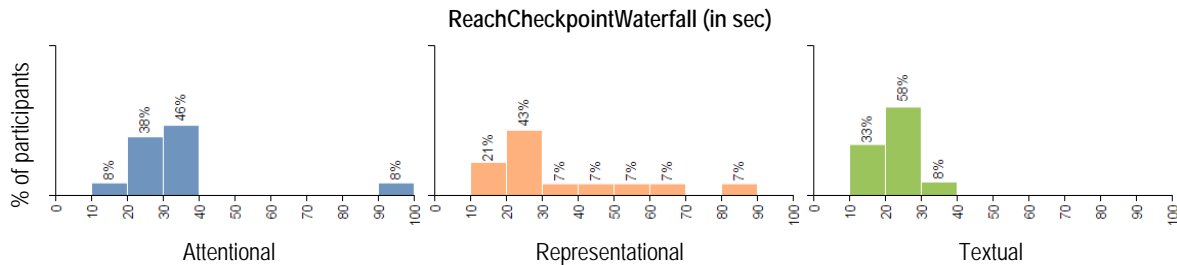
Figure 7.6   Distributions of task completion time for completing the Climbing space and transitioning to the Waterfall area for Attentional, Representational, and Textual conditions

Figure 7.6 shows distributions of the time participants took to reach the last set of platforms and exit the Climbing area. These results show that, as predicted, participants in the Textual condition not only had the best performance. Overall, players in the Attentional condition were slower than those in the Textual condition and, unexpectedly, also slower than some players in the Representational condition. Nearly two-thirds of the participants in the Representational condition behaved on par with those in the Textual condition. The remaining players of the Representational condition performed worse than players in the Attentional and Textual conditions.

Table 7.14 presents the number of players per condition per themes related to the Climbing space. For example, ten participants in the Attentional condition, nine in the Representational, and two in the Textual condition reported that there were elements difficult to see in the Climbing space.

Table 7.14   **Number of participants per condition whose reports of perceived experience fall into the identified themes in the Climbing space**

Main category	Theme	Attentional	Representational	Textual
Information processing	Difficult to see	10	9	2
Information processing	Easy to see	12	11	11
Information processing	Difficult to understand	9	9	6
Information processing	Easy to understand	10	10	10
Observations on wayfinding	Misleading cues	2	8	2
Observations on wayfinding	Not enough cues	0	1	0
Observations on wayfinding	Too many cues	1	0	1
Quality of the experience	Negative	1	2	3
Quality of the experience	Positive	5	6	8

For all conditions, the participants who did not collect coins were the first to jump on the platform (first task). The desire, or lack thereof, to collect coins or any other reward in games is an individual difference that reflects on task completion time and is not necessarily related to wayfinding cues. An exception is when players collect objects because the players do not know what to do. In such cases, collecting objects becomes a way of coping with being lost, and issues with wayfinding cues surface.

During the cued recall debrief, many participants in the **Attentional condition** mentioned that they took their time to explore the environment and collect coins. Although they did not quickly jump on the platforms, none of them reported they felt lost or uneasy in this second space. Some of the players who took longer to accomplish the tasks actually knew where they were supposed to go but they were not skilled enough to jump on the platforms and ended up taking longer to trigger the sensor that tracked the event timestamps. Two players, however, took overly longer than most of the players to jump on the platform because they wrongly interpreted some of the objects in the game: the first one wrongly believed the platform (combined with the visual effect) was an elevator and kept trying to get underneath the platforms instead of jumping on them. As that did not work, the player tried to destroy the tree logs blocking the secondary passage. The second player wrongly believed s/he would escape through the gaps between the very same tree logs. Those tree logs were coded as Misleading Cues. It is important to mention that, even though one of these players was an outlier (s/he took too

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long to accomplish the task), the player mentioned in the cue recall debrief that s/he was enjoying the game at that point:

> Then I pressed the cool button because I found the map just really cool. [P12]

Overall, players in the Attentional condition did not have any problem noticing the Controller (lever). The single outlier was not as skilled with jumping. Thus, it took the player many trials to go to the upper area of the level to interact with the controller, which increased her/his task completion time.

Finally, ten players in the Attentional condition reported that it was difficult to notice the pillars coming up after they interacted with the lever. The visual feedback was misinterpreted by several participants and became a distraction instead of a cue. As a result, participants kept pulling and pushing the lever to see what changed, or they just stood still near the lever waiting for something else to happen. That distraction led all players in this condition to take more time to progress to the next space (reach the checkpoint in the Waterfall area).

> Here, it's kind of hard to notice what it does. After pulling the lever, I saw a flashlight. At first, I thought it would blow up something but then I turned around and I didn't see anything just "boom!" And then I was just "I will keep going and try to find out. Maybe something will come up later in the game." [P02]
>
> I was looking at the blue light; I didn't look at the rocks. I hadn't noticed. [P07]
>
> I saw the blue light and turned to watch it... but I didn't do anything about it. I pulled the lever but there wasn't any feedback of anything happening. I guess happened somewhere off screen but I didn't notice it. [P10]

Overall, players in the **Representational condition** had the best performance in the first and second tasks (i.e., reach the platform and interact with the Controller). Nonetheless, there were four players in this condition who performed on par or worse than players in the other two conditions on the second task. Most of them mentioned they had no problem noticing the platforms and Controller (lever), suggesting that the use of familiar objects in games might be enough for players to understand where to go

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and what to do next. Another fact that may have affected these results is related to a learning effect. For example, players in the Representational condition did not spend as much time trying to break the tree logs as players in the Attentional condition. It may have been the case that the players in this condition already knew they could not break objects in order to advance in the game because they had spent a great amount of time trying to break the door at the Start of the game. For example, the player who took the shortest amount of time to accomplish this first task in the Climbing space was one of the last participants to find the Activator in the previous space.

> When I couldn't get out of the door [blocked by tree logs], I was like "maybe I should climb up", but it didn't work on the first time [starting area]. When I saw the platforms I just jumped right away. (P28)

Although most players quickly progressed, a few players had trouble noticing the Controller. Those expected the game to have more cues, especially because some of those players were already frustrated with the lack of cues in the previous space:

> I just climbed there and I kind of got lost there. It was easy to see the platforms, but after I got really confused. It doesn't really show where I have to go. So, like I said, if there was a green arrow pointing down to the lever then it would be better. Sounds really confusing… "Whaaat? Where do I have to go now?" [P19]

Also, although two-thirds of the players in this condition quickly reached the checkpoint in the Waterfall area, some players took a bit longer than the rest of the group. Those were confused by the lack of feedback after interacting with the Controller and, because they did not notice what had happened, they kept wandering in the space.

> I didn't notice that [pillars]. I only noticed when I fell down… because when I fell down I was "oh, I have to climb up again." Then I saw those rocks [pillars] and I realize they weren't there before. [P17]

> So I was like lost and I went back to the first room and I think I wandered for 5 minutes there. [P19]

Finally, participants in the **Textual condition** took longer to accomplish the first task in the Climbing space. Expectedly, participants were distracted by other mushrooms in the space. Interestingly, most players in this conditions mentioned they collected the

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coins either because they wanted to explore the space or because they felt lost. Also, some reported they hypothesized they needed to climb up only when they saw the woman at the upper area. That is, the mushrooms did not work well as wayfinding cues.

> Then I was surveying the map and saw an NPC on the top so I knew that there was a way to get to the top so I was looking and I noticed the mushrooms. [P40]

Participants in this condition performed well in the final task of this space (find the exit and reach the checkpoint). As predicted, the camera effect showing the pillars coming up from the ground was quite easy to understand by the majority of the players. In fact, many players mentioned they welcomed the visual feedback after they interacted with the Controller in this space, as it clearly guided the players on where they needed to go and how.

> I find it to be actually helpful because it gives you a hint of where to go next. So it does help a lot... You don't waste time trying to figure out what is different; having that kind of helps to direct you to what happened. It's actually a good thing because if you hit something and there is no action, then you are "okay, I guess there is another kind of trigger that I have to hit in order to make something work." But in this case is almost like a cause-effect that you do something you are rewarded for it. That helps a lot. [P33]

Waterfall area

Table 7.15   Expectations on players' performance for finding the Activator in the Waterfall area

Task	Hypotheses
SearchActivatorWater	Participants in the **Attentional condition** would reach the Activator faster than those in the Representational condition because of the visual effect, but slower than those in the Textual condition because the NPC's instructions would work better as a cue than the visual effect.
	Participants in the **Representational condition** would perform worse than participants in the other two conditions because of the limited use of cues.
	Participants in the **Textual condition** would have the best performance compared to the players in the other two conditions because the NPC would direct the players to where the Activator was hidden.

Note: Green text indicates the group(s) I expected to have the best performance
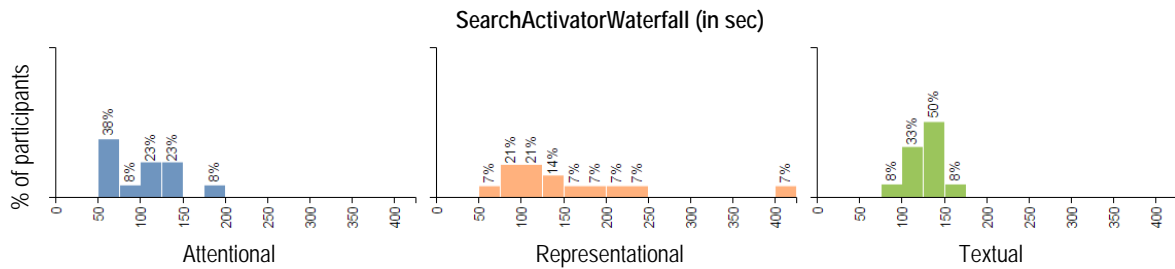
Figure 7.7   Distributions of task completion time for searching the Activator (key or gem) in the Waterfall are for all conditions

Figure 7.7 shows distributions of the time it took participants to reach the Activator in the Waterfall area. These results show that, overall, some participants in the Attentional condition performed better than other players, with 38% of them finishing the task within 75 seconds. Although the participants in the Textual condition did not perform better than those in the Attentional condition, they had the most similar behavior (i.e., smaller time range). As expected, players in the Representational condition took longer than players in the other conditions (although the fastest players in the Representational condition performed better than the fastest players in the Textual condition).

Table 7.16   Expectations on players' performance for reaching the Connector that gave access to the Castle

Task	Hypotheses
UseConnectorCastle	Participants in the **Attentional condition** would perform on par with those in the Representational condition (i.e., visual effect in front of the door would not make a difference in this case), and better than those in the Textual condition.
	Participants in the **Representational condition** would perform on par with those in the Attentional condition and better than those in the Textual condition.
	Participants in the **Textual condition** would take longer to complete this task as they, once again would need to interpret the NPC's message and notice the teleport in order to progress.

Note: Green text indicates the group(s) I expected to have the best performance
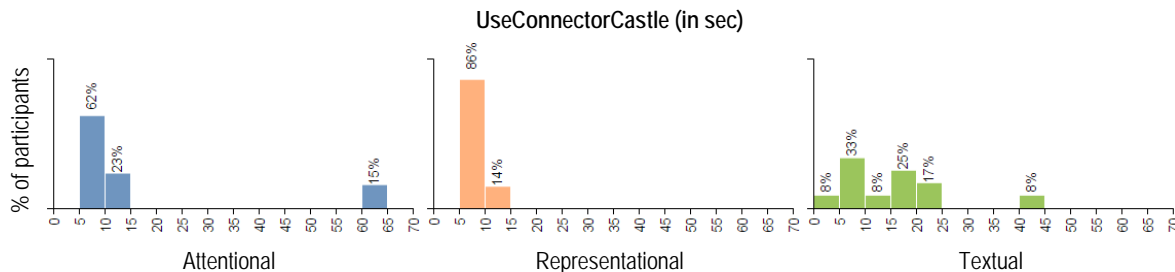
Figure 7.8   Distributions of task completion time for reaching the Connector (door or teleport) in the Waterfall space for all conditions

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Figure 7.8 shows distributions of the time elapsed between the time participants got the Activator and the time participants reached the Connector to the Castle. As expected, participants in the Attentional and Representational conditions overall performed better than those in the Textual condition. The two outliers in the Attentional condition did not have wayfinding problems; they were exploring the environment and appreciating the graphics after they found the Activator:

> I was swimming... it was just for fun... I was taking my time and exploring stuff. [P02]

As it happened in the Starting point, players in the Representational condition quickly moved to the Connector after finding the Activator and were the fastest in the task. Also similarly to the Starting point, players in the Textual condition took longer to reach the Connector than players in other conditions, likely because they needed more time to read and interpreted the message telling them what to do with the Activator.

Table 7.17 presents the number of players per condition per themes related to the Waterfall area. For example, six participants in the Attentional condition, seven in the Representational, and seven in the Textual condition reported that there were elements difficult to see in the Waterfall area.

Table 7.17   **Number of participants per condition whose reports of perceived experience fall into the identified themes in the Waterfall area**

Main category	Theme	Attentional	Representational	Textual
Information processing	Difficult to see	6	7	7
Information processing	Easy to see	10	7	8
Information processing	Difficult to understand	1	2	2
Information processing	Easy to understand	9	6	12
Observations on wayfinding	Misleading cues	3	6	8
Observations on wayfinding	Not enough cues	1	0	3
Observations on wayfinding	Too many cues	2	0	1
Quality of the experience	Negative	1	3	5
Quality of the experience	Positive	3	6	9

During the cued recall debrief, many participants in the **Attentional condition** mentioned they wanted to explore the area. In spite of the time spent with exploration, players in this condition had the best performance overall. For example, P06, the third to

last player to collect the Activator in the Attentional condition, explained how s\he spent time in the Waterfall area:

> Then I was walking and looking around to see if I could jump over the fence or not, checking the boundaries. […] For this game, I was taking time. I knew what I had to do because of the display [HUD] "defeat the enemies"… but… for example, here [watching the video] I wanted to see if I could get burned by fire. I was seeing if I could cut the wood in half with my sword, and then I was trying to dive or swim. [P06]

Just a couple of players in this group mentioned that it was difficult to notice the platforms even though there was a visual effect around the platforms. This may have happened because the visual effect, which is blue, was blending in with the background (the waterfall, also bluish). In addition, some players mentioned that the Activator was too small and, for this reason, difficult to see and collect. Players also mentioned that they wrongly assumed they would be able to dive and find a hidden object at the bottom of the lake (instead of behind the waterfall). Finally, as it happened in the Starting point, some players in this condition explored the environment after collecting the Activator. That was one of the main reasons why some of them spent more time to reach the Connector than those players in the Representational condition:

> I knew that I had to go through the gate, but I wanted to see if there were any extra coins around or any hints. [P12]

Many participants in the **Representational condition**, like those in the other two conditions, went to swim after defeating the enemies because they wrongly believed they would find something at the bottom of the lake. The lake, in this case, became a misleading cue, as it sent players off course.

As results suggest, it seems that players in this condition had more trouble noticing the platform than those in the other conditions. After swimming for a while, many players got out of the lake and explored other areas, away from the waterfall. That is, as players could not notice the platforms, they considered other alternatives: they tried to destroy tree logs, go back to the previous space (which had been blocked), roll beneath the Castle's gate, and pass through the invisible wall blocking the boundaries of the

game world. Those were the reasons why it took a while for those players to collect the key in this space.

> So then I tried to walk around, and go to the gate, and jump over the fence, so I came back to the waterfall and I started to poke around a little bit more. [P16]

> I didn't see the platforms at all so I was confused about what to do. I thought I was supposed to do something with the [tree] logs because of the two fires [two fire pits near the tress]. [P18]

Two players had trouble with noticing the key specifically. Those players noticed the platforms and found the chest where the keys were located. However, they did not notice they had not touched the key in order to collect them. Those two players actually pressed the frustration button when they got closer to the Connector (gate) and it did not open.

> I didn't get the key... I opened the box but I didn't pick the key up. I didn't notice that [Frustration button]. Yeah. I was, "the door was supposed to be open." [P28]

As mentioned before, players in the Representational condition had the best performance in the second task (reaching the Connect) in the Waterfall area. That was likely because, by the time those players found the key, they had already explored most of the Waterfall area so they knew they could go to the Connector right away:

> I was walking into the water but then I saw that ledge that I could jump to and that was where the key was. I figured out right away so I just kind of moved on because I had already explored the other side so I just had to move further. [P24]

Finally, in the **Textual condition**, participants had a steady performance. As mentioned before, the time range for finding the Activator was quite similar for most players. Players in this condition followed the woman who gave them the hint that the Activator was near the waterfall. As in the other conditions, most participants went to the lake, incorrectly assuming they would to find something at the bottom of it. However, contrary to players who wandered around the space in the other two conditions, most of the players who did not promptly notice the platforms in the Textual condition were still

aware that they needed to search the nearby area (instead of, for example, going back to the entrance of the Waterfall area):

> The person just says "it's nearby" so it hints on what I need to do, but then again it doesn't tell you directly how to solve it. So that was fine. At least it's not telling me "it's right there." If she had pointed, that would make it too easy. But it's good that it narrows the search down [so I don't] have to go all the way back. Then I talked to the other woman, and I looked for the coins and then I was exploring. But I'm still aware that it's still there. [P32]

> Then I went back to the waterfall because that's where the person left me so I thought it was definitely there. [P33]

Interestingly, those players from the Textual condition who were faster than those in the Representational condition mentioned that it took them a long time to notice the platforms. Those in the Representational condition, on the other hand, frequently mentioned that they noticed the platform right away. A hypothesis could be that the players in the Textual condition unconsciously felt more pressured to quickly find the Activator after they received the hint ("It's nearby"), whereas players in the Representational condition freely explored the space and accomplished the challenge relying on their own skills. That is, they felt they finished task within a reasonable time frame, considering they had not had any hints. A few players in the Textual condition were frustrated looking for the Activator:

> In this part I was quite frustrated again because I didn't see that there was a platform there. [P38]

As mentioned, players in the Textual condition had the worst performance in the second task (reach the Connector). As predicted, at this point in the game, players had yet to learn that the green pyramid was a teleport that was activated by the gem. Some players reported that they did not know what to do after collecting the Activator (gem):

> I noticed when I got the gem, but I didn't know what to do with it. I went to the woman... And then I think I inadvertently hit it [teleport] again. To me, it didn't stand out here [outdoors]. But here [in the castle], it really stands out because it doesn't blend in with anything so I'm like "okay, that's clearly something." [P36]

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Then, after I got the gem, I didn't know what to do. [...] I felt lost. Then I accidentally walked into the portal. I didn't even see the portal. [P37]

Castle

Table 7.18   Expectations on players' performance for reaching the first Checkpoint in the Maze (i.e., getting in the Maze)

Task	Hypotheses
Reach1stCheckpointMaze	Participants in the **Attentional condition** would rapidly notice the Guide and follow it, going to the Maze right away.
	Participants in the **Representational condition** would present an inconsistent behavior: some would follow the NPC, and some would explore the Castle because, at first, they would not understand NPC was a Guide.
	Participants in the **Textual condition** would go into the Maze right away because they would naturally comply with the NPC's message: "Follow me."

Note: Green text indicates the group(s) I expected to have the best performance
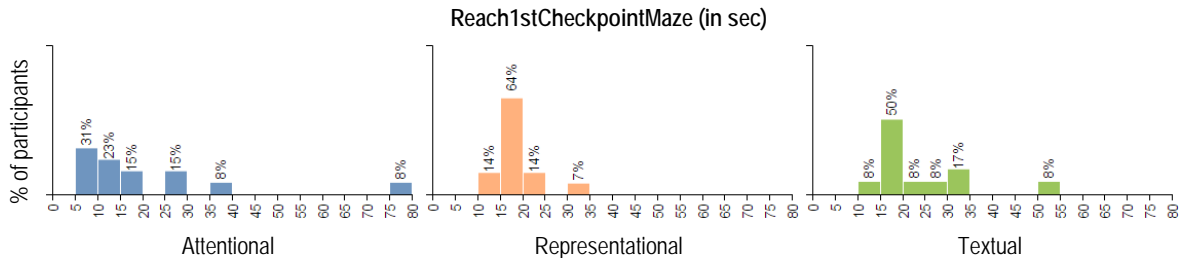
Figure 7.9   Distributions of task completion time for participants finishing the Castle for Attentional, Representational, and Textual conditions

Figure 7.9 shows distributions of the time elapsed between the time participants entered the Castle and the time they entered the Maze, reaching the Maze's first checkpoint. Overall, most participants, in all conditions, finished the task within 20 seconds or less. The Attentional condition had the fastest participants; however, this group unexpectedly presented the highest variation. P12, for example, performed worse than participants in all conditions and was an outlier in this task (note that this player was an outlier in most of the tasks of the game).

Contrary to my expectations, players in the Representational condition had the most similar behavior, as thirteen out of fourteen participants finished the task between 14 and 21 seconds. Finally, also contrary to my expectations, the data indicates great

variation in performance among players in the Textual condition. It seems that many players in this group did not promptly conform to the NPC's instruction "Follow me."

Table 7.19 presents the number of players per condition per themes related to the Castle. Overall, participants did not mention having issues with the wayfinding cues in this space. Many mentioned that the cues were easy to notice and understand.

Table 7.19   Number of participants per condition whose reports of perceived experience fall into the identified themes in the Castle

Main category	Theme	Attentional	Representational	Textual
Information processing	Difficult to see	1	0	0
Information processing	Easy to see	10	12	9
Information processing	Difficult to understand	4	2	2
Information processing	Easy to understand	9	6	9
Observations on wayfinding	Misleading cues	0	0	0
Observations on wayfinding	Not enough cues	0	0	0
Observations on wayfinding	Too many cues	0	0	0
Quality of the experience	Negative	0	0	0
Quality of the experience	Positive	1	1	0

During the cued recall debrief, most participants in the **Attentional condition** mentioned that they easily noticed the orb (wayfinding cue) but wanted to talk to the NPC before following the orb. Note that this was the first time that players in this condition had a NPC giving them instructions. They reported being curious to know what the NPC had to say. As mentioned before, two players took longer than others in this condition. The first one read what the NPC's message, but, before going to the Maze, the player checked all the other rooms in the Castle. After noticing that the rooms were locked, the player went to Maze. The other player though the NPC was an enemy and attacked him. When the player noticed that a message had popped up and disappeared, the player waited to see if the message would appear again.

Interestingly, one of the first players who finished this task in the Attentional condition reported that the camera actually shifted to the wayfinding cue, telling her/him where to go. However, such effect was not designed in the game. Only the Textual condition had a camera effect showing pillars (Climbing space) and platforms (Exit room).

My first instinct was to go and talk to him. And actually, when I walked up I just saw my camera pan towards where that little fairy light was, so I had that instinct that I had to go there as well. But the guy was top priority for sure. And then, as soon as I knew what to do, I knew the light was over there. [P03]

Like in the Attentional condition, players in the **Representational condition** had not received instructions from NPCs up until this point so they wanted to talk to the NPC because it was something new in the game. The outlier in task, who took longer than the other players to go to the Maze, mentioned that s/he wanted to explore the Castle before proceeding. Note that none of the players performed on par with the fastest players in the Attentional condition.

Players in the **Textual condition** mentioned they read the NPC's instruction to go to the Maze and they also read when the "Follow me" message. However, based on the cued recall debrief, it seems that a higher percentage of players in this condition wanted to explore the Castle before proceeding compared to the other two conditions. One of the reasons for that was that some players clearly saw the teleports (green pyramids) for the first time and they wanted to find out what they were. Other players mentioned that they usually explore the game environment before proceeding (i.e., the individual play style affected their performance).

I saw when the guy told me to follow him, but what are those green triangles for? [P37]

I read when the guy said, "follow me", but I wanted to explore the area first before following him. [P39]

Another hypothesis is that the players in this condition got used to receiving instructions from NPCs and they wanted to do some exploration on their own. In addition, players correctly assumed that the NPCs would wait for them before moving forward, so there was no need for rushing on moving forward.

Maze

As discussed in the previous chapter, the Maze was a complex environment in the sense that participants could choose between promptly accomplishing the main

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tasks and exploring side paths. In addition, contrary to other spaces in the game, players needed to backtrack in order to get out of the Maze and then reach the Meeting room. The other spaces in game, on the other hand, were pretty linear and players only needed to move forward.

Table 7.20   Expectations on players' performance for reaching the second Checkpoint in the Maze

Task	Hypotheses
Reach2ndCheckpointMaze	Participants in the **Attentional condition** would intuitively follow the blue orb all the way to the Activator.
	Participants in the **Representational condition** would present an inconsistent behavior: some would follow their guide and some would not. Those not following the Guide would not feel compelled to follow their guide because the NPC just rushed into the Maze without engaging or talking with the players.
	Participants in the **Textual condition** would comply with the instruction "Follow me" thus following their guide all the way to the Activator.

Note: Green text indicates the group(s) I expected to have the best performance
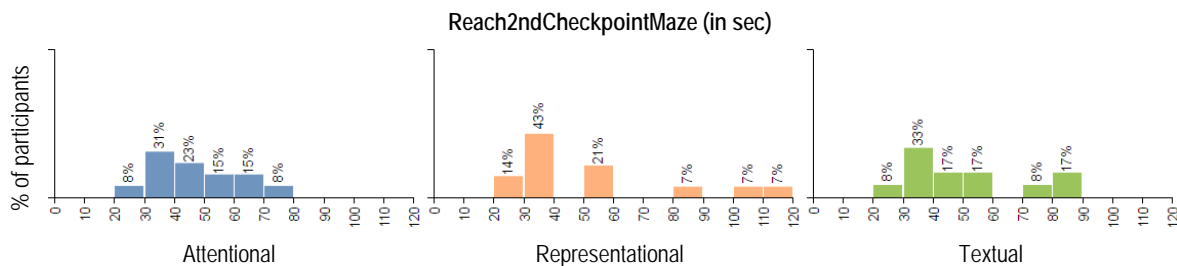
Figure 7.10   Distributions of task completion time for reaching the end of the Maze and completing the first goal (finding an Activator) for Attentional, Representational, and Textual conditions

Figure 7.10 shows distributions of the time elapsed between the time participants entered the Maze and the time they reached the end of the Maze, reaching a second checkpoint. As expected, participants in the Attentional condition had a more similar behavior (completion time ranging from 26 to 76 seconds), followed by those in the Textual condition (completion time ranging from 29 to 89 seconds).

Surprisingly, most players in the Representational condition behaved on par with those in the other two conditions (completion time ranging from 25 to 84 seconds). In fact, 57% of those in the Representational condition finished the task within 40 seconds (compared to 39% in the Attentional and 41% in the Textual condition respectively). Two

participants in the Representational condition, however, took longer than all participants, finishing the task in 100 and 115 seconds (those two players explained their behavior during the cued recall debrief).

Table 7.21   Expectations on players' performance for opening the Connector that gave access to the Meeting Room

Task	Hypotheses
UseConnectorMeetingR	Participants in the **Attentional condition** would intuitively notice the torches because of its visual effect and easily get out of the Maze and reach the Meeting room. They would perform better than those in the Representational condition but worse than those in the Textual condition.
	Participants in the **Representational condition** would present a mixed behavior: some participants would notice the torches and easily leave the Maze and some would not notice the Maze and struggle to find the way out. This conjecture comes from findings from Study 1 where most players did not notice nor understand the torches as cues showing the path.
	Participants in the **Textual condition** would perform better than players in the other conditions as they would know they could rely on the torches to find a way out. The expectation is that they would promptly follow the NPC's instruction.

Note: Green text indicates the group(s) I expected to have the best performance
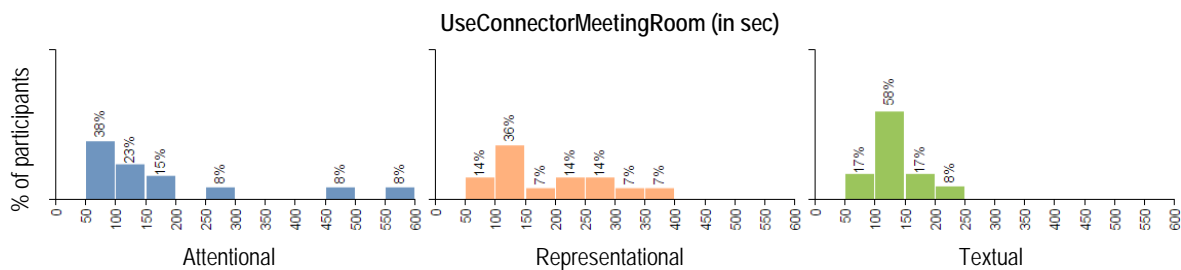
Figure 7.11   Distributions of task completion time for completing the Maze and finding the Meeting Room for Attentional, Representational, and Textual conditions

Figure 7.11 shows distributions of the time elapsed between the time participants reached the Maze's second checkpoint and the time they reached the Meeting room. Overall, results confirmed the expectations for this task. Participants in the Textual condition overall performed better than participants in the other two conditions, with task completion time ranging from 69 to 204 seconds. These results indicate that the NPC's instructions (i.e., follow the torches) worked as expected. Participants in the Attentional condition had the second best overall performance, with completion time ranging from 83 to 258 seconds. There were, however, two outliers who finished the task in 483 and

584 seconds (see cued recall debrief for details). Finally, as expected, participants in the Representational condition were not as fast as those in the other conditions (even though their overall performance was on par with those in the Attentional condition).

Table 7.22 presents the number of players per condition per themes related to the Maze. However, due to the complexity of the space, I would argue that those numbers alone do not comprehensively explain how the wayfinding cues affected the player experience or task completion time in the Maze. Insights from the cued recall debrief are presented in the following paragraphs in order to clarify how players reacted to the Maze and its wayfinding cues.

Table 7.22   Number of participants per condition whose reports of perceived experience fall into the identified themes in the Maze

Main category	Theme	Attentional	Representational	Textual
Information processing	Difficult to see	6	4	5
Information processing	Easy to see	5	10	4
Information processing	Difficult to understand	6	8	7
Information processing	Easy to understand	13	14	10
Observations on wayfinding	Misleading cues	2	4	1
Observations on wayfinding	Not enough cues	4	3	0
Observations on wayfinding	Too many cues	2	4	2
Quality of the experience	Negative	4	7	8
Quality of the experience	Positive	9	9	5

As mentioned, players from all conditions performed on par in the first task in the Maze. Results indicate that the different cues did not affect players' performance in that context. For the second task, however, players in the Textual condition performed better than players in the other two conditions. Those in the Textual condition had specific instructions of what to do to get out of the Maze so they never wandered around for too long. Players in the Textual condition took between 69 and 204 seconds to reach the Meeting room. Participants in the Attentional condition had the second best performance in the second task, followed by those in the Representational condition. Three players in the Attentional condition and six in the Representational condition took longer than 200 seconds to do the same task. That is, those players took longer to accomplish the task than the player who finished last in the Textual condition. In general, players who did not explore the Castle did not know where the Meeting room was so they spent a significant

amount of time searching for the Meeting room inside the Maze, instead of going back to the Castle. The following paragraphs reveal some of the problems faced by those players and give more information on players' overall performance in the Maze.

In the cued recall debrief, participants in the **Attentional condition** mentioned that they understood the orb was guiding them to the next objective so they followed the orb all the way to the Activator. On the way out, the fastest players in this condition preferred to leave the Maze without exploring it. Most players, however, explored the Maze and collected coins. It is interesting to notice that, although most players in this condition performed quite well in the second task, many mentioned they did not follow the torches but relied on their own memory to get out of the Maze. Many also mentioned they had not noticed the torches being lighted up on the way in (as reported in the "Difficult to see" theme). It might be the case that those players unconsciously followed the visual effects, so they could not comment on that.

As previously explained, three players in the Attentional condition took more than 200 seconds to reach the Meeting room. Some of their wayfinding issues were: P02, who took 483 seconds, mentioned that s/he did not notice the torches/visual effects and relied on her/his memory to get out of the Maze. This player did not know where the Meeting room was and went back to the Maze after s/he found the way out to confirm s/he had not forgotten something or had not missed the Meeting room's entrance. The player also mentioned that s/he expected to have a map indicating the game's locations. P10, who took 258 seconds to reach the Meeting room, mentioned that s/he relied on the guide on the way in and could not remember the path s/he had taken. After collecting the Activator, the player stayed there, waiting for the guide to take her/him back to the Meeting room. This player mentioned that getting out of the Maze was pretty frustrating and that it would have been better if a map had been provided. P12 took longer than any other player to finish the task because of two main reasons: first, the player stood still, waiting for the guide to show the way back; second, the player misunderstood a message related to the Sword the players could pick up and believed that s/he needed to stay in the Maze until s/he could find another Warrior. P12 mentioned not feeling lost in the Maze but actually being quite interested in keep playing the game.

I'm still interested in playing the game and I'm trying the hardest to find a hint to find the warrior because I thought that I was supposed to. [P12]

Most players in the **Representational condition** didn't have any trouble getting into the Maze because they followed the guide until they found the Activator. Two players however, took longer than all the other participants in the study. Both players mentioned they wanted to explore the Maze on the way in. P22 mentioned that he would explore the Maze independently of having the guide. P24, on the other hand, mentioned that the guide gave the player confidence to explore, without the risk of getting lost. Both players agreed that the guide was useful to differentiate between the main path and the side paths.

But I'm exploring the maze because I want to find all those coins. So [the guide] would be on the sidetrack. I felt that it was nice for [the guide] to be there, just in case I do get lost. But given that I would explore the maze, she was not that relevant. If I wanted to do the game quicker, then I would just go to her and not collect the coins. But I think I wouldn't miss her. [P22]

This woman was pretty good. She doesn't move too far away so... In this maze there are some fork paths so, even if she goes one way, I usually think... Well, since I'm an achiever, if she goes one way, I know I have to go the other way. That's my habit when I play games: when there are two paths and I know that one way is for sure the one to move on with the story, then I will take the other one because there are probably treasure chests in there. So that's what I was doing here as well... wherever the girl is walking to, it's probably towards the objective and not the other treasures, so I usually walk to the opposite direction. After I finally know that I have explored everything, I just continue to follow her. [P24]

As mentioned before, six players in the Representational condition took longer than 200 seconds to reach the Meeting room. P15 took 254 seconds; however, the player mentioned that s/he was never lost in the Maze because he had noticed that the NPC lighted up the torches on the way in. The player was just exploring the Maze on the way out. P19 spent 398 seconds to reach the Meeting room because the player did not know where the Meeting room was – the player wrongly believed the Meeting room was inside the Maze. The player did not feel lost, as s/he could recall all areas s/he had been before. P23, P26 and P28 got lost on the way out because the players did not notice the

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torches and also because they were not sure where the Meeting room was. P25 mentioned that s/he got lost exploring the Maze while backtracking and enjoyed the challenge at first (the player mentioned that s/he pressed the cool button). However, the player felt frustrated after spending some time looking for the Meeting room.

Finally, as mentioned before, participants in the **Textual condition** performed well in both tasks (on the way in and on the way out of the Maze). As predicted, the NPC's instructions made it clear for most players what they needed to do. The NPC's instructions were specifically important in the second task, when players needed to find the meeting room. Participants in the Textual condition implicitly knew they needed to get out of the Maze. Although most players explored the environment on their way out (like players in the other two conditions), those in the Textual condition did not spend time searching for the Meeting room inside the Maze because of the NPC's instruction: "Remember that you can rely on the torchlight to get out." Two players mentioned they got lost or disoriented in the Maze when trying to follow the lights so they relied on landmarks to get out. Although they got disoriented, they knew their next goal was back in the Castle, whereas some players in the other two conditions did not know that.

> It was very hard. I read the thing: "follow the lights on the way back," but I kept running in circles. There's a loop and I got trapped. I made wrong turns. It was trial and error, pretty frustrating. I didn't know what I was doing. When I saw the place where I got the sword, I was "okay." [P34]

Meeting room

Table 7.23   Expectations on players' performance for searching and collecting one of the Activators in the Meeting room

Task	Hypotheses
Search1stActivatorMeetingR	Participants in the **Attentional condition** would promptly notice both chests because of the visual effect and promptly go upstairs and collect the first Activator. They would perform better than players in the other two conditions.
	Participants in the **Representational condition** would perform worse than those in the Attentional condition and better than those in the Textual condition because they would intuitively take the stairs and reach the Activator.
	Participants in the **Textual condition** would perform worse than those in the Attentional and Representational condition because they would need more time to perceive the teleports taking them to the platforms.

Note: Green text indicates the group(s) I expected to have the best performance

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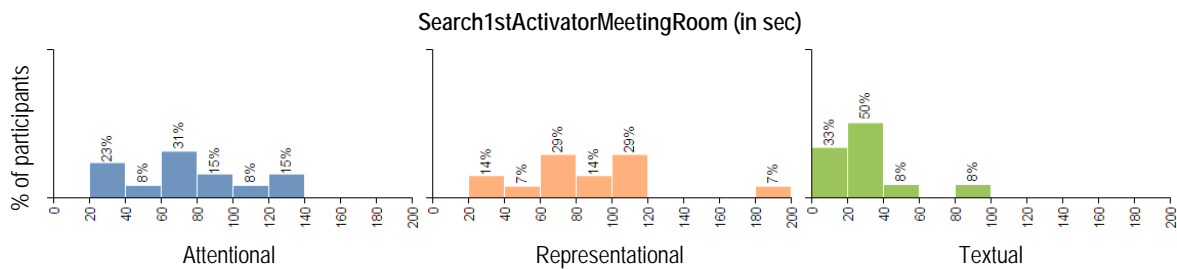
Figure 7.12   Distributions of task completion time for searching/finding the first Activator in the Meeting Room for Attentional, Representational, and Textual conditions

Figure 7.12 shows distributions of the time elapsed between the time participants entered the Meeting room and the time they collected the first Activator.

Surprisingly, participants in the Textual condition performed significantly better than those in the Attentional and Representational conditions. There was a single outlier in the Textual condition, who finished the task in 99 seconds. The other participants in this condition performed better than those in the other two conditions with completion time ranging from 13 to 44 seconds. Participants in the Attentional condition overall performed on par with those in the Representational condition, with most participants finishing the task within 120 seconds in both conditions. Task completion time ranged from 21 to 138 seconds and 28 to 182 seconds for players in the Attentional and Representational conditions respectively.

Table 7.24   Expectations on players' performance for searching and collecting the second Activator in the Meeting room

Task	Hypotheses
Search2ndActivatorMeetingR	Participants in the **Attentional condition** would perform better than those in the Representational and Textual condition because of the visual effect.
	Participants in the **Representational condition** would perform worse than those in the Attentional condition and on par with those in the Textual condition as those in the Textual condition would have learned how to reach the platform.
	Participants in the **Textual condition** would perform worse than those in the Attentional condition and on par with those in the Representational condition.

Note: Green text indicates the group(s) I expected to have the best performance

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Search2ndActivatorMeetingRoom (in sec)

Figure 7.13 **Distributions of task completion time for searching/finding the second Activator in the Meeting Room for Attentional, Representational, and Textual conditions**

Figure 7.13 shows distributions of the time elapsed between the time participants collected the first and the second Activator. The hypothesis about participants' behavior in the Attentional condition was partly confirmed, with most participants (75%) finishing the task within 13 seconds and thus performing better than most participants in the other two conditions (only 54% of the participants in the Representational condition and 20% on participants in the Textual condition finished the task within that range). Overall, players in the Representational condition performed slightly better than those in the Textual condition.

Figure 7.14 shows distributions of the time elapsed between the time participants collected the second Activator and reached the Connector to the Exit room. Participants in the Representational condition were slightly faster than those in the Attentional condition. Contrary to my expectation, players in the Textual condition performed significantly worse than those in the other two conditions. Actually, only 25% of those participants performed on par with participants in the other two conditions.

Table 7.25 **Expectations on players' performance for reaching the Connector that gave access to the Exit room**

Task	Hypotheses
UseConnectorExit	At this point in the game, participants from all conditions would have a good understanding of how the game worked: collect Activators and open Connectors in order to progress. So, my expectation was that there would be no difference in performance between conditions for the third task.

Note: Green text indicates the group(s) I expected to have the best performance

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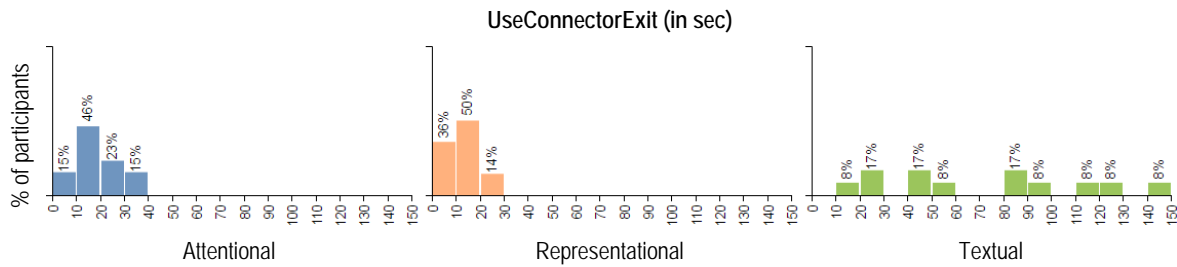
Figure 7.14 **Distributions of task completion time for completing the Meeting Room and transitioning to the Exit for Attentional, Representational, and Textual conditions**

Table 7.26 presents the number of players per themes related to the Meeting room, grouped by condition. Results indicate that participants in the Textual condition had problems understanding some features of the game. Some participants in the Representational and Textual conditions made negative comments related to this room (whereas none of the participants in the Attentional condition did so).

Table 7.26 **Number of participants per condition whose reports of perceived experience fall into the identified themes in the Meeting room**

Main category	Theme	Attentional	Representational	Textual
Information processing	Difficult to see	3	4	4
Information processing	Easy to see	8	9	6
Information processing	Difficult to understand	2	1	8
Information processing	Easy to understand	8	8	7
Observations on wayfinding	Misleading cues	0	0	0
Observations on wayfinding	Not enough cues	0	2	1
Observations on wayfinding	Too many cues	0	0	0
Quality of the experience	Negative	0	4	3
Quality of the experience	Positive	4	1	3

In the cued recall debrief, participants in the **Attentional condition** mentioned that the Meeting room was pretty straightforward and easy to know where to go and what to do. Based on participants' comments, the symmetrical layout and the stairs were stronger as cues than the visual effect. Overall, participants knew that needed to go upstairs but most of them triggered the sensor that made enemies spawn in the area and they engaged in combat before they could reach the first Activator. That was the main reason why participants in this condition took longer than those in the Textual

condition to finish the first task. After finishing the fight, they quickly picked up both Activators and left to the Exit room.

It is also important to mention that one participant in the Attentional condition took a long time to notice the second chest, becoming the last player to finish the second task in this condition. Also, one participant opened one of the chests, but did not collect the key (this participant did not see the key on the ground and proceeded to the Exit room; s/he came back to collect the key though). Finally, one participant completely missed the second Activator and I disregarded his data for that task.

Like those in the Attentional condition, participants in the **Representational condition** mentioned that they did not have problems knowing where to go and what to do in the Meeting room. The staircases were clear hints informing players what to do next. Also similarly to those in the Attentional condition, players in the Representational condition engaged in combat before reaching the chests.

Three players in this condition did not notice one of the keys after opening the chest. They left the key behind and proceeded to the Exit room. They went back to the Meeting room because they could open the gate to the Exit room. Also, one participant completely missed the second Activator and I disregarded his data for that task. Finally, it is important to mention that P21 had the best performance in all three tasks in the Meeting room. However, this player explained that s/he just wanted to progress as fast as s/he could because the player was frustrated with the game. P21 had had several wayfinding problems up until this point, being last player in the Representational condition to finish some of the tasks in the game. This player was in the middle of combat when s/he noticed the chests. So, instead of finishing the encounter, the player promptly went to the chests and proceeded to the Exit room to finish the game as fast as possible. The lack of wayfinding cues had an impact on this participant's performance and involvement with the game.

Contrary to my expectations, players in the **Textual condition** did not take long to notice the rock that teleported them to the platform that contained the first Activator. It is likely that participants in the Attentional and Representational condition established that the stairs were there so they could explore downstairs first and go upstairs later.

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Participants in the Textual condition, however, wanted to use the "new object" as soon as it was found. They wanted to understand how that worked. That was the main reason why participants in the Textual condition were faster than other players to acquire the first Activator. Players in the Textual condition usually engaged in combat after collecting the first Activator and before they reached the second one. Those who did not engage in combat watched their companions fight on their behalf from a platform (enemies could not reach the platforms in the Textual condition). In both cases, task completion time was affected. Finally, as explained, participants in the Textual condition took longer to reach the Exit room than participants in the other conditions. Some finished fighting after collecting the second Activator, but six participants had wayfinding issues. Four of those participants (P36, P39, P40, P41) missed the message telling them to break the rock that would open the gate that allowed them to go back to the Castle so they were locked inside the Meeting room for a while.

> I didn't think of breaking that think [magic rock]. Then, after killing all of them, I ran around the room and I got frustrated because I didn't know how to get out. [P36]

Two participants (P30, P37) did not know where to go after collecting the Activators because they had not learned or understood what the Activators were for.

> Then I collected the gem but I didn't know what they were for. [P37]

Exit room

Table 7.27   Expectations on players' performance for reaching the first platform in the Exit room

Task	Hypotheses
ReachPlatformExit	Participants in the **Attentional condition** would quickly spot the first platform because of the visual effect highlighting it. Participants in the Attentional condition would notice and interact with the Controller faster than participants in the other conditions because of the visual effect.
	Participants in the **Representation condition** would perform worse than those in the Attentional condition and on par with those in the Textual condition as the platform looked the same and only participants in the Attentional condition had an advantage because of the visual effect.
	Participants in the **Textual condition** would take longer than players in the Attentional condition and on par with those in the Representational condition.

Note: Green text indicates the group(s) I expected to have the best performance
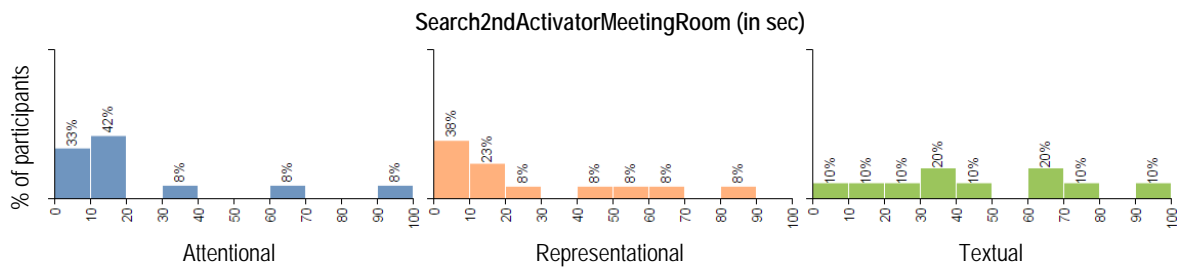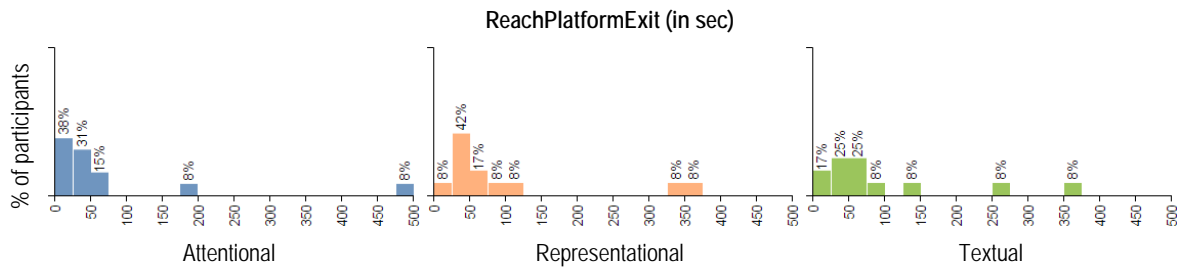
Figure 7.15   Distributions of task completion time for participants finding and jumping on the first platform in the Exit space for Attentional, Representational, and Textual conditions

Figure 7.15 shows distributions of the time elapsed between the time participants entered the Exit room and the time they jumped onto the first platform.

As expected, players in the Attentional condition in general performed better than those in the other two conditions where nearly 85% of the players finished the task within 52 seconds (compared to only 50% of participants in the Representational condition and 42% in the Textual condition). Nonetheless there were two outliers in the Attentional condition that did not promptly jump onto the first platform. Similarly, there were two outliers in the other two conditions.

It is also curious to notice that two participants in the Representational condition never jumped on the first platform. Those participants "broke" the game by managing to go up through a path not intended by the designer. It never occurred to those players to jump on the first platform, even though it was the lowest platform in the room. Therefore, there was no data related to those participants for the first task. Data from the remaining twelve players indicate that, as expected, participants in the Representational condition overall performed on par with those in the Textual condition.

There was also missing data from four participants in the Representational condition for the second task because they managed to interact with the Controller from the ground while they were in the lever's trigger area. That happened because players needed to press (B) to both roll and pull the lever. As a consequence, I only have data from ten out of fourteen players in the Representational condition for the second task.

Table 7.28   Expectations on players' performance for triggering the Controller in the Exit room

Task	Hypotheses
SearchControllerExit	Participants in the **Attentional condition** would notice and interact with the Controller faster than participants in the other conditions because of the visual effect.
	Participants in the **Representation condition** would perform worse than those in the Attentional condition and on par with those in the Textual condition.
	Participants in the **Textual condition** would perform worse than those in the Attentional condition and on par with those in the Representational condition.

Note: Green text indicates the group(s) I expected to have the best performance

SearchControllerExit (in sec)
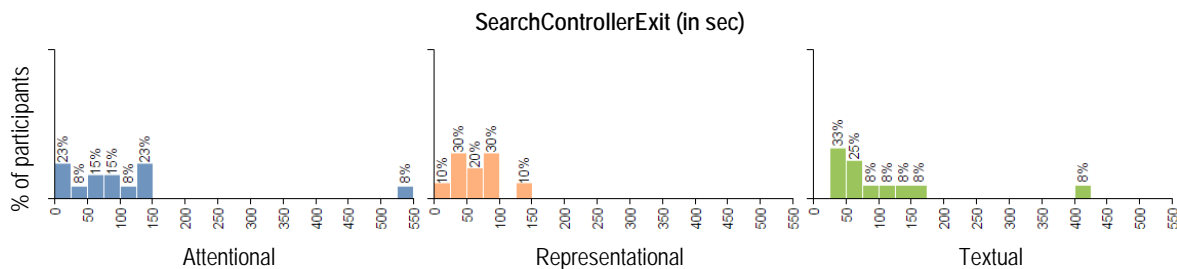
Figure 7.16   Distributions of task completion time for interacting with the Controller (lever or breakable rock) in the Exit space for Attentional, Representational, and Textual conditions

Figure 7.16 shows distributions of the time elapsed between the time participants jumped onto the first platform and the time they interacted with the controller in the Exit room. Contrary to my expectations, overall players' performance was somewhat similar between conditions. Nonetheless, there was one outlier in the Attentional condition and one in the Textual condition. As the data indicates, the visual effect in the Attentional condition did not give participants in that condition a great advantage.

Table 7.29   Expectations on players' performance for reaching the Connector that gave access to the Village

Task	Hypotheses
UseConnectorVillage	Participants in the **Attentional condition** would, overall, perform better than those in the Representational condition because of the visual effect showing them the new set of platforms, but worse than those in the Textual condition because the camera effect works better as a cue than the visual effect – that is, I would expect that some players would miss the visual effect.
	Participants in the **Representation condition** would perform worse than players in the other two conditions because of the lack of feedback after interacting with the Controller.
	Participants in the **Textual condition** would be the fastest in this task because of the clear feedback indicating the new platforms in the environment.

Note: Green text indicates the group(s) I expected to have the best performance

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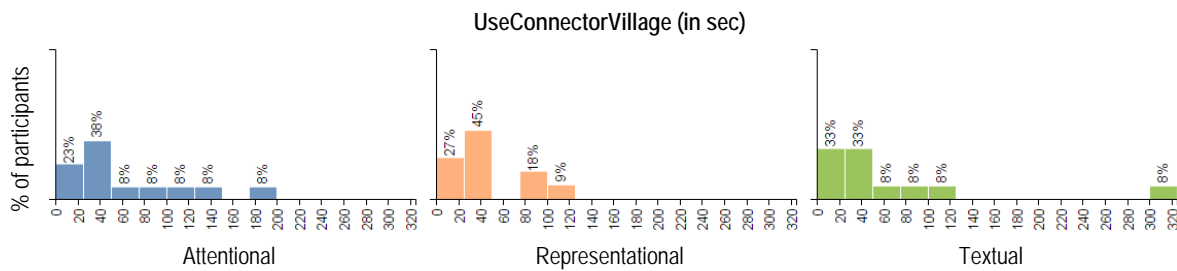
Figure 7.17   Distributions of task completion time for transitioning to the Village for Attentional, Representational, and Textual conditions

Figure 7.17 shows distributions of the time elapsed between the time participants interacted with the Controller and the time they reached the Connector to the Village. Since I could not calculate the exact time four participants from the Representational condition took to interact with the Controller, I could not calculate the delta between the time they interacted with the Controller and the time they reached the Connector. Once again, all comparisons between conditions are made based on the ten remaining players in the Representational condition.

Unexpectedly, most participants performed on par with one another regardless of the condition they had been assigned to. Eleven players in the Attentional condition (time ranging from 16 to 102 seconds), all ten players in the Representational condition (time ranging from 11 to 102 seconds), and eleven players in the Textual condition (time ranging from 12 to 100 seconds) accomplished the task within almost the same time frame. However, two players in the Attentional condition took longer than most players, finishing the task in 131 and 182 seconds. There was also one outlier in the Textual condition that finished the task in 321 seconds.

Table 7.30 presents the number of players per themes related to the Exit room, grouped by condition. Note that the analysis below takes into account data from all participants, even those four players that were not included in the task completion time analysis. Based on counts from the thematic analysis, it seems that many players in the Representational condition had issues understanding wayfinding cues or wayfinding related tasks (i.e., where to go or what to do). It also seems that more players in the Textual condition than those in the other two conditions reported that there were not enough cues in the Exit room. Interestingly, players in the Textual conditions were the

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ones who made more positive comments about the Exit room (although they also had the highest number of negative comments).

Table 7.30   Number of participants per condition whose reports of perceived experience fall into the identified themes in the Exit room

Main category	Theme	Attentional	Representational	Textual
Information processing	Difficult to see	7	8	7
Information processing	Easy to see	13	10	11
Information processing	Difficult to understand	6	10	7
Information processing	Easy to understand	6	4	8
Observations on wayfinding	Misleading cues	0	0	0
Observations on wayfinding	Not enough cues	1	2	5
Observations on wayfinding	Too many cues	1	0	0
Quality of the experience	Negative	4	5	10
Quality of the experience	Positive	2	3	11

As explained there were two outliers in the first task (i.e., jump on the platform) in the **Attentional condition**. During the cued recall debrief, P02, who took 476 seconds in this task, mentioned that s/he did not promptly jump on the first platform because the player did not see a reason for doing so. This shows that P02 did not interpret the lighting effect as a cue indicating locations that needed to be explored in the game. It is important to mention that P02 took longer than most players to accomplish most of the tasks in the game. P10, on the other hand, performed well in most tasks of the game, but was the second to last to accomplish the first task (186 seconds). Like P02, P10 concluded that s/he would not be able to jump to the next platform. P10 explored the game environment for a while, until s/he decided to jump onto that specific platform.

> I noticed that light there [first platform] but I wasn't sure of what to do with it yet because I was looking around the room and there's a platform above so I knew that you could not jump beyond that. And then, I think there are these planks on the side but, from the ground, I didn't see those... So I was trying to jump on other things first. So I was looking to see how to progress. [...] I was just exploring because I knew that I had to jump on something, but I didn't know which one. Then I went back [to the Castle] because I wasn't sure of what to do in that room, so I just exploring around. [P10]

There was one outlier in the second task as well, who finished the task in 540 seconds. After quickly accomplishing the first task, P07 had trouble noticing the

Controller. The player left the exit room several times and finally gave up on the task. P07 was the only player in the experiment who stopped playing asked the researcher for guidance. S/he later mentioned that s/he had not interpreted the lighting effect as a wayfinding cue.

> Oh, so "blue light" is where you need to go basically? I didn't know that. Then, I took a lot of time to find the lever. [P07]

Finally, in addition to being outliers in the first task, P02 and P10 were outliers in the third task. P02 reported that s/he knew where to go, but the player fell from the platform and had to jump all the way up again. P10 on the other hand, did not feel compelled to visually follow the effect after using the Controller so s/he did not promptly notice the second set of platforms. After interacting with the Controller, the player went back to the Meeting room to gather the Warriors (as indicated in the message on the HUD). P10 believed that s/he would be able to progress after collecting all Warriors.

Eight players from the **Representational condition** were at first confused about what to do in the Exit room. Those players did not know where to go because there was no indication that players needed to jump onto the first platform.

Here are some consequences of the lack of cues in the Exit room on players' in-game behavior (which, consequently, affected players' performance:

- Most of the players ended up going back to the Castle, wondering whether they had missed something (e.g., a switch) outside the Exit room.
- Two players (P18, P25) managed to skip the first platform and jump on a platform they were not supposed to.
- Many players ended up noticing the lever from the ground as they looked up to search for a way to climb to the upper area. The Controller became a cue to those players as they understood they would eventually interact with it.
- Many players behaved haphazardly, jumping everywhere without any planning, rolling to move faster, and trying to break objects (e.g., boxes and platforms).

Because of such haphazard behavior, some players (P15, P18, P19, P25) managed to roll while inside the lever's trigger zone and unintentionally interacted with

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the Controller. P18, who managed to both skip the first platform and unintentionally interact with the lever from the ground, talked about her/his experience in the Exit room:

> I knew how far [the character] could jump. At this point, I didn't know what I was supposed to do, but I knew that one of those platforms was the key to get out. I was a little bit confused on what to do because I tried to jump on that platform but I didn't succeed so I thought that maybe it's not this room, but I have to go look for another platform to get to this platform. But I realized that it wasn't there so I was just going back and forth trying to find [the player is referring to the fact that he was going back and forth between the Castle and the Exit room]. But I didn't get frustrated. So when I saw the lever, I knew that I was supposed to go there. So I realized that couldn't jump on that platform [where the lever was], but I could jump on that one, and I started to experiment with them. [P18]

The players who performed well in the first task in the Representational condition mentioned that they hypothesized that they would need to climb up because of the environmental layout. They explained that the first platform was the only platform they could reach, so they jumped there to visually explore the environment (i.e., they were not expecting that to be the solution to the puzzle). As mentioned before, players in the Representational condition performed on par with players in the other two conditions in the second and third tasks. Regarding the second task, most players noticed the Controller from the ground, while trying to find out a way to climb. As for the last task, some players reported that they promptly noticed the platforms after interacting with the Controller and some players mentioned that they went back to the Castle to investigate whether the lever had opened one of the gates inside the Castle. Again, these results are not surprising; I expected split results for the final task in the Exit room. However, as already mentioned, it is surprising that, for this final task, players in this group performed on par with players in the Textual condition.

As expected, players in the **Textual condition**, like those in the Representational condition, had trouble understanding that they needed to jump onto the first platform because of the lack of cues. P35, for example, took longer to jump on that platform because the player went back to the Castle to finish the fight (as s/he did not know what else to do) and P39 spent quite some time trying to jump on other platforms.

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So I think I spend a lot of time jumping on that double platform. Then I got frustrated with the jumping. I thought I wasn't doing it right... So far, the game is pretty straightforward... I think I was frustrated because I thought that that was the way to go... and it wasn't. So, that's when the frustration came from." (P39)

This one was the more challenging puzzle because I knew that I had one more [Activator] but I didn't know where to use it. And I didn't know that there was another NPC up higher so I thought that this level was it, so I kept going back and forth between this part and the other room until I noticed that there was a platform there. I was kind of guessing that I had to do something there but, at the same time, I was, "Do I have to go back to the maze?" but the maze was closed. Then, I went to the meeting room because I thought that I had to collect everything first [...]. That's when I noticed the NPC [close to the Exit to the Village in the Exit room] but I didn't quite know or understand how I was supposed to get up there because I didn't see anything. So I was trying to survey and tried climbing up the wood platform by double jumping. Then I realized that I could stand in between one of the beams but I couldn't jump from there. Eventually I figured it out. [P40]

P34 was the only outlier in the second task. The player mentioned that there were two main reasons why the player took so long to accomplish this task: first, it was difficult to notice the Controller on the platform because the Controller was hidden behind barrels. Second, the player was not skilled enough to quickly jump on the platforms so s/he needed more time to reach the Controller.

Finally, unexpectedly, many players took overly long to reach the Connector that gave access to the Village (final task). Three players (P30, P35, P38) mentioned that they missed the feedback (cut scene) after interacting with the Controller. P35, for example, was an outlier in this task and mentioned that s/he got distracted because s/he also fell from the platform after breaking the Controller. Instead of focusing on the cut scene, the player visually searched the screen to locate his own character. In short, the player focused her/his attention on the wrong area of the screen. The players who noticed the cut scene knew where to go. Yet, their performance was affected by the fact that they either fell from the platform (so needed to climb up again) or wanted to explore the space before progressing in the game. For those reasons, they ended up performing on par with players in the other two conditions.

Village

        As explained in Chapter 6, players' behavior in the Village was supposed to be the most complex to analyze (based on the data collected) because players would have the freedom to explore the space as they pleased. The Village was vast and there were so many areas and objects that had the potential of distracting the participants that it would not make much sense to analyze player performance based on completion time. There were no hypotheses around player performance in this final space. This part of the analysis was completely exploratory.

        I started to explore the telemetry data by looking at how many houses were visited by players based on each condition. The data indicates that players in the Representational condition seemed more inclined to visit a greater number of houses than those in the Attentional and Textual conditions.
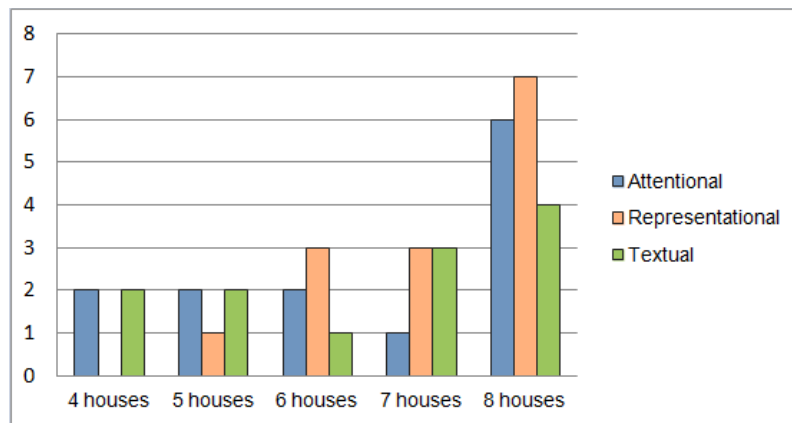
Figure 7.18   Number of houses visited by participants per condition (note that there was a minimum of four and maximum of eight houses to be visited in the Village)

        Figure 7.18 illustrates the following:

- Not a single player in the Representational condition only visited the four required houses. In comparison, two players (15%) in the Attentional condition and two (17%) in the Textual condition only visited four houses.

- Only one player (7%) in the Representational condition visited only five houses. In comparison, two players (15%) in the Attentional condition and two (17%) in the Textual condition visited only five houses.

- 43% of the players in the Representational condition visited six and seven houses (combining those groups), compared to 23% of participants in the Attentional condition and 33% of players in the Textual condition.
- 50% of players in the Representational condition visited all eight houses in the village (compared to 46% of the players in the Attentional condition and 33% of the players in the Textual condition).

Also, based on further analysis of the telemetry data, I found that most players who visited four or five houses did so in the sequence suggested by the Village's Guide, indicating that those players followed the wayfinding cue. However, based on telemetry data alone, it is unclear whether these results are due to cue type or player type. For example, some players may have wanted to progress faster in the game so they decided to simply follow the Guide to required locations. In this case, player type, and not cue type, may have affected the results. Other players may have decided to explore the Village on their own because they wanted the challenge of finding the houses by themselves (player type affecting behavior) and not because they did not notice or did not understand they could follow the Guide (cue type affecting behavior). I go back to this topic when discussing results from the cued recall debrief.

It is unlikely, however, that players in the Textual condition missed the Guide because they deliberately asked to choose between following and not following the Guide. Also, the Textual condition had the lower number of players visiting eight houses. It may be the case that those players stopped going into houses as soon as they noticed that the Guides had finished their tasks. Those players may have understood that no further exploration was required. Player behavior in the Village was further investigated in the cued recall debrief.

Table 7.31   Number of participants per condition whose reports of perceived experience fall into the identified themes in the Village

Main category	Theme	Attentional	Representational	Textual
Information processing	Difficult to see	6	7	6
Information processing	Easy to see	10	12	8
Information processing	Difficult to understand	5	7	7
Information processing	Easy to understand	8	9	11
Observations on wayfinding	Misleading cues	1	1	0
Observations on wayfinding	Not enough cues	3	4	5

Main category	Theme	Attentional	Representational	Textual
Observations on wayfinding	Too many cues	9	5	3
Quality of the experience	Negative	8	6	7
Quality of the experience	Positive	11	12	12

Table 7.31 presents the number of players per condition per themes related to the Village. The more significant difference between players' reports in the cued recall debrief seems to be in relation to the number of cues. Nine players (69%) in the Attentional condition (compared to five - 36% - in the Representational and only three - 25% - in the Textual conditions) mentioned that there were too many wayfinding cues in the Village. In the next paragraphs, I present players' reports on how wayfinding cues affected player behavior in the Village.

The wayfinding cues in the **Attentional condition** affected players' behavior in a few ways:

A few participants mentioned that they found the Village too contrived and the cues (especially the Guide) too obvious, so they just followed the cues. They explained they did not feel compelled to further explore the space. That is, the cues had an effect on the players' sense of freedom:

> Oh, again there are more glowing lights to tell you which house that you need to get into to find your allies. I didn't enjoy that much. Whenever I see a light, I'm not free to explore. I just went to the important houses. I ended up following the lights. […] I wasn't in a hurry, but if it wasn't because of the lights, I might have enjoyed a little bit longer. Like the lights rushed me. Without the lights, I would do whatever I wanted. [P05]

In fact, the majority of players (77%) mentioned that they wanted to explore the Village without the Guide. Many participants decided to deliberately avoid or ignore the Guide all together and explore the Village at their own pace. Most of those players only followed the Guides at the very end of the level, when they could not progress on their own.

> When I saw the blue thing, I went the other way. [P02]

> Then I noticed that wisp and I thought, "oh, so I guess this wisp will be around me a lot.' So I branched off a bit and then I used that at the

end because it would let me go out to the bridge. So I found the wisp and followed it around. [P09]

There were two non-consistent issues with wayfinding cues in the Village. A single player mentioned that it was difficult to see one of the keys and, as a result, the player visited the same houses several times wondering what s/he had missed. In that case, the wayfinding cue (i.e., visual effect on the key) was not effective. Also, one player wanted to follow the Guide but s/he did not understand the Guide's behavior; thus, the player gave up following the guide and explored the Village alone – taking longer than the player expected.

I started to explore on my own and it was fine. Later it got more frustrating because you are just walking around and going to the houses and you don't know what houses you have been into. […] I tried to follow [the Guide] like a bit, but it didn't go anywhere. It just went in a straight line and I was "whatever." [P10]

Finally, it is important to notice that eight players mentioned during the cued recall debrief that they intended to visit all the houses or explore "everywhere." Based on the telemetry data, six players in the Attentional condition visited all the houses. It is unclear if two of those eight players lost track of how many houses they had visited (so assumed that they had already been in all the houses) or if the wayfinding cues (the Guides and the message instructing players to go to the bridge) had a major influence on their decision.

Contrary to the Attentional condition where the majority of participants avoided the Guide, 50% of participants in the **Representational condition** reported that they actually wanted to follow it, even if just to start the task or to satisfy their curiosity about where the Guide could possibly go:

At this point it was fun to follow her. But then I wanted to go on my own. Although I think I followed other characters as well. […] I think I like the people to help you but you [also] have the freedom to explore on your own. [P18]

I was curious to where they would lead me just in case they may lead me to some place that I can't go unless I follow her. So, even though I probably explored the whole area I just followed until the end. [P24]

A few players, however, reported that they felt lost in the Village and that there were not enough cues in that area. Some of those players misunderstood the main goal; others did not notice the message instructing them to go to the bridge. Also, some players did not understand that the Guide was in the Village to show the way. Those players explored the area alone, even though they did not intend to.

> There were only one or two guides to help me around... I just felt that there's not too much help. There are only a few helps. I am lost again here (video). I visited every house, one by one. [...] but it was just a task so I had to complete it. I felt that I had to go to every house." [P19]

> I saw a few NPCs, but I didn't notice they were trying to help me. If I had seen them I would follow them because they would help me to progress faster, so I would use it. [P21]

> I kind of just went on my way... I knew my goal [text on the HUD]. And I wanted to explore the village. And I actually thought that the warriors were the people talking to you, for some reason and that after you had killed the bad guys, those would be the people that you would take with you. And then I realized, "no there are two keys, so there's more to explore in the game." So, I couldn't figure what houses were missing; I kept going back to the same houses because of my bad memory. [...] I tried [to follow the Guides] but I think they were not guiding me. I tried to press B, and nothing happened. So I thought that that it was only me to explore. [P26]

One player kept walking around the Village because s/he could not find the final group of warriors. This player probably did not notice the last Guide (although the player had followed other Guides in the village).

> I wouldn't say that it was completely overwhelming, but this is the kind of point where I would like to have a map and then pop up a map and see: "I have been in this house, and this house, but I missed this one." [P16]

While the majority of participants in the Attentional condition reported that the Guide was unnecessary and made the game too easy, only a few players in the Representational condition shared the same opinion and wanted to explore the Village on their own.

The village is quite nice to explore. Because it is more an open space and you kind of know which houses that you have been already, so that woman wasn't necessary. Mazes are all blocked so you don't really know where to go... Houses you are free to explore, that's kind of cool. [P22]

And then after, I just preferred to explore on my own. Especially here because it is the village... well there are enemies in the houses but I guess you don't really need so many girls trying to lead you to the houses. Every time I explored a room the door was left opened so that's already a good indication. It helped a lot. [P24]

Finally, nine players in the Representational condition reported they intended to visit all the houses in the Village. According to the Telemetry data, seven of those players accomplished that goal.

The majority of players in the **Textual condition** mentioned that they appreciated having the Guide in the Village and wanted to follow it at least at the beginning of the level so they could better understand what they needed to do in the space.

I just read something about "locked" and then I could decide about her leading the way or going on my own. And I was "please show me." [P34]

Then I said "yes" to the woman. I thought that it would take me a long time, without her, to figure it out because there are a lot of houses. So that was good. I also followed other characters. [P35]

I wanted to explore everything but then one of them [NPCs] said that they could help me along the way. And I was, "okay" because I really didn't know where the warriors were supposed to go and then I thought that the people I had rescued were the only of The League of Warriors. And I noticed that there were others from the League in the homes. [P40]

Contrary to the Attentional and Representational conditions where respectively eight and nine players mentioned that they wanted to explore all the houses, only six players in the Textual condition mentioned that they wanted to go everywhere. Also, the majority of players in this group decided to follow the Guide to the houses.

P36, for example, mentioned that s/he did not usually like following NPCs in video games. But, the player wanted to progress faster in the Village and move on to the

next area. As a result, the player followed the NPCs and only visited the main houses. It was interesting to find out, however, that the player mentioned that s/he had visited all the houses in the Village when, in fact, s/he had visited only four houses. This suggests that there were not enough cues in the Village to make players track of how many houses they visited (as pointed out by P35).

> I wanted to progress faster, just "get the hell out of here" and do what I could with the warriors. I assumed some big battle was coming or something... I wasn't sure of what would come next because there are a lot of guys so I assumed we would beat up someone big or... [P36]

> The houses were a little bit difficult because I didn't know which houses I had already been to. So I had to slow down and look through each individual house again. It was kind of tough to make sure that I had been to each house. I would prefer to have a mini-map. [P35]

The cues (or the lack thereof) also affected other players' performance (e.g., P38, P39, P41). Those players did not want the Guide to show the way and decided to explore the Village alone at first. They reported that they spent a long time wandering in the Village because they did not know where to go or what to do. P39 and P41 knew they could have chosen to follow the Guide at the start, so they looked for a Guide and asked for help.

> I read that part and I wanted go on my own. It seemed to have a few houses to explore, and it was a secluded open area so... I thought, "hey, I can explore this." And there was time where I was just wandering around because I kept forgetting what houses I had explored and what houses I hadn't. [...] At that point, I wanted her to guide me... I needed help. [P39]

> "I said "no" because I wanted to explore... maybe there were some secrets, you know? A secret chest or whatever. That's the only reason why I said "no." [...] Then, I went back to the woman and I decided, "oh, just show me. I don't want to explore anymore." [P41]

Contrary to P39 and P41, P38 did not go back to get help from the Guided and stayed longer than expected in the Village.

> The village was frustrating. It's really big because things are not close together and I didn't know. I read the instructions on top and it says: "Bring the league of warriors together"... and then I thought that I only needed to bring them across the bridge. And it kept saying that "they

are not ready" but it doesn't tell me how to get them ready. So, I assumed that I had to go into the houses. [P38]

Summary of findings: wayfinding cues and wayfinding behavior

The analysis presented so far shows evidence that different wayfinding cue types influenced wayfinding decision and, consequently, elicited different wayfinding behavior. Thus, one can argue that wayfinding cues have great potential to shape player-game interactions, as this research has aimed to show. Unexpectedly, those behavioral differences were not highlighted by task completion time data. That is, task completion time was not a useful metric to indicate how wayfinding cues affected players' wayfinding behavior. For example, I could not distinguish exploration from wayfinding issues by looking at time stamps alone. Nonetheless, I found task completion time useful for giving context to qualitative results. The qualitative data, on the other hand, proved to be more suitable for unpacking those differences (Murray et al., 2000), as players could explain some of the reason why they favoured one path over another.

Wayfinding cue type clearly affected the overall wayfinding behavior in ways that confirmed general hypotheses for each condition. For example, most players in the Attentional group were more aware of where they needed to go than those in the other conditions. Also, except for some objects that were difficult to notice in the environment (e.g., key), players in the Representational condition could quickly advance through the game, as they could easily recognize and interpret Representational cues like doors and stairs. Finally, as players in the Textual condition were not familiar with the objects in the game, they certainly needed more instructions in order to understand how the game world worked (e.g., cues highlighting the mushrooms and instructions explaining the Teleports).

Although the type of wayfinding cues generally seemed to affect wayfinding behavior according to design decisions, there were unforeseen findings and lessons learned, as summarized next. I will explain how wayfinding cue types influenced wayfinding by describing the most common behavioral patterns based on the following game contexts: learning phase (Starting point), linear levels (Climbing space, Waterfall

area, Meeting room, and Exit room), and non-linear levels (Castle – as a connector between the Maze and Meeting room, Maze and Village).

Learning phase (Starting point)

Attentional cues seemed to be more effective than the other cues in pushing players through the first level because those cue types attracted players' attention to important objects and locations. In general, players quickly noticed and associated the key and the door, and intuitively progressed through the game.

Representational cues were not as effective as Attentional cues only because the key was too small and difficult to notice. That greatly affected players' performance, as being aware of the door, but not aware of the key, led players to make wrong inferences about what they needed to do to escape from that location: e.g., break the door, break rocks, jump all the way up and escape through the upper area. In the cued recall debrief, players mentioned that some changes to the game would probably help them to make better inferences and wayfinding decisions: e.g. adding a keyhole to the door or changing the goal from "escape from garden" to "find the key."

Textual cues were less effective than the other cue types. Players in the Textual condition raised two main issues: messages were not as intelligible and the Teleport not as legible. Fixing those problems would help players to progress more efficiently and avoid misleading cues like the Checkpoint. All those elements had an impact on players' wayfinding decisions and performance.

Finally, it is worth mentioning that some players, from all conditions, expected to have explicit instructions at the start of the game, not only more explicit goals but also high-level instructions about how the game worked and/or a background story. They wanted to know the game premise or what they could expect from the game. Even players who quickly moved to the second space clarified that, had they had received better explanations as to how the game worked, they would have been able to make quicker and better wayfinding decisions through the entire game. This reveals that wayfinding should not be seen as an isolated part of games. They should instead be carefully integrated within the game world and story.

Linear levels

As explained, **Attentional cues** successfully attracted players' attention to important objects and locations, helping players to quickly progress from space to space, at least in most circumstances. However, there were a few unanticipated outcomes that underlined ways Attentional cues did not improve players' decisions and performance.

Some players did not interpret static Attentional cues as intuitively as I expected. Those players did not understand that visual effects highlighted important elements. Also, the majority of players did not understand the dynamic visual effect connecting the lever to the new set of platforms in the Climbing space and Exit room. These results indicate that, in the context of video games, Attentional cues should be seen as a visual language to be taught to players. Designers should not assume that Attentional cues will easily be understood and hence will always improve performance.

Representational cues worked as well as Attentional cues in many scenarios, especially when important objects were in players' view (e.g., doors and stairs). Adding visual effects to those objects had little to no benefit on performance or wayfinding decisions. Nonetheless, Representational cues alone did not boost players' performance at times and were greatly complemented by Attentional cues in the following conditions:

- When important objects were too small or difficult to notice in the environment (e.g., key).
- When there were similar objects in the environment but it was not clear which one was interactive (e.g., first platform in the Exit room).
- When there were too many distractions in the environment, making it difficult for players to identify important objects (e.g., door in the learning phase).

It is also important to note that the lack of (obvious) cues in the Representational (and Textual) condition led players to non-meaningful gameplay, where players behaved haphazardly and progressed through trial and error.

Finally, findings related to **Textual cues** were rather similar to findings in the learning phase: players quickly understood that NPCs would give them tips, helping them to progress through the game faster. Thus, players intuitively tried to get closer to

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NPCs, even when the path leading to an NPC was not as clear at first (e.g., NPC standing close to the Teleport to the Village in the Exit room).

However, some of the NPCs' messages were not intelligible or detailed enough to make players associate the gem and the teleport. That negatively impacted players' behavior in linear levels. Also, unexpectedly, the NPCs in the Meeting room died and a few players missed that NPC's message; thus, players were locked in the Meeting room until they could guess what to do. Once again, this specific issue emphasized how complex it is to design and integrate wayfinding systems in games: designers need to consider a second plan in case players miss important information.

Non-linear levels

The Maze and the Village are the two non-linear levels of the game. However, before I discuss issues in the Maze, it is important to summarize what happened in the Castle since the Castle, the Maze and the Meeting room are all connected:

- The wayfinding cues in the Castle strongly affected the wayfinding behavior of the majority of players (from all conditions) by making them promptly follow the Guide (NPC or visual effect) into the Maze before exploring the Castle.

- As a consequence, players did not learn where the Meeting room was and they were lost after finishing the task in the Maze. That, once again, highlights that there is a high probability that players will miss important information in their journeys hence designers need to help players deal with that.

- Cue type had no effect on players' wayfinding behavior when players were getting into the Maze. All Guide types worked well as cues.

- On the other hand, players' wayfinding behavior changed depending on players' assumptions about the Guide: players only explored the Maze on their way in if they believed the Guide would wait for them.

The effect of wayfinding cue type on players' behavior and performance was more evident in exploration tasks, or when players were given more freedom to navigate the environment as they pleased: getting out of the Maze and exploring the Village.

Overall, it seems that players unconsciously followed the **Attentional cues** when leaving the Maze. Although players in this condition performed better overall than those in the Representational condition, many players reported that they had not noticed the

Attentional cues in the Maze. As happened in a few linear levels (and reported in the previous study), static Attentional cues seemed not to be enough to communicate to players that they were supposed to leave the Maze. That is, even the players who noticed the torches and visual effects did not comprehend that those cues were supposed to be followed; they were seen as part of the background, just a good addition.

Finally, as the Attentional cues became overly noticeable, they affected players' wayfinding behavior in two major ways: players either avoided the cues (especially in the Village) or they indiscriminately followed the cues and did not want to explore the space.

Many participants in the **Representational condition** mentioned they noticed the torches, contrary to those in the Attentional condition. This was likely because the Guide was holding a torch and lighting the torches on the wall on the way in. However, on the way out, players were confused by the goal of the game: they did not know where the Meeting room was, they did not know they were suppose to go back to the Castle, and they did not realise they were supposed to follow the torches.

Players in this condition seemed to be more eager to explore the Village and visit every single house. Also, contrary to those in the Attentional condition, participants in the Representational condition wanted to follow the Guide. Nonetheless, Representational cues had an impact on players' wayfinding behavior, as many participants reported they felt lost in the Village since there were not many cues.

Textual cues had a great impact on players' behavior when it was time for the players to reach the Meeting room. Participants knew exactly what to do and where to go. Some players, however, mentioned that they wish the game had voice dialogues as approaching NPCs and reading messages were dull at times.

Interestingly, the majority of players in this condition wanted to follow the Guide through the Village and never explore alone (at least in the very beginning). In addition, they only wanted to visit as many houses as needed so they were never curious to know what was inside the other houses.

Finally, it is important to note that players seemed to react differently to the cues the longer they stayed in the game. This became more evident once players reached the Village. This result indicates that researchers should test games as much as possible, and with longer play sessions, if they want to uncover issues that will be raised over time. In the next sections I discuss how wayfinding cues affected the player experience.

7.8.2.   RQ2: How do different types of wayfinding cues affect players' involvement with 3D action-adventure games?

I start this section by introducing my qualitative results (cued recall debrief), demonstrating how the cues affected players' perceived experience (participants' involvement or attitude towards the game). Then, I discuss the Immersive Experience Questionnaire (IEQ) results (quantitative data). Finally, I summarize my findings about the relationship between wayfinding cues and players' perceived gaming experience.

How wayfinding cues affected players' perceived experience

Contrary to performance-related research questions, where most participants could explain their wayfinding decisions and identify the reasons why they took more or less time in a task, finding out the reasons why The Warrior's Story was more or less involving was not a straightforward task. For example, some players mentioned that specific wayfinding tasks were difficult to accomplish, but later they explained that they were actually fun and part of the challenge. Also, besides the wayfinding cues, there were other game features that influenced participants' attitudes towards the game (e.g., combat). Instead of taking note of all those features, I focused my analysis on comments related to the wayfinding cues and wayfinding tasks, the core of this research.

In the following sections, I present the qualitative analysis of cued recall debrief. Levels are presented in the same sequence as they are seen in the game. As previously explained, I considered positive and negative comments about wayfinding. The purpose was to identify breakdowns and breakthroughs in each condition to answer to the following research question: RQ2.a How do different types of wayfinding cues improve or disrupt the player experience, making a game more or less enjoyable?

Starting point

As shown in Table 7.10, the majority of players in the **Attentional condition** did not report problems at the starting of the game. They had no problem noticing the key and understanding what to do in the level. Two players, however, were confused by the checkpoint as they wrongly assumed that the checkpoint would open the door.

> And then, I stumbled upon this thing [checkpoint] that you jump or walk on it and it kind of blows up. So, I thought it was very interesting, but I didn't know what it was for or its meaning. So, I tried to do stuff around it and nothing really happened so I decided to move on. [P06]

> So, I just randomly went around and I hit the stone [checkpoint] on the ground to see if something would happen. [P13]

Also, two players (P04, P12) mentioned that they were frustrated at the start of the game because they did not know how two get out. P12 was an outlier, being the last player to finish the task, and reported:

> [...] I didn't know how to get out. I thought I was supposed to jump to get out. I first just went to one of the edges and I looked around first to see... I mostly looked upwards to see if I could jump out of here and the door didn't catch my attention because I kept looking upwards. Then, after I was, "oh, I just got a key" and then that was how easy that was. And I was "Oh my God." [P12]

All players in the **Representational condition** mentioned that it was difficult to notice the Activator, so most players unintentionally picked up the key while walking around the space. The players mentioned that there was a need for more cues at the starting of the game because they were not even aware that they needed to find a key in the first place. Also, half of the players in the Representational condition reported that they had a negative experience in the Start space because of the lack of wayfinding cues and instructions telling players what to do.

> I wasn't sure what I was supposed to do. I tried to knock down the gate and I played around with the safe point. [...] It took me quite a while to find the key. In the end I was just navigating around the circle to try to find a key. Then I pressed the frustration button because it's frustrating when it says "escape from the garden of joy" and I don't know what to do. I wasn't aware that I had to find a key. I was just

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punching everywhere. I pressed the frustration button again when I found the key because I'm not aware that I am supposed to find a key. [P18]

There was a gate, so I just assumed that I had to open the gate. And I was just wondering how to open the gate. So I was attacking the door to see if I could break it open, but it ended up that it is not. So I just kept wandering around, without any clues or hints provided. And that was a frustrating moment. [P19]

Participants in the **Textual condition** did not mention they were as frustrated at the starting of the game as those in the Representational condition. In fact, only one player talked about how frustrating that space was.

I was lost; there was no hint. I was waiting that maybe something would happen. I got frustrated. [P38]

Players in this group were more confused than frustrated. Most players reported problems with noticing the Activator and the Connector. Also, a few players wrongly assumed that the Activator (gem) needed to be used with the checkpoint because those players associated the color of the gem with the color of the checkpoint's visual effect. The checkpoint became a misleading cue.

But I kind of got confused with the initial spawning area because, for some reason, when I walked over it, it kept doing something. So then I thought I needed something to make it do that, somehow differently... As soon as I got [the gem], I started walking [on the checkpoint] thinking that it would do something differently. [P32]

In addition, many participants were confused by the written instructions. As a result, they thought they needed to give the gem to the woman instead of using it on the teleport (as mentioned before, many players did not even notice the teleport).

Then, I collected [the gem] and I thought I was supposed to bring it to the person, not specifically to the green stone. [P35]

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Climbing space

Overall, participants from all three conditions reported that they had no wayfinding issues in this space. The Climbing area was considered clear and easy in terms of wayfinding.

Many players in the **Attentional condition**, however, had trouble noticing and/or understanding the visual effect pointing out the pillars in the third task. Nonetheless, that seemed not to have a significant impact on the player experience in this space.

Most players in the **Representational condition** also reported that they did not notice what happened after they pulled the lever. One player got frustrated with the lack of instructions and feedback before and after s/he pulled the lever in the Climbing space.

> Then, when I pulled the lever I thought that something had opened, something moved. But I never noticed what moved though. I never had an idea of what moved. I thought that this thing had opened... or, that the wood had fallen... [...] There was no explanation or description of where to go. And no other hints or something like that. So, in the finished product, there could be an agent saying, "oh man, that rock moved so you have to get in there..." Something like that... Or maybe a mini-map and some of the obstacles in the mini-map have moved... so you know that you have to go there and find the exit there. [P19]

Finally, players in the **Textual condition** also mentioned that the Climbing space was easy and that they really liked the wayfinding cues in this area, especially compared to their experience at the start of the game.

> I only noticed the [exit] when I went to that area. I was going with the flow, and then I pressed the cool button. [P32]

> I find [the guided tour/cut scene showing what happed after I pulled the lever] to be actually helpful because it gives you a hint of where to go next. So it does help a lot... You don't waste time trying to figure out what is different. Having that kind of hint helps to direct you to what happened. It's actually a good thing because if you hit something and there is no action, then you are "okay, I guess there is another kind of trigger that I have to hit in order to make something work." But in this case is almost like a cause-effect that you do something you are rewarded for it. That helps a lot. [P33]

The few players who took longer to accomplish the first task were frustrated in the Climbing space at first. It took a while until those players noticed the mushrooms and understood that they needed to go to the upper area in order to exit the space.

> I think I was kind of confused for a bit because I thought I had to escape through the trees and then I had to find another way. So I was trying to see if I could use my sword to break the rocks but that didn't work. Then I was surveying the map and saw an NPC on the top so I knew that there was a way to get to the top so I was looking and I noticed the mushrooms. [P40]

> I pressed the frustration button because I didn't know what to do. [...] After breaking the rock, I saw that coming up. That definitely helps a lot. That was perfect. In adventure games, you kind of don't know what to do so… [P34]

Waterfall area

Players in the **Attentional condition** did not report negative feelings towards wayfinding in the Waterfall area. Not many reported on positive feelings either. At this point of the cued recall debrief, players started to reveal their play style or preferences. For example, the players who took longer than the majority of players in this group reported that they actually liked the tasks (instead of reporting any signs of frustration). Other players, who finished the tasks in a short period of time, mentioned that they wanted more cues or guidance in the Waterfall area.

More specifically, P08, P12, and P01 (the last, second to last, and fourth to last players to notice the platforms and find the Activator) reported that they were curious about the waterfall and liked the challenge of the task. Those players mentioned they had hypothesized that the waterfall was related to whatever that had to do next and they felt rewarded after spotting the key because they could confirm their hypothesis about the puzzle in that area:

> As soon as I saw the waterfall, I had a feeling that there was something to do with the waterfall. I thought I could go underwater, maybe to find a key. But I wasn't able to dive. So I was, "let me check around here." It was just part of the exploration of the game. So then I noticed the light straightaway, and that matched with my previous thought that there was something around the waterfall. So I was "that's the way." [P08]

So, when I first got here, I got the coins and then I tried to find the key so I was just looking around. I jumped into the water because I thought... you know some dramas or TV shows, especially those... because I used to watch those Chinese TV shows that tell stories about ancient Asians when those warriors and those... because back in China there were different countries that fought each other... I just had some kind of impressions that there must be something behind the waterfall. And this is not just because of the TV show that I watched; there is also the Manga that I watch... something tricking was in here [waterfall]. I just had to find out. [...] It was pretty cool; I just got the key and it was pretty cool [watching the video, showing when the player pressed the cool button]. [P12]

The waterfall was a little bit tricky, but it was fun when I saw that. I saw the gate. I didn't realize there was something in the waterfall. I actually ran all the way back to the starting point to see if I had missed any key or anything. Then when I saw the platforms; I pressed the cool button because I found that cool. [P01]

P04, on the other hand, did not take long to finish most of the tasks in the game. Nonetheless, the player expected more feedback on where to go and what to do, especially in the beginning of the game (the Waterfall area inclusive). Those types of feedback, it seems, teach the player about the game not only on a local level but also on a global level. That is, players learn what to expect from the game.

I went to the gate first because, sometimes, gates open without a key. And, normally, if you need a key, it will tell you that you need a key. So I guess that the lack of feedback in the beginning was a little bit frustrating... Not knowing that I needed the key. [P04, Waterfall]

Players in the **Representational condition** did not express a negative attitude towards wayfinding in the Waterfall area. They mentioned they liked exploring the space, swimming, and discovering the Activator behind the waterfall.

Three players had trouble progressing in this area though. It took a while for P18 to notice the platforms and the player wandered around the space trying random actions and expecting that those alternatives would help the player to progress in the game:

I didn't notice [the platforms near] the waterfall. That's why I pressed the frustration button. I wasn't sure what I was supposed to do. I didn't see the platforms at all so I was confused about what to do. I thought I was supposed to do something with the [tree] logs because of the two fires [two fire pits near the tress. [P18]

Finally, two players in this group found the platforms and opened the chest with the Activator. However, those players did not pick up the Activator because they did not know they needed to walk over the key to collect it. Those players were frustrated because they could not understand the reason why the gate did not open when they got near the gate.

Most of the players in the **Textual condition** had a positive attitude towards the Waterfall area. For example, many players liked the NPC that gave them instructions on where to search for the Activator. Some players mentioned that the NPC was a way of narrowing down the searching area and preventing players from wandering around a level without knowing what to do:

> The person just says "it's nearby" so it hints on what I need to do, but then again it doesn't tell you directly how to solve it. So that was fine. At least it's not telling me "it's right there." If she had pointed, that would make it too easy. But it's good that it narrows the search down side to have to go all the way back. [P32]

> I think it was really helpful because it doesn't tell you directly where you have to go… but at the same time you are not completely blind and lost. If it wasn't for that NPC, I wouldn't probably figure out where to go and I would have thought that that waterfall was just a normal waterfall. [P40]

Most players in this group reported that the waterfall itself was an interesting puzzle to solve and that the NPC helped them to solve the puzzle. However, some players mentioned that specific details about the NPC's behavior disrupted their experience, even if not strongly. The examples below show how some players found the NPC a little disruptive:

> The character that I had to follow, that was not really necessary because… If the person was standing by the pool, that would be enough. This was a short distance… Further on, when there is a maze, and someone guides you in the maze, that would be fine. But here, it's an open world and no other distractions so I don't think it's necessary. The woman could be standing by the water. [P33]

> She was really quick, so that was good. […] I don't like following people too much, no… unless, it is really quick. And they were generally pretty fast [in this game], so… but typically not. [P36]

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Some players also reported that the lack of clear cues had a negative impact on their experience. Four of those participants mentioned that it took them a while to notice the platforms. They were confused by the NPC's instructions because they wrongly assumed the NPC was directing them to the pool. Those players mentioned they were a bit frustrated while searching for the Activator.

> Then I went to the water and here it was frustrating. I assumed it was underneath the water and I was trying to swim downward. I thought I had to eventually go get you to help me, but… Then I pressed the frustration button. [P36]

> So I started to look around to see if there was any place that I could jump and I didn't find any place. I felt a little bit frustrated because I didn't find the way. There is no hint in here saying "okay, here is an object" and by seeing the object I will presume a way to get up or get down. But here I don't know what the object is so I have to look around. [P42]

Also, one player in this group mentioned that it was difficult to know where to go after the player picked up the gem. This player had not yet learned the relationship between the Activator and the Teleport.

> I went to the water because she said: "it's nearby." It took me some time to see the platforms, but not too long. Then, after I got the gem, I didn't know what to do. […] I felt lost. Then I accidentally walked into the portal. I didn't even see the portal. [P37]

Castle

As this section was rather short, players did not comment on their experience in the Castle. Players made comments about the Castle when they commented on their experience in the Maze. More specifically, many participants mentioned that they did not know they needed to leave the Maze to go to the Meeting room because they had not explored the Castle and found the Meeting room before going to the Maze.

Maze

Overall, players in the **Attentional condition** had a positive rather than negative attitude towards the Maze. For example, more novice players, and players who usually

do not like to solve Mazes, mentioned that they appreciated the Guide because it helped them with the navigation task.

> I was just following [the Guide]… Oh, that's pretty cool. [P06]

> So, if this light had been there throughout the game, it would have been very boring. But if the light is there to guide me through difficult parts, for example this maze, I need the light because I didn't know where to go. [P08]

Also, some mentioned they found the torches to be useful as a wayfinding cue, as they allowed players to explore the Maze without worrying about getting lost. Many players learned that they needed to go to the brighter areas of the Maze in order to backtrack and get out – or go to darker areas if they wanted to explore unvisited areas.

> I was exploring. And then, because when I came into the maze, I saw the torches lighting up, right? So the parts where the torches were not lit were the parts where I hadn't been yet. So I only went to the places where there was no light. […] [The torches are] like a way to let me know where I'm and where I should go. [P13]

Besides the functional role of the Guide and the torches, some players clarified that they liked both features because of their aesthetic role. This indicated that the appearance of the wayfinding cues also contributed to players' involvement with a game.

> When I was getting in, it seemed just a neat visual, that's why I pressed the cool button there… I like the idea; it has a cool aesthetic to it. [P03, talking about the torches]

> It felt really special because, visually, it is the brightest thing on the screen, so it catches your eyes. And then second, it is like some kind of spirit and some kind of spiritual world that will lead you on the way… [P12, talking about the Guide]

The wayfinding cues were detrimental to the player experience when they felt too much, especially for more hardcore gamers who wanted a challenging experience:

> I think, on those torches, those spotlights don't need to be there because the torches are already lit up… So the torches being a cool puzzle solution that that's the way you find your way out, you have to notice… But then, the spotlight takes away the chance that you have to figure out yourself. It was a little bit too much because you have

the light and then you have the spotlights to look at the light. [P03-Attentional condition, talking about the visual effect in the Maze]

In addition, more novice players either did not notice the torches on their way in or forgot to rely on them on the way out. Those players mentioned being frustrated or feeling lost when they tried to leave the Maze.

> I just found my way out. It was okay. I was confused, but I got out anyway. I didn't memorize; I was trying every way. [P07]

> But that [Guide] wasn't guiding me anymore and I didn't remember what path I had been to. So I spent a lot of time trying to get out. [P10]

Contrary to the Attentional condition where comments on wayfinding in the Maze were more positive than negative, the attitude towards wayfinding in the Maze was split in the **Representational condition**. Like participants in the Attentional condition, many players in the Representational condition mentioned they liked having a Guide because it worked as a companion in the Maze. Companions seemed to be a great way of making players more involved with games.

> And I've really liked when I found other people. In the beginning I was by myself, but I like to be around other people... So when I had people around me, that's when I started to enjoy the game a little bit more. Like "okay, I am not by myself, there are other people here." I don't like when there are too many people, not like *World of Warcraft*, I like when you are with one or two other people and then you feel like you are doing things together. I like that kind of thing. [P17]

> So I pressed the cool button because it was the first time I saw an NPC that actually leads you around, guides you around. And the thing that she actually gets close to the lights and the lights turn on is actually pretty cool [...] [P15]

However, some players expected a more refined work on some wayfinding cues. For example, they expected some cues to be more realistic. Those kinds of details have the potential to improve or disrupt the player experience:

> [...] but then it lacks the action where she actually goes to light it up. It would be better if there is an animation where she lights up the [torches]. [P15]

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Some players in this group had a positive attitude towards the NPC lighting up the torches. The torches, as well as the Guide, gave those participants reassurance that they could navigate or explore other areas in the Maze without getting lost.

> The lights did help me to get out of the maze because I know what path I took. But then I was just exploring because I know there is a path so I could just explore. I didn't need to think "oh, what if I get lost?" [P15]

> I noticed that; I think it's a cool effect as a way to tell you where you have been and that's where you are going right now. [P18]

Most players, however, reported that backtracking in the Maze was frustrating either because they did not notice/follow the torchlight or because of the lack of more obvious cues indicating where the Meeting room was. Those players felt lost in this part of the game.

> I went outside but I didn't know that the meeting room was there. So it doesn't indicate that to you. Maybe the NPCs in that place could be like "the meeting room is over there" because the meeting room was never mentioned at all until you actually get to it. I think I tried the other door [Exit room], and then this one [Waterfall] but I didn't try the meeting room. I don't know why I didn't try that one though... Then back to the maze and I got lost. That was the most frustrating part... [P25]

> In the maze I felt totally lost. I found more things for my health and I didn't notice the traps... So it was more trial and error to get out; I was lost and I didn't have a certain path that I wanted to take. [P26]

Finally, the Guide had a negative impact on the experiences of two players in this group. Those players would rather solve the puzzle by themselves, so they thought the NPC spoiled the fun.

> I thought the maze was too easy because it's a maze so you were supposed to get lost. Then you have this woman running in front of you, and to lead you. I thought that was a bit too easy. The thing about the basis is that you are supposed to try to figure out how to solve the maze and how to get off the maze. So, compared to the beginning, where you were looking for the key, this was too easy. [P18]

And I was like confused about where to go. [...] I thought that somehow I had lost something... "Maybe I have missed a small switch. Maybe I have to break that blue stuff [vases]. Maybe I have to climb that stuff." I tried everything. [P19]

I felt that that woman was blocking my way. I wanted to explore because I can progress faster. [P21]

Overall, participants in the **Textual condition** made more negative than positive comments on wayfinding in the Maze. Some players reported they did not want to spend much time lost in the Maze so having the Guide there to help was good.

I liked this guy because if I walk into the maze I can never find the way. But if I followed this guy, I easily know where to go. This is something I like in other games as well. [P30]

But some players in this group mentioned that they expected to explore and solve the Maze by themselves because that is what Mazes are for. Those players explained that the Guide truly disrupted their experience. They added that they did not even see the point of having a Maze in the game if the solution of the puzzle was forced on the players.

You don't need... he is there to lead your way and he lights the torches as well while he is walking. But I think he can just tell me to find my way by myself. Maybe it would be more fun. Because here is like: "I already gave you the hint..." So there is no reason to make a riddle like this. If he tells you the way, you can just make a straight line and go there. If there is a maze, just let the players solve it by themselves. If you show the way, make it straight because there is no point. [P42]

Some comments from players in the Textual condition indicate that wayfinding cues can potentially break the immersion if they are not believable or tied to the story or context of the game. Also, like those in the Representational condition, players in this group mentioned that they expected the wayfinding cues to be realistic. Failure to fulfill those requirements will potentially result in disruption players' involvement with the game:

He said that I had to find the warriors and he is leading the way... so I was, "if you know the way, why do you need me? If you know where the warriors are, why do you need me if you can just go there?" Maybe

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I guessed that he couldn't find, and that's why he needed me. But maybe he is just leading me through the maze… I thought that I could explore. I thought that I could find my way through the maze. [P41]

[The way the torches lighted up] was kind of unnatural because it's just automatically. It feels unnatural because he's just walking past them. You would think he would light them up, maybe holding a torch. There are some games where the torches light up but there is some context behind it. If there is a tomb and the place is magic… But here it's a maze and they are lighting up for no reason. So it kind of disconnects you. [P32]

Finally, similar to what was reported in the other two conditions, some players really liked using torches to get out of the Maze. They also appreciated that the Guide instructs them to follow the lights. Some players, however, got lost on the way out and that negatively affected their experience. Some players needed to rely on landmarks to get out. One player tried to follow the lights, as instructed, but the player still got lost.

It was very hard. I read the thing: "follow the lights on the way back," but I kept running in circles. There's a loop and I got trapped. I made wrong turns. It was trial and error, pretty frustrating. I didn't know what I was doing. When I saw the place where I got the sword, I was "okay." [P34]

Overall, most players from all conditions understood the purpose of the cues in the Maze. Based on these results, it seems that player style significantly influenced how players felt about the cues in the Maze. For example, in all three conditions, there were players who liked and disliked the Guide, players who noticed and did not notice the torches, and players who got and did not get lost on the way back. None of the players in the Attentional condition, however, complained about how the Guide "automatically" lightened up the torches as the players in the other two conditions did.

Meeting room

Overall, participants in the **Attentional condition** did not have much trouble with wayfinding in the Meeting room. Table 7.26 shows that none of the players made negative remarks about their wayfinding experience in this area. Most players easily noticed important objects in the area and found the tasks pretty clear.

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Participants in the **Representational condition**, like those in the Attentional condition, mentioned that the room layout made the navigation pretty straightforward. Some players, however, had problems noticing the keys on the ground, after they opened the chests.

> Here, when I opened the boxes... Well, usually when you open a box, you just get the key. So I thought I had gotten the keys just by opened the boxes, but actually I didn't. So that's why, for five minutes, I was just walking up and down like "what am I supposed to do?" [...] I thought I had gotten the key. So that's why he pressed the frustration button. [P17]

> "I got frustrated when I noticed that I didn't pick up the key." (P19)

Finally, players in the **Textual conditions** reported that they had a few problems understanding how some objects in the Meeting room worked.

First, instead of stairs, players needed to use a new type of teleport. Some players avoided using those at first, likely because they feared they would progress with the story before exploring the area. Other players accidently used the new teleport while dodging near it (as the same button was used to both dodge and activate the teleport). Unintentionally teleporting to a new location can be quite disorienting because players need to relearn where they are in relation to other objects in the space.

Second, contrary to my expectations, some players had yet to learn that that there was a breakable rock (Controller) and that it cause something to happen or change in the game environment. In other words, performing that task only once was not enough to make players recall that specific game mechanic. Not knowing the meaning and function of the Controller became a real problem for some players when the NPC that gave players instructions of what to do with the rock died in combat. Some players did not know what to do to get out of the Meeting room.

Finally, a few players noticed the green pyramids (teleport/Connector) in the Castle for the first time. Because those players did not know what those pyramids were and how they worked, they also did not know what to do after collecting the Activators.

Note that, although only three participants in the Textual condition explicitly made negative comments on wayfinding in this space, the fact that they mentioned that they did not clearly understand or were unaware of some core wayfinding elements is a great indication of breakdowns on the player experience.

Exit room

Most players in the **Attentional condition** did not have trouble accomplishing the tasks in the exit room. Many mentioned that they were pleased that the wayfinding cues informed them of where to go, especially the visual effect on the first platform.

> I didn't take a long time to jump on that platform because the light was there... And there was nothing there so there was a reason why the light was there so I went to see what would happen and then the platforms popped up. In this case, the light didn't bother me. I probably would have jumped on that eventually, but in this case there was no reason for me to do, so I think it would have been sort of frustrating if it wasn't there. [P03]

As it happened in the Climbing space, players did not understand the visual effect that pointed to the set of platforms that appeared in the space after the players interacted with the Controller. Only one player mentioned that s/he actively followed the visual effect to verify where s/he needed to go. However, most players in the Attentional condition did not report being frustrated by not knowing what to do after interacting with the lever (i.e., Controller). They realized where to go within a reasonable amount of time.

Even though most players did not mention they were frustrated in the Exit room, there were a few outliers from the Attentional condition who were frustrated. Those outliers took a long time to accomplish the tasks because they had not understood that the stationary visual effects indicated places that needed to be explored, thus the players spent some time to realize what they needed to do to progress. Those issues with performance led to problems with players' involvement with the game, as the players started to get frustrated. In fact, P07 was the only player in the experiment who stopped playing the game at that point and asked the researcher for help.

> I got a little bit frustrated here because I didn't know how to leave this room. I didn't try to jump here [first platform with visual effect] because I thought: "there is no way that I can jump from here to

here." I was frustrated because I didn't know I had to jump there. [P02]

It took a while for many players in the **Representational condition** to jump onto the first platform in the Exit room. The lack of wayfinding cues indicating what players needed to do in that room led to confusion and frustration as some players explained:

> This one, I was lost a little bit because I kind of felt that I had to jump onto some place but I just don't know how to get up to it. So that's why you can see the camera keeps rotating, just to see what platform I could be landing on or jumping. Later on I saw a lever on the platform and I didn't know how to get there. This one frustrated me because I was thinking: "oh, maybe I should double-jump to there, or jump somewhere." Then I was randomly jumping on things to see how it goes. They all look the same so I really didn't know where to jump. And later, I even thought that I could use that axe to cut that platform or something. [P23]

> I was trying to find a switch or something. I was trying to double check if I had missed a switch. Then, I found out that there were platforms that they were hiding, like hidden platforms. Yeah, I pressed the frustration button because I got stuck here too. If you look here [watching video], you can't actually see that there are hidden platforms. [P15]

Note that wayfinding cues were particularly important when the spatial layout did not intuitively inform players of where to go, as P15 continued to explain:

> And there is another thing: it's kind of weird for a castle. I don't know... the placement of things... I'm referring to the way to get up there. I mean, it's a little weird that you have to get up there; it's a castle, right? It's weird that there are hidden platforms... It's fun to jump around, but it doesn't make sense for a castle to have that. [P15]

P27 also pointed out:

> This was confusing because I saw the path here and I knew that I had to explore around, but I didn't think that the exit was inside [the Exit] room, in that top area, because it seems to me that this [door to waterfall] is the place where I came from, and the exit there [in the Exit room] is like a little window. So it didn't seem really like an exit. [P27]

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In addition to having problems understanding that the first platform was where they needed to go, a few players in the Representational condition took a while to notice the second set of platforms that appeared in the space after they interacted with the lever. Those players were frustrated because they did not know how to proceed. Many went back to the Castle and to the Meeting room a few times.

Like those in the Representational condition, players in the **Textual condition** also had problems with the lack of wayfinding cues in the first platform, which affected both players' performance and the player experience, as some players were frustrated in the first task:

> Then I had to find my way out and I noticed there is verticality. I tried to see if I could jump on anything and I noticed that I couldn't, but still, it doesn't hurt to try. That's when I jumped onto this and I was "oh, there is a platform that comes out." I would say that that kind of breaks immersion because it comes out from nowhere and you want at least some hint of why that happened like a platform button or something. I would need some cue. The fact that that block was similar to the one on the other side… It needs some sort of cue; they have to be somehow different. You have to hint to the player "that's where you want to go." But you don't want to point [directly], it should be subtle. That's when the platform button would come handy. [P32]

> I was thinking about getting up somewhere but I didn't have a clue on how to get up. I was looking around so I went out a while. Then I am jumping again… I guess here I pressed the frustration button once or twice because I didn't find the stage [first platform] because there is no hint. It says: 'leave the castle and take the warriors with you' and this is a general objective but 'what should I do right now?' I think I saw the woman here [near the exit to the Village] and I tried to get up, but I found that there was no way. I was confused and a little bit frustrated because nothing was working. [P42]

Dynamic cues like cut scenes (i.e., guided tours) in the Textual condition were usually well understood and welcomed by participants. P32, for example, appreciated the hint. P33 also found it encouraging.

> I broke that [Controller/rock] and then I saw the platforms. That was nice. The camera really helps. [P32]

> The cut scene was like just the other one to show you that after you hit you get rewarded. You know what happens. This one is kind of encouraging… Because it's better to show what happened after you do

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something rather than having people finding out what the reward was. [P33]

A drawback of the cut-scene (i.e., guided tour) was that it only played a single time and the players who missed it had no idea of what had happened after they interacted with the Controller. Missing that feedback, led to frustration at times:

> Then I broke the rock, but I missed this camera effect [the player noticed the effect by watching the video]. I didn't know that there was a path; then, I pressed the frustration button. Because I saw the woman there, I knew I was supposed to go there [teleport to the Village] but yes, I totally missed the animation. I felt frustrated and then I went outside. When I came back I saw the bridge [second set of platforms] and I continued. [P30]

Village

The Village was the last level. The majority of players in the **Attentional condition** mentioned that they liked talking to the woman once they left the Castle, and that they wanted to explore the entire area. It seems fair to say that players had a positive experience overall based on the fact that players were interested in exploring the game at that point. A few players mentioned that they found the Guide helpful because there were too many houses in the Village. It was important to have some hint of where they needed to go. One player specifically mentioned that s/he liked the Guide because the cue was not there at all times, but only when s/he was about to get lost:

> Then I saw [the Guide] and I thought that there was a specific house to go to and the [Guide] would take me to that house. And it just popped up whenever I was going astray and it put me back on the right path. […] It was fine. It was a reasonable amount [of guidance]. It was not there all the time so it was okay. [P08]

Most players, however, mentioned that the wayfinding cues disrupted their experience in the Village. As previously mentioned, the wayfinding cues affected players' sense of freedom and, consequently, player involvement, as the cues prevented players from exploring and discovering the Village by themselves:

> Oh, again there are more glowing lights to tell you which house that you need to get into to find your allies. I didn't enjoy that much.

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Whenever I see a light, I'm not free to explore. I just went to the important houses. I ended up following the lights. […] I wasn't in a hurry, but if it wasn't because of the lights, I might have enjoyed a little bit longer. Like the lights rushed me. Without the lights, I would do whatever I wanted. [P05]

Also related to players' sense of freedom, one player explained that by adding non-subtle wayfinding cues or too many cues to a game designers might disrupt the player's experience because such cues may break the suspension of disbelief as they clearly reveal the designer's intents to the player:

Yeah, this is an adventure game, so it is better if you explore. Because if it leads you all the time, it is like following the programmer so it's not that fun anymore. [P07]

Most players mentioned that there were too many cues in that space, making the tasks in Village particularly easy.

Then I followed the blue trail. I think they make things a little too easy. You just follow it and it shows you where to go. [P11]

I think [the Guide] was a bit too much of help. If you had just like a hint… let's say that you are taking too long, then a hint would appear after a few minutes that you have been in the area and you don't know what to do… But yeah, that was a bit much. [P09]

In fact, ten of thirteen participants from the Attentional condition mentioned that they would rather explore the village on their own. These reports indicate that the cues in the Village clearly affected player involvement:

I kind of wanted to go to all of [the houses]. That wasn't too many that I couldn't just go to all the houses. I just kind of rotated around and then I saw the spotlight in this one so I thought "I should go to that one." I think having only spotlights would have been enough because the trails imply that there is a correct order to do the scene, and there isn't really. [P03]

I just followed it. I think the first time it is helpful because there are so many buildings and it's a big place so I don't know what I should do. But for the second time, I think it is too much help because now I know that I should go into some buildings and open the doors and rescue people. I am already familiar with my task. I think I can achieve it by myself, without help. [P13]

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Other players mentioned they had their experience disrupted by the fact that the cues did not disappeared after they visited a house so players easily lost track of the tasks they had already accomplished. In those circumstances, wayfinding cues became misleading cues, attracting players to previously visited locations:

> So I just followed the orb. I felt sort of annoyed, I guess, or better saying, bored. I followed for a while and then I was "okay, I don't want to follow you anymore." It made it easier than it is. And at this point I started to get annoyed by the lights too, because one problem with the lights is that, if you achieve a goal, where the orb is to rescue the people, the light doesn't disappear but stays on. That's a little annoying. [P06]

Similar to most participants in the Attentional condition, most players in the **Representational condition** (ten out of fourteen) also wanted to explore all the houses.

> I pressed the cool button because I was in the underground for a while and then I had this entire village so I guess I had a good impression. I felt like I had accomplished something because I had finished the dungeon. [...] There are so many rooms to explore so I wasn't in a rush to move forward. There were a lot of treasure chests and coins. I kind of like collecting coins so I was just... I like when I see a bunch together; it's like that accomplishment factor. [P24]

However, contrary to the experience in the Attentional condition, players in the Representational condition did not report that the Guide negatively affected their experience. Players seemed more forgiving or less annoyed by the Guides pointing out the way. In fact, many players in this group mentioned that they followed the Guide at first as they did not know where they were supposed to go.

> Then I followed her. At this point it was fun to follow her. [P18]

> I talked to the woman and I followed her. I pressed the cool button because "oh, more people." [...] Yeah, I don't like making decisions, that's why I like multiplayer games. I always prefer being the person behind, I like to support more than being the main person. I don't like to lead. [P17]

> Then I followed her to see what was going on, outside. Then I explored a bit. [...] Because the previous girl just guided me, I thought this one was doing the same thing. After the girl in the maze left me, I could do my stuff. So, for this one, I was just "let her finish her stuff, then I'll do my stuff later." It was okay to have her there. [P20]

There were a few problems with the wayfinding cues in the Representational condition though. P19, for example, did not notice all the Guides and ended up getting lost in the Village. As explained, the Guides in the Representational condition do not talk to the players; they basically walked to the next location. That may not be enough as a hint for players to know that they are supposed to follow the Guide.

> There were only one or two guides to help me around... I just felt that there's not too much help. There are only a few helps. I am lost again here. I visited every house, one by one. [...] it was just a task so I had to complete it. I felt that I had to go to every house. [P19]

P19 also missed the message to go to the bridge and ended up visiting all of the Village's houses. Finally, three players mentioned that there were too many houses in the Village and they wrongly assumed they needed to visit all of them. That negatively affected their experience. It is also important to mention that those three players wanted to explore the Village without any guidance.

Similarly to participants in the Representational condition, most participants in the **Textual condition** appreciated having the Guide in the Village. Also similarly to the previous group, many players in the Textual condition explained that they followed at least the first Guide to better understand their task.

> I prefer to have people helping me because they would provide tips. I felt that, interacting with people it was more helpful than exploring myself. Having guidance is important. [P35]

> I pressed the wrong button first, then I said "yes". It was like a large map and it says 'bring the league of warrior together' and I was like: "Who is the warrior? How should I find them? And how can I gather them?" I didn't know anything so the guide is needed at that moment. It's a whole new map: chapter 2 right now. Then I said "yes" again to her [second Guide]. [P42]

Some players in the Textual condition also reported they appreciated the fact that they could choose whether to follow the Guide or not. P32, for example, had the first Guide leading the way. Later on, the player chose to explore the Village alone.

> Here I have a choice: either she helps me or I can find it on my own, but I haven't explored the village yet, so I said "I would rather do it on my own." [P32]

As mentioned before, only six players (50%) in the Textual condition reported that they wanted to visit to every single house in the Village (compared to ~70% of the players in the Attentional and Representational conditions). Players gave different reasons as to why they wanted to follow the Guide instead of exploring the Village alone. P41, for example, explained that s/he wanted to follow the Guide at all times because the player did not want to get lost in the Village. The players, however, eventually got lost because the player missed the final message instructing players to go to the bridge. Likewise, P34 preferred following the Guide to avoid getting lost.

> I was very focused on not losing this person, because if I lose this person, I won't be able to figure out what I need to do. [P34]

P35 explained that following the Guides would make him progress faster since there were too many houses to visit. This player, however, stopped following the Guide and eventually got lost. P36 also did not wanted to explore because the player was expecting a great battle after being done with the Village (the player wanted to get to the battle as soon as possible).

> Then I said yes to the woman. I thought that it would take me a long time, without her, to figure it out because there are a lot of houses. So that was good. I also followed other characters. […] The houses were a little bit difficult because I didn't know which houses I had already been to. So I had to slow down and look through each individual house again. It was kind of tough to make sure that I had been to each house. I would prefer to have a mini-map. [P35]

> I wanted to progress faster, just "get the hell out of here" and do what I could with the warriors. I assumed some big battle was coming or something… I wasn't sure of what would come next because there are a lot of guys so I assumed we would beat up someone big or… [P36]

Finally, P38, as explained before, felt frustrated because the player did not understand that the Guides were leading the way. This player ended up lost and visited all the houses. The player had problems with both wayfinding cues: the Guides and the final message to go to the bridge.

Based on players' statements, it is evident that the wayfinding cues had an effect on players' involvement and, consequently, players' overall attitude towards the game. In the next section, I present quantitative results from the IEQ.

Immersive Experience Questionnaire

First, immersion scores (ImmScore) were calculated based on multiple questions of the IEQ (instructions on how to calculate IEQ scores can be found in Appendix B). To verify whether ImmScores reliably reflected participants' immersive experience, they were correlated against the IEQ's single question measure of immersion (Q32. How immersed did you feel on a 1 to 10 scale?: ImmSingleScore). A Pearson product-moment correlation coefficient was computed on the two immersion measures and they were found not to be significantly correlated with one another within the Attentional condition, r(13)=0.30, p=.3050. In contrast, there was, a significant correlation between the two variables within the Representational, r(14)=0.88, p=.0001*, and the Textual, r(12)=0.73, p=.0061*, conditions. Further tests indicated that measurements were not normally distributed so Spearman correlations were also carried out on the two immersion measures and similar results were found: rs(13)=0.24, p=.4265 (Attentional); rs(14)=0.94, p=.0001* (Representational); rs(12)= 0.69, p=.0124* (Textual).

Attentional (a) Representational (b) Textual (c)
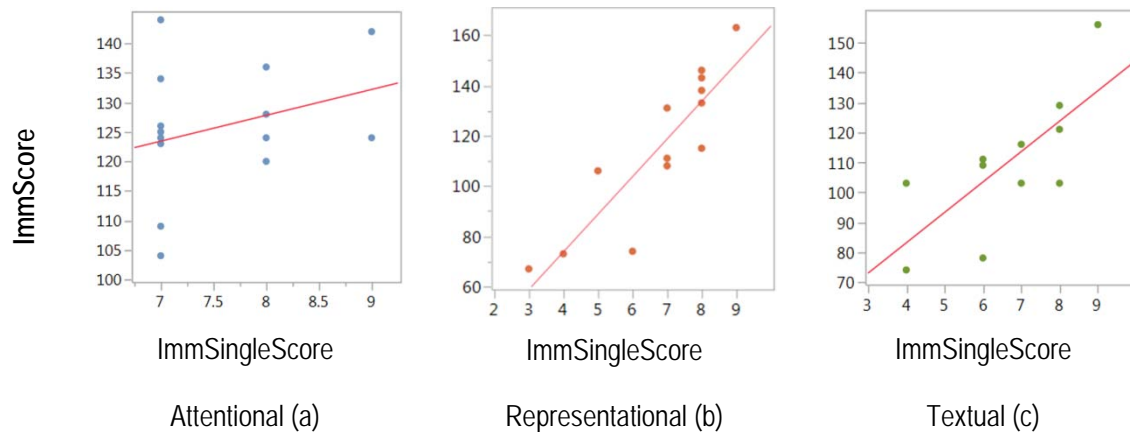
Figure 7.19 Scatterplots showing correlations between immersion score measurements from multiple (ImmScore) and single question (ImmSingleScore) for Attentional (a), Representational (B), and Textual (c) conditions

By looking at scatterplots (Figure 7.19), it is apparent that scores of the Attentional condition did not vary as much as in the other conditions in both scales (ImmScore and ImmSingleScore). That lack of variance might be the reason why the two measurements are not correlated. However, by observing the scatterplots, it is evident that participants in the other two conditions also gave 7 and 8 ImmSingleScores when the ImmScore range was between 100 and 140. Because values seem to be consistent with scores in the other conditions, I believe it is valid to continue to analyze ImmScore values for all conditions. Table 7.32 presents summary statistics on the ImmScore and ImmSingleScore.

Table 7.32   Univariate simple statistics: ImmScore and ImmSingleScore

Condition	DV	N	DF	Median	Mean	StdDev	Min	Max
Attentional	ImmScore	13	12	124	125.92	11.47	104	144
Representational	ImmScore	14	13	113	115.42	29.21	67	163
Textual	ImmScore	12	11	109	109.33	21.52	74	156
Attentional	ImmSingleScore	13	12	7	7.61	0.76	7	9
Representational	ImmSingleScore	14	13	7	6.78	1.71	3	9
Textual	ImmSingleScore	12	11	6.5	6.58	1.56	4	9

Before comparing mean scores of ImmScores between conditions, I looked at ImmScores distribution and I verified that data scores violated the normality assumption. Also, a Levene's test for equality of variances was computed on ImmScores and it was found that the variance between groups were not equal (Table 7.33). Because the assumptions of normality and equal variance were not met, neither a one-way analysis of variance nor a Kruskal–Wallis one-way analysis of variance could be used to compare ImmScores between conditions. Thus, I carried out a Welch Anova and found that there were no statistically significant differences among ImmScore group means based on results as shown in Table 7.34.

Since there was insufficient evidence to claim that the ImmScore group means were not equal based on the Welch Anova at the 0.05 significance level, I calculated scores for the five factors associated with game immersion: cognitive involvement (CogInvol), emotional involvement (EmotInvol), real world dissociation (RWD), challenge, and control. I carried out a Levene's test for equality of variances and four factors passed the test. The only exception was EmotInvol (Table 7.33).

Table 7.33   Levene's test for equality of variances for the Immersion score all five factors associated with game immersion

Factor	F Ratio	DFNum	DFDen	Prob > F
ImmScore	3.83	2	36	**0.031***
CogInvol	1.88	2	36	0.166
EmotInvol	3.36	2	36	**0.045***
RWD	2.67	2	36	0.082
Challenge	0.70	2	36	0.501
Control	1.28	2	36	0.289

Note. Numbers in bold* indicate that group variances are different.

However, because the factors measures were not normally distributed (and for the sake of consistency between EmotInvol and other factors), I preferred to carry out a Welch Anova for all factors to find out whether there was a statistically significant difference between groups. None were found to be statistically different at the 0.05 significance level (Table 7.34).

Table 7.34   Welch Anova testing whether Score Means are equal for all immersion factors, when Standard Deviations are not equal

Factor	F Ratio	DFNum	DFDen	Prob > F
ImmScore	3.08	2	20.80	0.067
CogInvol	3.23	2	23.59	0.057
EmotInvol	1.67	2	21.99	0.211
RWD	0.49	2	22.61	0.615
Challenge	0.40	2	23.77	0.674
Control	3.29	2	23.92	0.054

Note. Numbers in bold* indicate that groups are significantly different.

Due to the fact that no differences between groups were found, I continued to analyze the data by correlating ImmScores with the five immersion factors. That is, since ImmScores are a product of five factors, I expected those factors to be correlated to the overall ImmScore. Spearman correlations were computed on the overall immersion score and each of the factors individually. For the Attentional condition, only CogInvol and EmotInvol were significantly correlated to ImmScores. For the Representational and Textual conditions, all factors, except Challenge, were correlated to the ImmScores (Table 7.35).

Table 7.35   Spearman correlations on each immersion factor by overall immersion scores

Condition	CogInvol	EmotInvol	RWD	Challenge	Control
Attentional	0.78 (p=.001*)	0.78 (p=.001*)	0.20 (p=.501)	0.39 (p=.186)	0.50 (p=.081)
Representational	0.87 (p=.000*)	0.95 (p=.000*)	0.94 (p=.000*)	0.12 (p=.668)	0.81 (p=.000*)
Textual	0.92 (p=.000*)	0.87 (p=000*)	0.71 (p=.009*)	0.15 (p=.633)	0.93 (p=.000*)

Results indicate that the wayfinding cues might have affected participants in different ways depending on the condition they were assigned to. Based on these results, it is clear that factor distributions were different between each condition.

Since no significant differences between factor scores were found, and considering the scope of this research, I focused on ImmScore distributions to visually explore the data. Figure 7.20 shows immersion scores distributions and summary statistics for each condition.
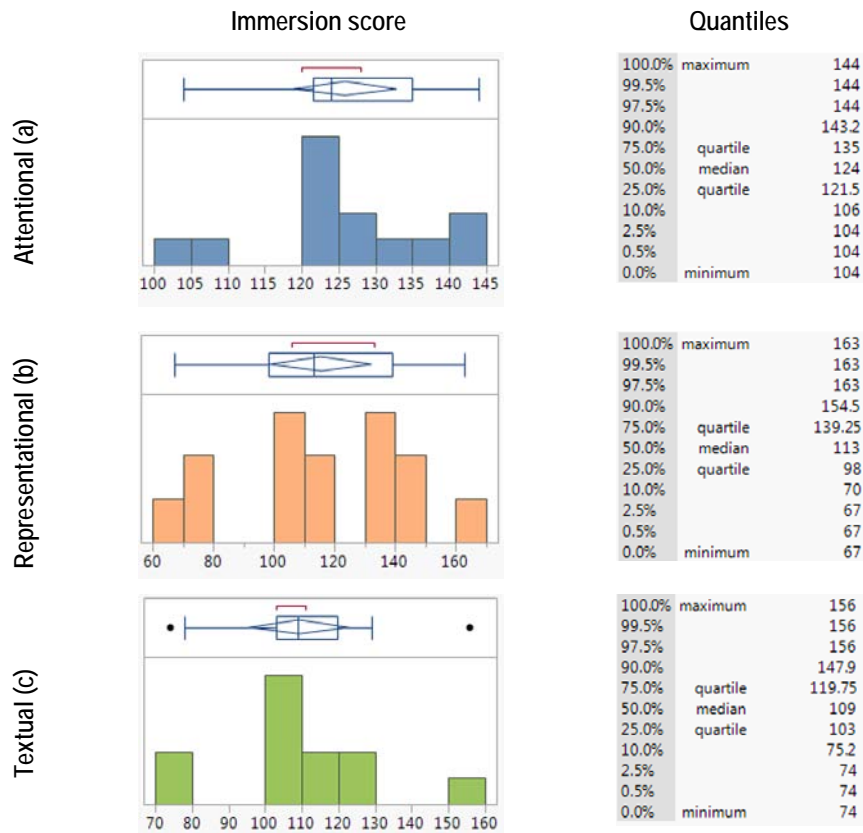
Figure 7.20   Immersion score distributions and summary statistics per conditions (Attentional, Representational, Textual)

ImmScore distribution shapes differed between conditions. These distributions show that the Attentional condition elicited more consistent perceived involvement with the game. ImmScores of the Attentional condition were not as spread as in the other conditions, ranging only from 104 to 144, with most of the scores located in the middle (120-130 range). For the Representational condition, ImmScores were not as consistent, ranging from 67 to 163 (the lower and higher scores all conditions considered), and four distinct groups are highlighted. Similarly, ImmScores for the Textual condition range from 74 to 156; and, although most scores range from 100 to 130, some scores are located on the extremes of the distribution. Apparently, players seemed to be more sensitive to the Representational and Textual cues.

Data from the IEQ does not provide enough evidence that wayfinding cues affected players' involvement with the game. However, to avoid accepting a false null hypothesis (Type II error), some factors should be considered.

First, even though none of the statistical tests on IEQ data indicated significant differences between conditions, the fact that ImmScore distribution shapes varied might indicate that wayfinding cues indeed affected players' involvement but those differences were not captured by the IEQ likely due to the small sample size. The variance within groups was rather large, especially in the Representational and Textual conditions. It might be the case that an increase in sample size would make trends more evident.

Second, the IEQ's questions were meant to measure the overall degree of involvement with a game, so the questionnaire does not ask question specifically related to wayfinding – neither about many other specific game features. Although some question items could be interpreted as being related wayfinding (e.g., "To what extent did you find the game challenging?"), they could be related to many other elements of the game (e.g., combat) or a combination of elements. It is difficult to pinpoint the features that mostly affected players during gameplay based on the questionnaire alone. Even though participants gave evidence that the wayfinding cues affected their involvement with the game (through the cued recall debrief), it was probably difficult for the IEQ to disentangle when wayfinding cues alone affected how engaged players felt while playing. For example, some players reported that they truly liked the graphs and

environmental layout. Some players, on the other hand, were disappointed by the lack of music variety, cut scenes, and a more elaborate story. Thus, all those game features probably influenced players' involvement and, consequently, IEQ's scores. A more targeted questionnaire may be necessary if one wants to measure whether wayfinding cues has an effect on player involvement.

In addition, the creators of the IEQ instruct players to answer the questions based on their overall experience with game – rather than taking into consideration specific features. Based on those instructions, players may not have thought about the cues or wayfinding tasks while filling out the questionnaire.

Based on the above discussion, it seems qualitative data was more appropriate for understanding the effect of wayfinding cues on the player experience. That is aligned with previous work (Connolly et al., 2012; Murray et al., 2000) that suggests the importance of considering participants' subjective opinions when one wants to understand how players experience game and other digital tools.

Summary of findings: wayfinding cues and the player experience

The results presented here provided evidence that wayfinding cues indeed had the potential to affect players' involvement with the game. Even though that evidence could not be captured through the Immersive Experience Questionnaire, through the cued recall debrief, participants gave concrete examples of how wayfinding cues either disrupted or improved their gaming experiences.

Overall, I found that, when properly designed, wayfinding cues gave players reassurance, letting players progress through the game at their own pace and based on their own skills. When not properly crafted, wayfinding cues disrupted the player experience in different ways, which will be discussed shortly.

I have also observed that there were several interwoven factors contributing to how a specific wayfinding cue or to the entire wayfinding system affected the player experience. Factors raised from the cued recall debrief were: player's personal preferences, expertise, and expectations (de Castell et al., 2015; Murray et al., 2000; Si

et al., 2017); the number of cues applied to the game; the quality or aesthetic values of the cues (Hoeg, 2008; Liszio & Masuch, 2016; Moura & Bartram, 2014; Moura & Seif El-nasr, 2014); the game genre and its premise; and the wayfinding tasks.

Players' personal preferences, skills, and expectations affected players' responses to the wayfinding cues at times. For example, a few players mentioned they did not like the NPCs guiding them because they usually don't like following NPCs around the game world. Others players mentioned they would have wanted to explore the maze relying on a map instead of torches. Other players, however, seemed to be more open to what the game had to offer them. Players' preferences and expectations is an interesting yet intricate topic that requires attention as more and more games are designed for bigger audiences with diverse preferences and motivations (J. L. Chen & Stanney, 1999; Williams, Yee, & Caplan, 2008; Yee, 2016).

Players also mentioned they experienced breakdowns based on the number of cues in the game, i.e., when they perceived the game as either lacking wayfinding cues or featuring too many cues. As a result, players either behaved haphazardly, advancing through trial and error, or they felt less motivated to try out new areas as their sense of freedom had been diminished when they felt they were presented with way too many cues. In both cases, problems with the number of cues hindered meaningful play and affected players' involvement with the game. Although this seems to be an intuitive finding, to my knowledge, no one had empirically demonstrated the effects of number of cues on player involvement – previous works show that the lack of cues in virtual worlds may result in users feeling lost, but no previous work has described the consequences of adding too many cues to a virtual world.

The appearance of the cues, together with players' expectations, also had an impact on how players responded to the wayfinding cues. Players focused on several details and mentioned that several features that either influenced on their cognition (e.g., how they learned the game) or on their attitude towards the game. For example, players did not expect to need to find a key at the start of the game due to the fact that doors did not have a keyhole. As another example, players mentioned that the suspension of disbelief was broken because there was not an animation showing the NPCs lighting up

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the torches in the Maze. Although less elaborate visuals for wayfinding cues did not always cause wayfinding issues (e.g., players did not get lost because of an unrealistic animation), the way cues looked affected the player experience.

The **game genre** also positively or negatively influenced players' responses to wayfinding cues. For example, some players expected to see fewer cues since the game was in the action-adventure category. Such game genre usually requires players to search and explore the environment more intensely and some players felt disappointed when they did not need to make greater effort to find their way through the game.

Finally, players had different responses to wayfinding cues depending on the **wayfinding tasks**. For example, many players appreciated having the Guide in the Maze, as it was a dark and somewhat confusing environment, but most players did not find the Guide necessary in the Village as they wanted to explore the area alone.

Also, in several occasions, players did not know what to do next because the overall goal was not clear enough. That consequently affected both performance and involvement with the game. The fact that games need "clear goals" has been discussed in several works, but my point here is to highlight the connection between global goals and necessary actions that will allow players to achieve those goals. The goal is what players need to do in a broad sense and the wayfinding task is the step-by-step of how players should do it (tactics and operations). To evoke good experiences, games need to successfully communicate goals and sub-goals. Failure to deliver those may result in meaningless experiences: when players understand the goal but do not know how to accomplish it or when players are able to accomplish sub-goals but they do not know why, as they do not have a global goal in mind.

Table 7.36 summarizes the major findings related to the player experience based on the type of wayfinding cues.

Table 7.36   Examples of how wayfinding cue types positively and negatively affected the player experience

Cue type	Positive responses toward the cues	Negative responses toward the cues

Cue type	Positive responses toward the cues	Negative responses toward the cues
Attentional cues	▪ Highlighted important objects that would otherwise go unnoticed ▪ Made the game more aesthetically pleasant though visual effects ▪ Gave the game an unique look and feel ▪ Were easily integrated into the game narrative, mood, or tone	▪ Quickly became a distraction/annoyance when overused ▪ As any other media-specific language, Attentional cues still needed to be learned by players and players who did not know the language eventually got frustrated by the "lack of visual cues"
Representational cues	▪ Were quickly and easily interpreted (recognition) ▪ Did not require expertise/learning, making players smoothly progress in the game	▪ Objects needed to be highly recognizable (never tending to abstractions) ▪ Objects needed to be in players' visual field (easy to perceive) ▪ The proportion of some objects should have been augmented, as smaller objects went unnoticed
Textual cues	▪ Were good for providing additional instructions or teaching how certain objects worked in the game ▪ Were useful for showing how some objects were related to each other ▪ Were useful for pointing out to objects that were out of players' visual field	▪ Quickly became a distraction/annoyance when overused ▪ Quickly became a distraction/annoyance when NPC's utterances were confusing, not believable, or repetitive

Chapter 8.

Discussion and conclusion

I started this research with the idea that wayfinding cues had the potential to influence players' wayfinding behavior and that those changes in behavior had the potential to affect the player experience, as illustrated on Figure 8.1.

Figure 8.1 **Illustration of how wayfinding cues could potentially affect players' behavior and experience in 3D action-adventure games**

However, as illustrated in Figure 8.2, this research extended my perspective on how those elements interact since results indicated that:

- In fact, wayfinding cues can directly influence player wayfinding behavior.

- But, wayfinding cues can also directly affect the player experience or players' attitude towards a given game.

- Finally, player wayfinding behavior and player experience affect each other.
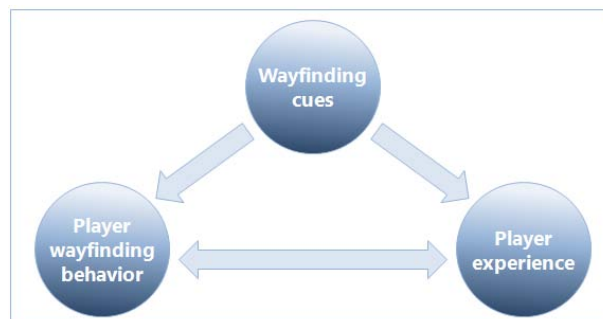
Figure 8.2 **Illustration of the relationship between wayfinding cues, player wayfinding behavior and player experience**

Video games are interactive systems by definition, and wayfinding is an essential interaction in games, as players need to navigate from point A to point B to perform any activity in the game world. Designing wayfinding systems is an intricate task that requires several iterations because, among other reasons, there is still incomplete understanding on how to provide wayfinding support in games. For example, there is little research on the effects of wayfinding cues on gameplay and little research on players' difficulties, needs and preferences regarding wayfinding cues. This research attempts to address those concerns.

To my knowledge, this research is the first to investigate players' behavioral and attitudinal responses to wayfinding cues through the design of two complex action-adventure games – rather than through the use of sterile digital worlds. In cued recall debrief sessions, players were able to report on how wayfinding cues (or the lack thereof) influenced their decisions of what to do, where to go, and when to proceed. They also explained how the cues influenced their gaming experience and attitude towards the game. This research revealed how responses to the wayfinding cues (in terms of both wayfinding behavior and perceived experience) were influenced by:

- Cue-related factors (e.g., aesthetic values, number of cues, legibility, and intelligibility)
- Task-related factors (e.g., , primary or secondary task, exploration, searching)
- Game-related factors (e.g., game premise and genre, game context)
- Player-related factors (e.g., level of expertise, expectations, motivations)

In the remainder of this chapter, I revisit and discuss major findings, describing how the above factors are interrelated. Then, I present the contributions and limitations of this work, followed by suggestions for future research.

8.1. Players' behavioral responses to wayfinding cues

Results from this work showed that wayfinding cues strongly shaped player-game interactions, influencing players' decisions of *what* to do, *where* to go, and *when* to move on to another location. I found that different wayfinding cues elicited different behavioral responses overall.

8.1.1. Players were more aware of where to go with the Attentional cues

This research validated the assumption that, overall, Attentional cues are good at attracting players' attention to specific objects and locations as proposed by game designers (Davies, 2009; Lemarchand, 2012; Rogers, 2009). Those cues made players more aware of *where to go* in the game.

8.1.2. Players could more easily interpret what to do with Representational cues

Results showed that players could more easily interpret the Representational cues rather than the abstract cues in the Textual condition. Thus, Representational cues were good at telling players *what to do* next. This work confirmed that those cues worked well as invitations to interactions (D. Norman, 1988; D. A. Norman, 1999).

8.1.3. Players needed explanations through Textual cues when they needed to deal with unknown objects

As expected, players did not seem to be able interpret the objects in the Textual condition on their own - so they needed more explanation through Textual cues. Note, however, that Textual cues came through NPCs (which are Representational cues – remember cues categories are part of a long continuum), so players at least knew they could approach the NPCs for more information in the game.

There were also unexpected findings and lessons learned from both studies:

8.1.4. Attentional cues did not always attract players

Some players did not approach (and sometimes did not even notice) objects highlighted by static Attentional cues in a few circumstances in both studies presented here. This behavior is contrary to previous research in Attention Theory and related fields, which claim that users are (virtually always) attracted to high contrast elements in a scene. That shows that some players (especially more novice players) could not interpret Attentional cues as elements indicating important objects and locations.

In addition, players did not understand the feedback provided by the dynamic Attentional cue connecting the lever to the platforms in the Climbing and Exit spaces. Since players did not the dynamic Attentional cue was indicating where they needed to go next, they were also unable to know the consequences of interacting with the lever. The Guided tour (or cut scene) proved to be better at communicating the changes in the environment – for players in the Textual condition.

8.1.5. The perceived number of wayfinding cues affected player in-game behavior

At the end of the cued recall debrief, participants rated the game based on the number of cues on a 7-point scale. Figure 8.3 shows the distribution of players' responses in each condition. Rates for the Attentional condition leaned towards 'too many cues' and rates for the Representational condition leaned towards 'not enough cues.'
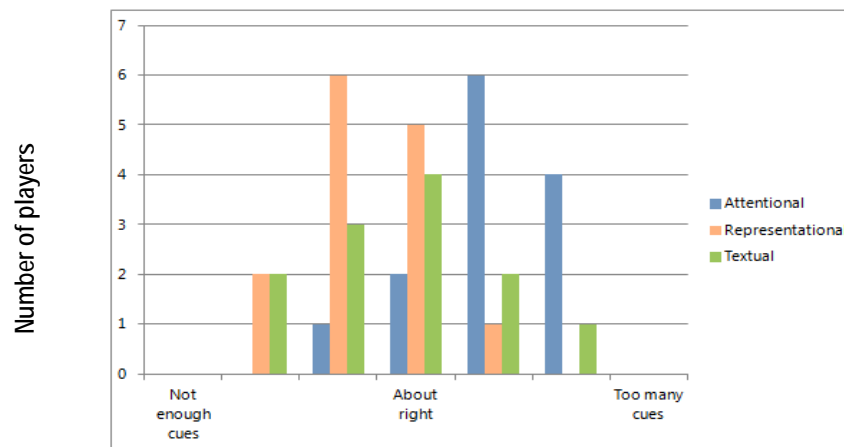
Figure 8.3 **Distribution of players' rates of the number of cues per condition. Rates ranged from 1 (not enough cues) to 7 (too many cues). The middle point is 4 (about right)**

Too many cues resulted in players avoiding the cues or losing interest in the game

Some players mentioned that the game had more cues than necessary. Such response was stronger with Attentional cues and resulted in players losing interest in the game at times. In those cases, the players *bluntly followed the cues* just to finish the

game as soon as possible. Other players, started to *avoid the cues*, as they made the game too easy and the players wanted to explore the game alone; that is, they wanted the game to be more challenging. The quotes below illustrate these issues.

> (The Guide/orb) is definitely helping... hmm... if the maze is too complicated, that will help. But... hmm... if you can have a map because I don't think players can remember where they have been or not. If you give them a map or give them a general idea of where they are... If you just give them a light, it shows them where they should go... Like I did there, I just followed the light instead of exploring the area by myself. If there was a tiny mini-map here [HUD]... even though the light shows that way, I would go check the other way to see if there is anything there. But if the maze is more complicated, it will be more difficult for the players to explore. The mini-map definitely helps. It helps but it's different from the light. I think it is better than the light... it's better than just showing you where you need to go. I kind of wanted to go there, but the light is pointing here... [P11)]

> [The visual effect highlighting specific objects] makes the game kind of linear, it tells you "this is the path; you must go there." There is no other alternative path that you can choose... I don't know if it lacks a sense of freedom... but I understand that some action games tend to... yeah, they make you have to do "this" before you get to another room. I think, without the lights, it would be more challenging... and more adventures. [P05]

Insufficient number of cues created uncertainty and made players behave haphazardly

Some players mentioned that the game did not have enough cues. When that happened, players were unable to make wayfinding decisions so they tried to find their way through trial error. This effect was stronger in the Representational condition, but was also observed in Textual condition when players did not know what to do. When cues were not noticed, players tried to interact with the wrong objects (misleading cues).

Note that the '**number of cues**' in the game is also concerned with the **legibility** and **intelligibility** of the cues. For example, from a player's perspective, if he can neither notice nor correctly interpret the cues, he will perceive the game as lacking wayfinding cues. On the other hand, if the cues are too evident in the game world, the game will be perceived as having 'too many cues' – so the issue might be the 'intensity of the cue

(aesthetically speaking) and not the actual number of cues applied to the game. I further discuss this topic in the section 8.2.5.

8.1.6. Players' in-game behavior relative to the cues changed over time

Results also indicated that many players started to either follow or avoid cues when they reached the Village – the last space in the game. For example, players in the Textual condition mentioned that they just wanted to follow the Guide at that point; they did not want to explore the game alone (likely because they felt lost before reaching the Village). Players in the Attentional condition, on the other hand, wanted to explore the Village without any guidance.

The fact that players may have a positive experience at first, but change their attitude towards the game after being exposed to the game for longer hours, is one of the challenges of researching the relationship between wayfinding systems, player behavior and player experience. It is important to test games for a longer period of time if one wants get a better depiction of how players will react to the wayfinding experience.

8.1.7. Wayfinding cues inhibited exploration at times

Several players reported that they promptly changed their inner goals because of the wayfinding cues. The quotes below illustrate how players quickly switched from free exploration to follow a cue as soon as the wayfinding cue was noticed:

> The reason why the gameplay is a lit bit longer is because I explore everything. But then, I get to be immersed in the environment and see how all these things are. So I jumped into the water to see if there was a swimming animation or if there was something in there. There wasn't and I noticed a platform right there, so I went there right away. [P22]

> Then I went to the water and I pressed the cool button because I found that being able to swim in the waterfall was kind of cool. I was thinking that there was a reason why that waterfall was there. So I thought I could jump and see if I could find a key or something. I think it would be even cooler if you can dive into it and swim. Then, when I was swimming, I saw [the platforms] and I just jumped. [P23]

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Previous studies focus on the effectiveness of cues or aiding tools for making navigation in virtual worlds as efficient as possible (Boer Rookhuiszen & Theune, 2009; Samarinas, 2009; Vembar et al., 2004; Wu et al., 2007). What this research shows is that, sometimes, "overly effective" cues can disrupt gameplay as users may avoid exploration and therefore miss important items or information in the space. This finding calls for more research on how to "properly guide" players based on more realistic game tasks as opposed to only focusing on "effective cues" in more sterile environments.

8.2. Players' attitudinal responses towards wayfinding cues

As summarized at the end of section 7.7.2 (also see Table 7.36), this research showed how wayfinding cues can either improve or disrupt the player experience based on several factors:

- Player's expectations, expertise, and motivations
- Game genre and premise as well as the wayfinding tasks in the game
- The quality (i.e., aesthetic values) of the cues
- The number of cues applied to the game
- The legibility and intelligibility of the cues

8.2.1. Players' expertise and expectations heavily influenced their attitude towards the wayfinding cues

Both studies presented in this thesis showed evidence that players' expectations, motivations, and expertise influenced players' responses to wayfinding (J. L. Chen & Stanney, 1999; de Castell et al., 2015; Si et al., 2017, 2017) and wayfinding cues. Expectedly, more experienced players usually had an action plan to solve the tasks and they also wanted to be challenged by the game; thus, they did not need or want much guidance. Being quite familiar with the game genre, those skilled players had a clear mental model of how to solve wayfinding tasks in actions-adventure games and they had strong opinions about the kind of cues they wanted to see. Less experienced players, on the other hand, needed more instructions and cues to be able to progress. They seemed to be collecting small pieces of a puzzle and rarely showed that they had their own

strategies to solve the wayfinding tasks. Novice players seemed to greatly rely on the wayfinding cues to reach the next steps (which often resulted in positive experiences).

Besides players' expertise, players' expectations in relation to wayfinding cues were heavily influenced by the overall context and wayfinding tasks. Some players seemed more opened to some types of tasks like solving mazes and searching tasks – whereas other players did not like those tasks as much and just wanted to progress as fast as possible through the game. Those different play styles had an impact on players' responses to the wayfinding cues. For example, players wanted more cues when they wanted to quickly progress; they were really impatient when they did not know what to do next. Conversely, players who wanted to thoroughly explore the game did not want to feel rushed by obvious cues. The next two quotes illustrated how two players reacted differently to the wayfinding cues in the Maze:

> So, if this light had been there throughout the game, it would have been very boring. But if the light is there to guide me through difficult parts, for example this maze, I need the light because I didn't know where to go. [P08]

> I thought the maze was too easy because it's a maze so you were supposed to get lost. Then you have this woman running in front of you, and to lead you. I thought that was a bit too easy. The thing about the maze is that you are supposed to try to figure out how to solve the maze and how to get off the maze. So, compared to the beginning, where you were looking for the key, this was too easy. [P18]

When dealing with players' motivations, expectations, expertise, and play style, there is little designers can do besides profoundly knowing their audiences. Several games already let players decide what tasks to do first (sandbox games), and others let players customize the amount of guidance in the game (GTA series, Rockstar Games). Ideally, designers should frequently test their games to balance the impact of wayfinding cues on the player experience. While allowing players to have some sort of control over their experiences is an interesting solution, designers should make sure that that will not break the game and the overall experience they envisioned.

8.2.2. Wayfinding tasks and their context influenced players' attitude towards the wayfinding cues

As mentioned before, players' attitudes towards the wayfinding tasks were very much influenced by individual play styles and expectations. Despite those individual differences, overall, players expected to see – and positively respondent to – more wayfinding cues in the learning phase, when they needed more information to make sense of the game. Also, they expected more guidance when they needed to solve primary tasks (those tasks tied to game progression). Note that I am not claiming that games should not challenge the player through the main storyline, but players expected not to be stuck when they were, for example, curious to see what would happen next in.

In addition to clear cues, players expected the game to state clear goals – the lack of clear goals negatively impacted the player experience even when players *were capable* of moving from one area to another relying on the cues alone. In short, tasks without a context or meaning goal were seen as make-work and they were not appreciated by most players.

Overtime, players expected less intrusive cues. That was brought up particularly when players wanted to explore the environment at their own pace. In those cases, designers should consider, for example, using subtle cues for tasks *not* tied to the progress of the story (i.e., secondary task). Players did not usually expect to be rushed through secondary tasks, as players only sought those tasks when they intentionally wanted to spend extra time in the game. In short, the player experience seemed disrupted whenever players wanted to explore the environment (secondary task) and felt obligated to follow a cue (i.e., the cue spoiled the experience).

The lack of distinction between primary and secondary tasks can be a real problem in action-adventure games and may lead to confusion and uncertainty at times. That was problematic in the studies when players did not know the consequences of taking one path over another. In some circumstances, players mentioned that they did not want to follow a wayfinding cue because that "seemed to be the main path" and they wanted to explore the area before moving on with the story. Those players assumed that

a cut scene or scripted event would force them to progress to a different area before they could fully explore the current area.

Finally, as discussed in the results, contexts such as a 'dark maze' or an 'open area' like the Village also influenced players' responses to the cues.

8.2.3. Cue characteristics (i.e., how they work and their aesthetic values) influenced the player experience and players' attitude towards the wayfinding cues

As summarized in Table 7.36, I found evidence that wayfinding cues can be used to captivate the players depending on how the cues are presented (i.e., aesthetic values) in the game. One of the most frequent comments was that wayfinding cues should be believable in the context of the game world. Wayfinding cues seemed to have captivated players when the cues were aesthetically pleasant, which contributed to players' involvement with the game. Attentional cues seemed to very good at creating positive responses from the players:

> When I was getting in, it seemed just a neat visual, that's why I pressed the cool button there... I like the idea; it's a cool aesthetic to it. [P03, Attentional condition, about torches in the Maze]

> [The Guide/visual effect] felt really special because, visually, it is the brightest thing on the screen, so it catches your eyes. And then second, it is like some kind of spirit and some kind of spiritual world that will lead you the way. [P12, Attentional condition, about the orb in the Maze]

Besides the visual effects, the NPCs also contributed to a positive player experience when they gave players more background story and when they made players feel like they were not alone in the game. NPCs can be a powerful way of giving players information about where they should go and what they need to do. Those cues can also be used to explain **why** players need to go to those places:

> Oh, it helps explain things that you have to do rather than just following [the Guide/orb]. If I hadn't seen him and gone back to interact with him and just followed the [Guide] I wouldn't understand what was going on... The guy was a good thing. [P04, talking about the NPC that gives players instructions in the Castle]

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So I pressed the cool button because it was the first time I saw an NPC that actually leads you around, guides you around. And the thing that she actually gets close to the lights and the lights turn on is actually pretty cool [...] [P15, Representational condition]

One of the challenges of adding NPCs to the game was that players had high expectations of them. They wanted the NPCs to behave more naturally and intelligently and have several different scripted lines, almost as if players wanted to engage in a conversation with the NPCs. Also, particularly regarding the NPCs in the Maze (Representational and Textual conditions), players expected them to have a better animation while lighting up the torches. Note that players in the Attentional condition did not have the same expectation in relation to the visual effect guiding them through the Maze. That lack of animation is an example of how a wayfinding cue (and other objects in games) can disrupt the player experience or the suspension of disbelief.

Another example of how cues can break the suspension of disbelief and player involvement was the breakable rocks substituting for levers in the Textual condition. Overall, players expected detailed explanations when the game broke conventions. The lack of background information affected players' attitudes towards the game, even when players were able to progress.

But I just thought: "you have to break that thing [rock] for the wood to come out [from the wall]" but I just didn't see the connection. Breaking that would make the platform come out... the sense of connection. If it was a switch then it would make sense. I just broke that because you break stuff in games. [P41]

8.2.4.   The perceived number of cues in the game world affected the player experience

Section 8.1.5 discusses how the players changed their in-game behavior based on the perceived number of wayfinding cues. That finding is closely related to how the players felt about the game. Overall, those who perceived the game as either having not enough cues or too many cues had a negative attitude towards the game or wayfinding cues, respectively.

Mostly less experienced players felt that the game did not provide enough cues. Unsurprisingly, those moments led to *uncertainty* and then *frustration*; and the degree of frustration seemed to be directly proportional to how fast players wanted to progress in the game – more investigation into this matter is necessary to confirm my perception. Also, frustration seemed to increase until the player did not care about progressing in the game any longer (i.e., frustration gave place to *boredom*).

> I was a little frustrated for every part of the game really, including the maze and the difficulty mess of finding the path. [P19 – talking about his frustration in the Exit room]

Other players negatively reacted to the cues when they perceived the game as having too many cues (mostly in the Attentional condition). It seems that the cues had an effect on players' perceived freedom. Those players reported that the cues became overly noticeable, making them feel constrained to the extent that they did not want to explore the game anymore (see section 8.1.5).

> And there are other times where games will just be like, it will became a crunch that we would never look at the environment, you will just like "there is the light" and then nothing else matters. So, I think there is a balance to it. I think you have to be careful about how you do it because if you start to just look for the light and then who cares about anything else... You just look for the light... For this game, there are parts that are done well, the torches being lit up through the maze. And there was other points where they were not really necessary, maybe say this door [to the castle], because there is no other place to go than that door. [P03]

Aligned to the flow theory elaborated by Csikszentmihalyi (1990), there also seemed to be times when the number of cues were just right, and that made players not only navigate at ease but also feel in control of their own experience. Overall, in those circumstances, players had a positive attitude towards the game: players reported the cues gave them reassurance that they were in the right direction, the cues were not perceived as something dictating what players needed to do. Those were usually seen as rewarding and pleasant experiences.

> I think it is okay because there is a woman beside the stone so you definitely need to do something with the stone, so... It is okay because I know what I have to do next. She makes me sure about what I am doing right now. [P42, Climbing space]

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This woman was pretty good. She doesn't move too far away so… In this maze there are some fork paths so, even if she goes one way, I usually think… Well, since I'm an achiever, if she goes one way, I know I have to go the other way. That's my habit when I play games: when there are two paths and I know that one way is for sure the one to move on with the story, then I will take the other one because there are probably treasure chests in there. So that's what I was doing here as well… [P24, Maze]

Figure 8.4 illustrates the core of this discussion, summarizing how the perceived number of cues affected the player experience (or how players felt about the wayfinding experience).
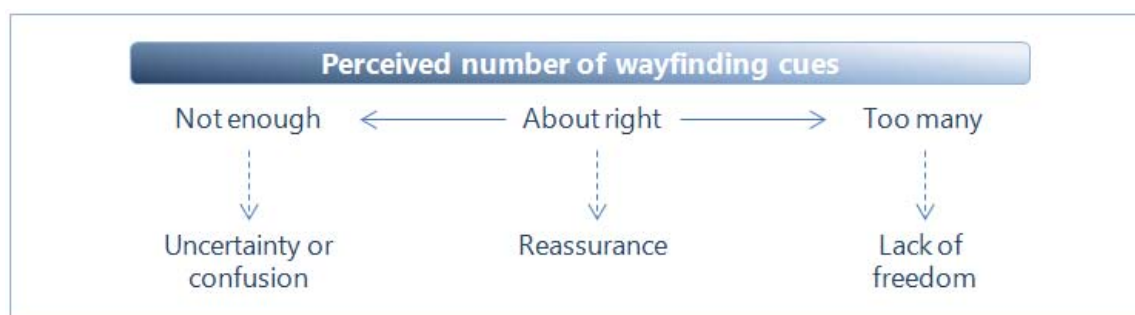
Figure 8.4   Illustration of the relationship between the perceived number of wayfinding cues and the effects on the wayfinding experience

8.2.5.   The legibility and intelligibility of the cues affected players' perceptions of the number of cues in the game as well as the player experience

As pointed out in the literature review, information processing is crucial for both wayfinding and the gaming experience (Arthur & Passini, 1992; de Souza, 2005; D. Norman, 1988; Ryan & Siegel, 2009), and that was confirmed in this research. Overall, frequent players could notice and interpret the wayfinding cues more easily than less experienced players. Not surprisingly, noticing and interpreting the wayfinding cues was intrinsically related to the perceived number of cues (see section 8.1.5). When players could not notice or interpreted the cues, they felt lost or unsure of what to do (section 8.2.4). Also, players negatively reacted to the cues when they found them too intrusive. P19 reported on how frustrated s/he felt when s/he could not progress through the Climbing room at ease:

Then I notice that [pillars] right there and then I pressed the frustration button... Oh, it was so hard to notice that, so I had to click that [frustration button]. There was no explanation or description of where to go. And no other hints or something like that. So, in the finished product, there could be an agent saying, "oh man, that rock moved so you have to get in there..." Something like that... Or maybe a mini-map and some of the obstacles in the mini-map have moved... so you know that you have to go there and find the exit there. [P19]

Regarding intelligibility, the player experience was also disrupted when players could not interpret the wayfinding cues. That generated confusion, uncertainty and frustration, as even though the cues were there, players could not make use of them. Discussions around the difficulty of interpreting game features are common in the literature. However, researchers sometimes fail to further discuss the root cause of interpretation issues. Being able to pin point the exact reason why players are having issues interpreting game features will certainly help designers to improve their work. In this work, I identified a few reasons why players had difficulty in interpreting the cues:

- They were unable to assign meaning to a feature (most frequently reported problem): players could not assign *any* meaning to a game feature

- They misinterpreted the meaning of a feature: players could not correctly interpret a feature or assumed that it represented something else

- They had difficulty in associating game features: players cannot see a connection between related game features

- They wrongly associated game features: players associated two or more game features that are unrelated (e.g., gem and checkpoint)

Conversely, when the wayfinding cues were noticed in a timely fashion and correctly interpreted, the cues helped to increase players' involvement. Many of the wayfinding cues motivated players to progress in the story with confidence. In those cases, the wayfinding cues shaped meaningful and rewarding experiences for the players.

8.3. Design considerations

The discussion above highlights the complexity of researching on wayfinding in video games. Through concrete examples, I presented how players responded to

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several wayfinding cues in two action-adventure games. I am not proposing that players will always respond to those types of wayfinding cues in the same way; in fact, I also presented examples of how players responded to the same wayfinding cues in different ways depending on a variety factors. Even though this research does not provide definitive answers, it begins to map out this intricate space.

Finally, there are several lessons learned from both study results and the prototype of The Lost Island and A Warrior's Story. Table 8.1 introduces some design considerations that may work as guidelines for the creation of wayfinding systems in games or serve as questions for future research.

Table 8.1   Design considerations for creation of wayfinding experiences in action-adventure games

Related factor	Design considerations
Players	• What are the players' expectations in relation to wayfinding experiences? • Is the wayfinding experience suitable for players at different skill levels? • How much control over the wayfinding experience do players have?
Games	• What is the context the wayfinding experience is unfolding? How large is the game environment? Does the game have indoor and outdoor settings? • How does wayfinding contribute to game experience? • How much guidance do players need based on the context and wayfinding goals? • Are the wayfinding cues believable and appropriate in the context of the game? Do they help to create the right atmosphere for the game?
Wayfinding tasks	• Do the wayfinding tasks welcome players with different play styles? • Do players have freedom to choose when and how to solve the wayfinding tasks? • Are primary and secondary wayfinding tasks clearly differentiated? • Are wayfinding goals clear to the intended audience? Do players know what they need to do and why? • Are there clear links between what players need to do and how to do it?
Wayfinding cues	• Are the wayfinding cues designed for primary or secondary tasks? • Are the cue types appropriate for the task? • Are the wayfinding cues noticed and interpreted in a timely fashion based on the task and context of the game? • How is the game helping players who misinterpret wayfinding cues? • Are there cues that need to be leaned by the players? How are those cues being taught? • Is the number of wayfinding cues appropriate for the tasks? Is the game providing enough cues to give players reassurance they are in the right path? • Can players control the number of cues by turning them on and off? What are the consequences of reducing the number of cues?

8.4. Contributions

8.4.1.   Effects of wayfinding cues on the gaming experience

Through concrete examples, this research demonstrated how wayfinding cues affected both players' wayfinding behavior and the player experience in different game scenarios and tasks. This research also highlighted ways in which players' attitude towards wayfinding cues affected player behavior in games.

8.4.2.   Design-oriented research

One of the challenges I faced in the beginning of this research was the lack of studies investigating wayfinding in complex, rich game scenarios, as most work studied wayfinding either in the real world or in sterile digital environments. To my knowledge, this research is the first to investigate players' behavioral and attitudinal responses to wayfinding cues through the design of two different action-adventure games that resemble commercial games.

8.4.3.   Mixed methods with focus on players' perspectives

This research demonstrated the value of more in depth mixed methods in understanding these difficult questions beyond the traditional methods of game telemetry and summative experiential post-hoc reports.

While previous work have also demonstrated how qualitative data can help investigators to better understand how people navigate and explore real and digital spaces (Liszio & Masuch, 2016; Murray et al., 2000; Si et al., 2017; Xia, Arrowsmith, Jackson, & Cartwright, 2008), to my knowledge, this work is the first attempting to investigate the relationship between *wayfinding cues* and players' wayfinding experience mostly grounded on players' perspectives. Listening to the players is important because they can quickly shift activities if they are not satisfied with their gaming experiences. That will likely result in product failure and losses of investment.

8.4.4.   Design considerations for wayfinding system design

Finally, this research proposes a series of design considerations in the form of guiding questions that may help designers to craft wayfinding systems for video games and help researchers to better frame their investigations on wayfinding in complex game worlds.

8.5. Limitations

8.5.1.   Game MODs

Although, I designed two games that resembled commercial games in terms of wayfinding cues, tasks, graphics, visual effects, and sound effects, I could only go so far in other aspects such as cut scenes, voiced dialogues, auditory cues, and narrative. Although players mentioned that they really liked many features of the game, many players also expected a better story to go along with the tasks. I believe that affected the involvement scores and the overall experience with the game.

Creating high quality game MODs is time consuming and quite complex. There are many tasks in the design and development processes that require knowledge in different fields, let alone the fact that I needed to learn two different game engines and visual programming languages to build my research tools. Not surprisingly, a few details were missed in the process. Nonetheless, several participants received the game positively. Their reports made it evident that they treated the game as a "real" game. Many mentioned they liked things like graphics and exploring the environments:

> I was just following [the Guide]… "oh, that's pretty cool." Then, because it is a maze, I knew that there would be coins. I sort of explored and sort of found my way back. I thought that that scroll there was like a treasure, but I couldn't really get it so I left it alone. I had played a game that there are things that you can't get until you either unlock ability or you get an especial tool. So I thought, "maybe further in the game I can come back to it after I learn a new ability or something." [P06]

> I see some coins so I picked them up. And there's a treasure box… I pressed the cool button because I was pretty amazed by the

environment… It is pretty beautiful. Then I was exploring, collecting. [P11]

I pressed the cool button here because you jump straight into battle, and because there are lots of cool coins and other stuff here. So it's not given to you straight away but you have to kill them first. [P18]

I pressed the cool button here because it was tricky, but in the right amount. This part was challenging enough. It's tricky because you can't see the lever so you have to find it. If you don't explore you don't know where to go. [P18]

This is the first room where I saw all the coins and I'm like "okay, I'm a collector." You know, I play games to collect things. I pressed the cool button here because I just really found the environment… it was immediately "wow, this actually looks nice." I like this artistic style of the game. It kind of reminds me of Fable. Then, I collected more coins, checked every nook and cranny because that's what I do in video games. [P22]

I thought that I had to go straight and break those woods because usually the path of the game is for you to go straight, right? That's the main thing. But I guess exploring is part of the game. It's pretty interesting. It's pretty cool actually. [P41]

In addition, I could only include some wayfinding cues of many others that have been identified in previous work (Moura & Seif El-nasr, 2014; Nerurkar, 2009; Rogers, 2009). For example, many players expected to have a map in the game. However, I decided not to use a map as they usually take players' attention away from the game world. Nonetheless, it is valid to compare how players' performance and attitude towards a game may change based on wayfinding guided by cues or maps.

8.5.2.   Concerns with external validity

As pointed out in Chapter 3, there is an ongoing debate about generalizability in games research, especially in works following a pragmatist perspective. In this research, I found evidence and I reported on players reacting in a similar way to some wayfinding cues in both The Lost Island and A Warrior's Story. This suggests that, given the same wayfinding cues and tasks, players may repeat those behavioral patterns. However, as also pointed out, this research did not aim for statistical generalizability found in post-positivist approaches.

In addition, I did not take into consideration participants' spatial ability and gende, so with such small number of participants (14 per condition) it is difficult to generalize. Further research is required to verify whether my findings can be generalized and how the set of design considerations proposed in this thesis can be complemented or ameliorated.

8.5.3. Time constraints

I collected both quantitative and qualitative data to be able to compare both strands on my analysis – using data coming from the same participants. Although that resulted in rich and interesting findings, I needed to sacrifice data collection from both strands. For example, I could not collect players' X, Y coordinates (or path length) due to limitations of the tool. That could have given me more information about where players went in the game. In addition, contrary to qualitative studies where researchers usually gather subjective data from extensive interviews, I had limited time available in the cued recall debrief due to the high number of participants in the second study. Undoubtedly, I missed relevant information.

In addition, I did not have the resources to further compare players' responses to wayfinding cues based on spatial ability and gender, as proposed in previous work (de Castell et al., 2015; Si et al., 2017). Further research is necessary to address these issues.

8.5.4. Lab setting

As pointed out, participants were left alone in the gaming room to play the game. Even though I believe that helped participants to feel more comfortable playing (in fact, many participants confirmed that in the cued recall debrief), players were still in a lab setting and that certainly influenced the player experience.

8.5.5.   Immersive Experience Questionnaire

Finally, I expected to see stronger trends through the IEQ scores. It was difficult to disentangle the extent to which wayfinding cues alone affected the scores since there were not significant differences between group scores. It might be the case that the game was easier than I intended (given that players in the Representational condition performed better than players in the other conditions at times) and the role of wayfinding cues was minimized, at least in some circumstances – further research is necessary to confirm this assumption. The need for a questionnaire that can specifically measure the relationship between wayfinding cues and player involvement remains.

8.6. Future work

As previously mentioned, this research only scratched the surface of a broad topic. There are a few directions I want to explore in the future. First, there are several other visual wayfinding cues and auditory cues that have not been validated in this work (Moura & Seif El-nasr, 2014). In addition, there are other game scenarios and game genre that could be explored with the use of different cues. More specifically, I want to further investigate how to use wayfinding cues as invitations to progress through the game, sustaining players' interested and making them motivated to play.

Second, due to the lack of resources, I could not explore how players of different skills, gender, and spatial abilities would respond to wayfinding cues. This is another valid direction for future research because those factors should be taking into account if one wants to design for a broader audience.

Third, based on the lessons learned through this work, I want to use the set of design considerations as guiding questions for future research. Thus, instead of taking a holistic approach, future research can be more targeted to specific factors affecting the wayfinding experience in video games.

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Appendix A.

Demographics questionnaire

ID: _____

Age: _____   Gender: _____   Native language: _____

Occupation: _____   Field of expertise: _____

1. I consider myself:

   ☐ A novice video game player
   ☐ An occasional video game player
   ☐ A frequent video game player
   ☐ An experienced video game player

2. 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)

3. In which platform do you play more frequently?

   ☐ PC
   ☐ Console (PS2/PS3, Xbox, Wii)
   ☐ Portable (Cell phone, DS, PSP)

4. 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

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

   _____

   _____

   _____

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

   ☐ Single player

   ☐ Multiplayer

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

   Yes ☐   No ☐

8. Do you normally feel overwhelmed by the challenges during the first couple of hours of play-time with a new game?

   Yes ☐   No ☐

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

   _____

Appendix B.

Immersive Experience Questionnaire and Scores

Your Experience of the Game: Please answer the following questions by circling the relevant number. In particular, remember that these questions are asking you about how you felt at the *end* of the game.

1. To what extent did the game hold your attention?
   Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *A lot*

2. To what extent did you feel you were focused on the game?
   Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *A lot*

3. How much effort did you put into playing the game?
   Very little   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *A lot*

4. Did you feel that you were trying you best?
   Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

5. To what extent did you lose track of time, e.g. did the game absorb your attention so that you were not bored?
   Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *A lot*

6. To what extent did you feel consciously aware of being in the real world whilst playing?
   Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

7. To what extent did you forget about your everyday concerns?
   Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *A lot*

8. To what extent were you aware of yourself in your surroundings?
   Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very aware*

9. To what extent did you notice events taking place around you?
   Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *A lot*

10. Did you feel the urge at any point to stop playing and see what was happening around you?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

11. To what extent did you feel that you were interacting with the game environment?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

12. To what extent did you feel as though you were separated from your real-world environment?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

13. To what extent did you feel that the game was something fun you were experiencing, rather than a task you were just doing?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

14. To what extent was your sense of being in the game environment stronger than your sense of being in the real world?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

15. At any point did you find yourself become so involved that you were unaware you were even using controls, e.g. it was effortless?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

16. To what extent did you feel as though you were moving through the game according to your own will?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

17. To what extent did you find the game challenging?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very difficult*

18. Were there any times during the game in which you just wanted to give up?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *A lot*

19. To what extent did you feel motivated while playing?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *A lot*

20. To what extent did you find the game easy?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

21. To what extent did you feel like you were making progress towards the end of the game?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *A lot*

22. How well do you think you performed in the game?
    Very poor   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very well*

23. To what extent did you feel emotionally attached to the game?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

24. To what extent were you interested in seeing how the game's events would progress?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *A lot*

25. How much did you want to "win" the game?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

26. Were you in suspense about whether or not you would do well in the game?
    Not at all   *1*   *2*   *3*   *4*   *5*   *6*   *7*   *Very much so*

27. At any point did you find yourself become so involved that you wanted to speak to the game directly?

Not at all	1	2	3	4	5	6	7	Very much so

28. To what extent did you enjoy the graphics and the imagery?

Not at all	1	2	3	4	5	6	7	A lot

29. How much would you say you enjoyed playing the game?

Not at all	1	2	3	4	5	6	7	A lot

30. When it ended, were you disappointed that the game was over?

Not at all	1	2	3	4	5	6	7	Very much so

31. Would you like to play the game again?

Definitely no	1	2	3	4	5	6	7	Definitely yes

How immersed did you feel? (10 = very immersed; 0 = not at all immersed)

1	2	3	4	5	6	7	8	9	10

Scoring the Immersive Experience Questionnaire (IEQ)

IEQ Immersion Score: Add up the responses to all 31 questionnaire items; responses to Q6, Q8, Q9, Q10, Q18 and Q20 are negated.

Single Question Measure of Immersion: The last question "How immersed did you feel?" gives the researcher an additional measure to check whether the IEQ is reliably reflecting the participant's immersive experience.

IEQ Immersion Factors: Scores for five immersion factors can be computed.
- For "Cognitive Involvement" add up 10 of the questions: Q1, Q2, Q3, Q4, Q17, Q19, Q21, Q22, Q25, Q29.
- For "Real World Dissociation" add up 6 of the questions: Q6, Q7, Q8, Q9, Q12, Q14 (where Q6, Q8 and Q9 are negated).
- For "Emotional Involvement" add up 12 of the questions: Q6, Q7, Q13, Q19, Q23, Q24, Q25, Q26, Q27, Q29, Q30, Q31 (no negations).
- For "Challenge" add up 5 of the questions: Q17, Q18, Q20, Q22, Q26 (no negations).
- For "Control" add up 8 of the questions: Q10, Q11, Q13, Q14, Q15, Q16, Q21 and Q28 (no negations).

Reference: Jennett, C., Cox, A. L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T. & Walton, A. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human-Computer Studies, 66,* 641-661.
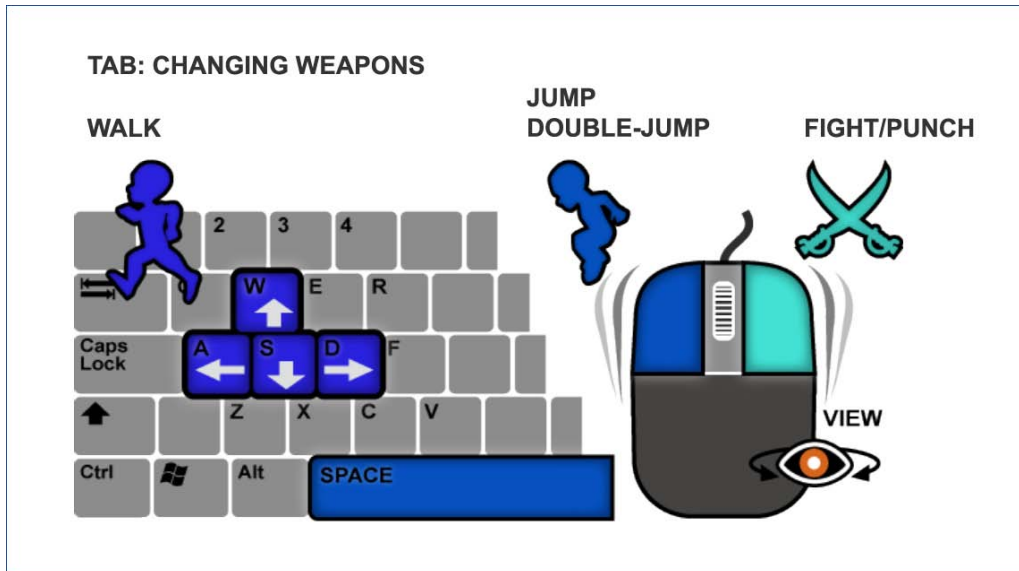
Appendix C.

Poster and Game Controls
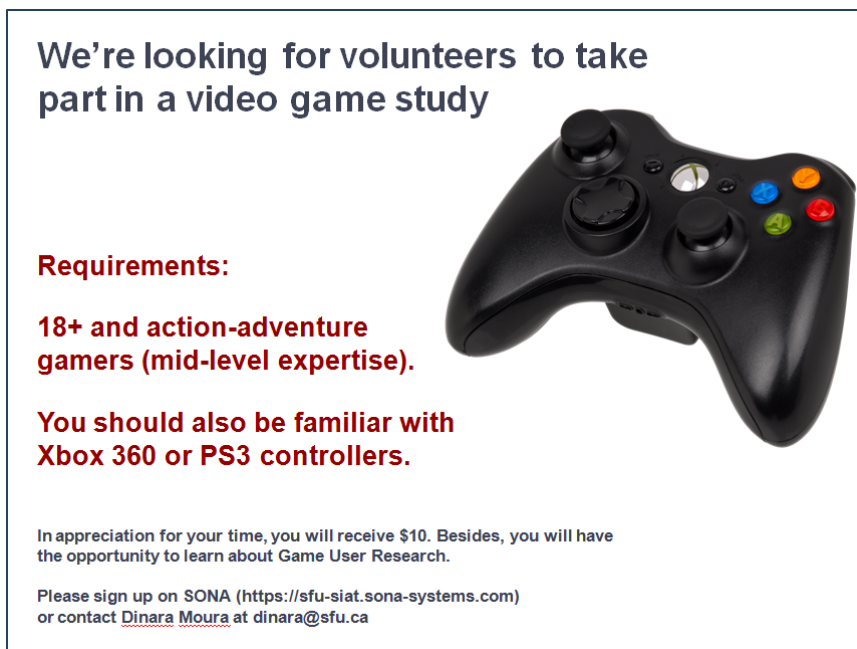

Figure C1: Poster with controls (Study 1)

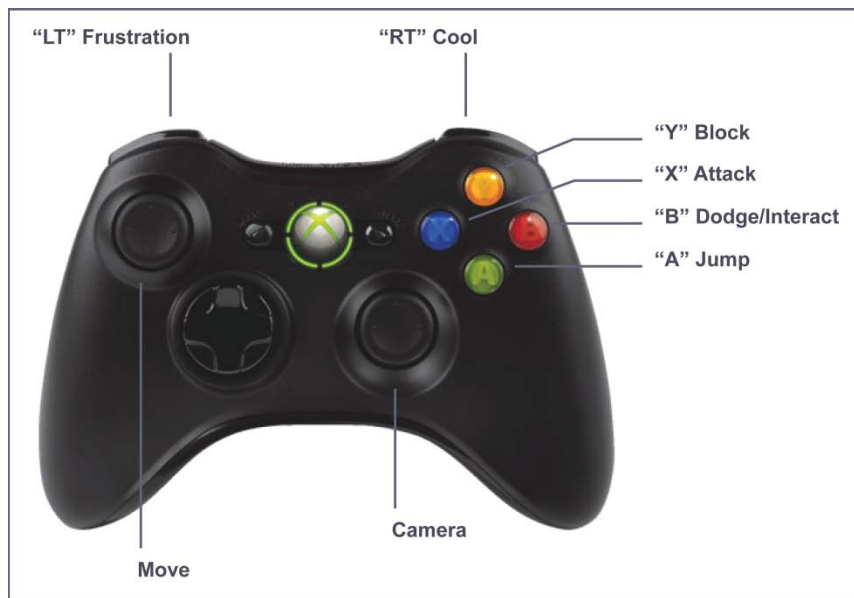**Figure C2: Poster advertising Study 2**

Figure C3: Poster with controls (Study 2)

Appendix D.

Images for Cued Recall Debrief in Study 1

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