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Out of Sight

Navigation and Immersion of Blind Players in Text-Based Games

Bachelor Thesis

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For Frank

Because, man, without you this would never have happened.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Behind the Scenes

If gaming, especially collaborative gaming, is considered as a social interaction, the development of collaborative online games opens up new questions: How can game designers ensure that players with different abilities in their everyday lives interact as equals playing the same game? How do they enhance their game with a potential experience of immersion that appeals to all potential players?

Creating an interesting and immersive game without an exclusively visual interface requires different methods than developing games that heavily rely on their visual interface. Representation of the game environment works differently, as does navigation in it. Text based online roleplaying games attract blind and sighted players alike. However, these two groups navigate using different approaches in their everyday lives (compare amongst others Loomis et al. 1993 or Noordzij, Zuidhoek, and Postma 2006). Further on this paper also attempts to assess whether different navigation systems influence the immersive quality of a game and how this relates to their everyday experiences.

Blind players of text based games say that they use this form of gaming to experience sensual feedback that they do not have in their everyday interactions with their environment:

"I'm playing to be sighted."[1]

Gaming is effective as a relaxation activity, similarly to the function of TV (compare Engell 2000), for example, this is because they feature repetitive activities such as those found in *hack-and-slash*[2]-themed games. However, gaming also works as social activity (compare Caillois 1958/2001, p. 37-42). In multiplayer text based online games, cooperative playing with sighted players on equal terms is not only possible, but also encouraged.

Which parameters create immersion for the blind player is not necessarily obvious though. In the 2010 documentary movie Get Lamp, an interviewed blind player explains how they interact with the game:

> "And then I walk into that room and it says: 'It's pitch black dark.' and I just think: 'Welcome to my life.'"

This shows that *immersion* is a subjective term, though this does not keep researchers from investigating features which could help increase the immersive feeling of games, books and movies.

Multiplayer text based online games are interesting to explore as a potential space where all potential players can play together, since a player's disability vanishes behind the screen. If it is revealed, it might at first be surprising to others, but soon become part of the *normal* (compare Foucault 2003/1974-1975).

The research presented in this thesis has been conducted by a sighted researcher. However, the assistance of blind and visually impaired players has been actively sought out to address potential bias issues. They were included in the research whenever it was possible.

The addictive qualities of computer games and whether they even exist are actively discussed in the scientific community (compare for example: Ahn and Randall 2007, Griffiths 2004 or Gruesser, Thalemann, and Griffith 2007). However, this topic is not discussed here, despite degree of immersion playing a big role in assessing addictive qualities of games. Immersive qualities of a computer game are not tied only to extraordinarily detailed graphics or hyper-realistic environments. Simple games like Puzzle Quest or Tetris can cause intense focus in their players.

[1] 'Get Lamp', Jason Scott Sadofsky (2010)

[2] This term refers to a gameplay that mostly consists of killing other player or non-player characters.

This paper attempts to establish parameters for immersion, with a focus on navigation in text based online roleplaying games. Furthermore, it is not only award driven gameplay, as described by Schultz 2004, that can make a player stick to a game and continue playing it over a great length of time. Other types of players have other reasons to play MUDs (compare Chapter 2.2 for a discussion of the relevant literature or directly Bartle 1996).

The general class of text based games is commonly referred to as *Interactive Fiction* (compare Jerz 2000):

> "Interactive fiction (IF) is computer-mediated narrative, resembling a very finely-grained 'Choose Your Own Adventure' story. The interactor reads a short textual description ('You are standing at the end of a road before a small brick building.'), and types instructions to the computer ('enter building'). The plot can change based on what the interactor types. It has the potential to be more truly interactive than hypertext."

The first text adventure game[3] was inspired by pen and paper games such as Dungeons & Dragons and called Adventure (1975)[4]. The multi-player variants of text games are called Multi-User Dungeons (MUDs). Their rise started when more and more content was available from different sources over the internet, but the speed of the user's connection and hardware did not allow for graphically impressive games. Nowadays the player bases are smaller, since they have to compete with games like World of Warcraft. However, those are not accessible to visually impaired players, whereas MUDs and other text based games are.

1.2 Research Questions

With the assistance of screenreaders and specialised client software, blind players are able to play text based games. In multiplayer online versions they can also do so with other players. However, in their everyday lives as well as in games, blind and sighted players interact differently with their environment. Text-based games are usually written by sighted gamers with a focus on textual representation of

[3] For a definition of the term *adventure game* how it is used here, compare Pias (2002)
[4] For a detailed history of Interactive Fiction, consider Montfort (2004)

visual features. An exception is the game Blind, which was an entry to the Interactive Fiction Competition 2011[5]. It relies heavily on the textual representation of sounds and feedback given through sound and touch instead of visual representation. These further senses could be incorporated into text game development to increase immersion for different player groups and provide additional information to every player. However, the author leaves potential research in this field to their colleagues for now.

There are two different fundamental ways of navigating through a textual world: ego-centric coordinates (such as left, right, forward and backwards) or cardinal coordinates (such as north, south, east and west). When examining immersion, this fact raises the following research question: Which of these coordinate systems in text based games creates a gameplay that is more immersive for blind players and which is more immersive for sighted players?

Attention has already been paid to the needs of blind players within the community, mostly by sighted players[6]. Scientific research, however, focuses on more general obstacles that are imposed on a blind person by certain technologies (compare for example Ahn et al. 2006). Research with a focus on game-related accessibility for blind players mostly relates to audio-based games (compare for example Miller, Parecki, and Douglas 2007) or general multi-modal enhancement of games (compare for example Velleman et al. 2004). There is some general research into text-based games, but not with a focus on blind players (compare Montfort 2004).

Computer science research, and other technology research in general, appears to have a history of analysing special needs of focus groups without those groups participating in the actual research (compare Jacobson, Giudice, and Moratz 2011). The results presented here were achieved with the heavy participation of blind players who actively play text based games as well as inexperienced blind test subjects.

To assess the level of immersion for blind players, there is a control group of sighted players and an assessment of how the reference frame for navigation influences the respective playstyle and immersion. The findings of this thesis can help in the design of future text based multiplayer games, where different navigation systems could be offered according to the preference of the individual player.

[5] available at http://www.ifarchive.org/indexes/if-archiveXgamesXcompetition2011Xtads2Xblind.html
[6] See for example: http://www.inthecompanyofgrues.com/?cat=66

1.3 On Display

This thesis first deals with a literature analysis of the terms and concepts that are important for the research in Chapter 2. The terms covered are *immersion* and *presence* including a discussion of how to measure these. The concepts discussed are playstyles in text based games, players with visual impairment, existing games for these players and how perceptive cues as well as the representation of areas influence navigation. This paper then discusses the motivation for the thesis and why it is important to conduct this research at all in Chapter 3. The hypothesis and design of the research as well as the findings of the pilot study and their implications are described in detail in Chapter 4. Chapter 5 then deals with the analysis of the different data types that have been recorded, whereas Chapter 6 then puts the findings in perspective and discusses possible applications as well as the validity of the research. The thesis concludes with deliberations about the limitations of this work and hints towards possible further work that could be conducted going forward.

Chapter 2

Literature Review

Relevant literature for this thesis is discussed in the following chapter. First the term *immersion* from the perspective of social sciences and human-computer interaction, followed by an analysis of playstyles in interactive fiction. Furthermore, players with visual impairments are portrayed and an analysis of games produced for them preceed an explanation of perceptive cues in the process of navigation.

2.1 Immersion

The terms *immersion* and *presence* have been discussed in the fields of social studies and computer science alike. The analysis in social studies generally focuses more on what happens between the player and the game, whereas computer science tries to establish parameters and methods to acquire quantitative and qualitative data about them. To account for all these different viewpoints, this chapter first presents a definition from the side of social studies and then discusses play styles in multiplayer text based online roleplaying games. After a brief look into the specifics of playing games and being visually impaired, it will then discuss *immersion* from the perspective of computer science, which parameters exist and how they may be measured.

2.1.1 What is Immersion?

In social studies, early film is a popular example when discussing the concept of *immersion*. Experiments with the new medium around 1900 had train rides as a popular subject – movies about five minutes long where a train moves towards or away from the audience. It is reported that the audience, which had not yet found a way to deal with the new medium, often reacted with panic to a train coming towards them from the screen (compare Fielding 1970). Some of the concepts that are usually tied to the immersive qualities of movies also apply to the immersive qualities of games. For example, Lehmann (2008) defines three bodies that play a role in the immersive perception of 3D computer-animated films. Translated to games, these bodies could be defined as:

1. The physical body of the player
2. The projected body or avatar which is being manipulated within the game world
3. The body in between

The third body describes the dispositive entanglements of the player and the game, such as the environment around them while playing and the rituals which are unique to every player and game. This point in between player and avatar could, according to Lehmann, be described as the point of immersion.

This understanding of immersion overlaps in parts with the concept of *presence experience* as described in Wirth and Hofer (2008). The experience of presence can be seen as a part of immersion, where the term immersion describes the circumstances of the game and how much the player is involved as a whole. According to the theory of Wirth and Hofer any type of narrative medium determines first the *Spatial Situation Model*. This is then expanded to *Spatial Presence* due to high levels of involvement. *Spatial Presence* can be disrupted by the suspension of disbelief. The author disagrees on the use of the term *involvement* in this context, since it describes a larger process than just the creation of a spatial presence within the game. Especially in multiuser games, social interaction with other players can influence an individual player's immersion greatly. However, analysis on how spatial

models are formed can help understanding the navigational process in games of Interactive Fiction. The player moves an avatar around the game space and hence has to develop an individual *Spatial Situation Model*, which can be influenced by the navigational frame of reference.

Another aspect of immersion has been further described by Voss (2009):

> "Immersion erwiese sich (dann aber) nicht als ein psychologisch eindeutig bestimmbarer Zustand, sondern als die analytisch uneinholbare Einheit der mit jeder konkreten Rezeptionssituation wechselnden kausalen, logischen und leiblichen Einlassungen auf einen filmischen Input."[1]

Although that is a discussion of the term immersion in the context of film theory, this idea is applicable to games as well. The rules provided by a game have to be accepted by the players. Otherwise, the interaction between player and game could not take place at all, or at least would result in a disruption of gameplay. This acceptance is also true for the navigational frame of reference in text based games. If a player does not accept the perspective given to them, they may find their gameplay frustrating and stop playing altogether.

According to Neitzel (2008), immersion is bound to the creation of a space through text and sound. Also the actions that are available to the player play a role. Neitzel prefers the term *involvement* over *immersion*, since the latter is in their analysis generally defined as passive. The author disagrees, as the distinction between *presence* and *immersion* is not always clear. Also, spaces do not require sound; in text based computer games the space is created via text alone. The construction of the worlds in Interactive Fiction can be seen as a set of linked hypertext that creates the virtual space. Perception of a room is influenced by the navigational frame of reference. An egocentric frame of reference gives the player information about how their avatar relates to the world while an allocentric reference frame gives the player information on how the space they are in relates to the whole world[2].

All in all, where immersion can be described with elements of presence experience and involvement, it can then in the context of games be defined as the

[1] Translated: "Immersion would (then) not be a psychologically distinct determinable state, but rather an analytically uncatchable entity of the causal, logical and phyisical involvement towards a cinematic input, that changes in every situation of its adoption."

[2] For a definition of the terms *allocentric* and *egocentric* navigation compare Chapter 2.5.

player's' undisrupted and focused engagement with the game they are playing. This includes the cognitive processes of creating a working spatial model of the world as well as the potential for disruption.

2.1.2 Parameters of Immersion

The term *immersion* has additonally been discussed in the field of Human-Computer Interaction (HCI), specifically with a focus on digital games. Bowman (1998/1999) specified parameters important for interaction while travelling through virtual realities, though he did so with a focus on graphical games. His concept of *speed* does not always play a role in text based online games, since it is mostly dependant on server-side lag and the speed with which the player types in their commands. Players move directly from one room to another, despite the actual size of a room. This can be compared to constant movement through portals where the actual time spent moving between two spaces is nonexistant; but the number of destinations is limited, since only the rooms adjacent to the one a player is in can be entered. However, the player can still choose a wrong direction, which makes *accuracy* a suitable parameter for the discussion of immersion in text-based games.

Spatial Awareness, the player's knowledge of their position within the game space, is presented on two different levels, depending on the chosen navigation system. In an egocentric system, players know how they are positioned in relation to their current room and can determine their relationship with the world from that, whereas in an allocentric system players know their position in the world and can establish their position in relation to other rooms from that. This also alters the view a player has of the world and which levels of *presence* are achieved. Witmer and Singer (1998) provide a useful definition:

> "Presence is defined as the subjective experience of being in one place or environment, even when one is physically situated in another. (...) As applied to a virtual environment (VE), presence refers to experiencing the computer-generated environment rather than the actual physical locale."

Bowman also establishes the parameters *ease of learning* and *ease of use*, which are general usability metrics. However, taken alone, they are actually not

as important as the other metrics used to assess the immersive quality of a game. For example, a game can have a tutorial section, where players can both immerse themselves and learn how to play the game. While learning the game though, it probably cannot be established by the player how easy to use the interface of the game is. They can nevertheless immerse themselves, if the area is well written.

One of the other early works of research related to immersion was done by Witmer and Singer (1998). Besides their definition of *presence*, they also established different factors that play a role in it:

- control factors - such as degree of control, immediacy of control, anticipation of events, mode of control, physical environment modifiability
- sensory factors - such as sensory modality, environmental richness, multimodal presentation, consistency of multimodal information, degree of movement perception and active search
- distraction factors - such as isolation, selective attention, interface awareness
- realism factors - such as scene realism, information consistent with objective world, meaningfulness of experience, separation of anxiety and disorientation

However, they simply list these factors without an explanation of how they can be influenced by the actual game design.

With them in mind, they built the *Presence Questionnaire* (PQ); however, there is no consistency over how distinct factors are assessed. A further problem with this questionnaire is that the definitions of the factors and the questions asked to assess them argue against each other.

More ground has been covered by their *Immersive Tendency Questionnaire* (ITQ), which can be used as a normaliser over the answers given to more specific questions.

The factors defined by Witmer and Singer are all *subjectively* defined, according to Slater (1999). That means that the PQ can only assess subjective features as well. Furthermore, while Witmer and Singer's point seems to be to find *presence* factors, it is never directly stated, which makes it difficult to actually find out more about the level of presence and the connection to possibly influencing parameters.

In addition, the design of the PQ appears to produce results that always correlate with each other. Slater proves this with some basic statistical analysis. The ITQ, on the other hand, is deemed to possibly be useful as a normaliser. Slater has a general dislike towards questionnaires due to them only providing subjective results.

Slater (1999) also offers the criticism, that Witmer and Singer use a definition of immersion based purely on the player's response to a virtual environment. His own definition is as follows:

> "I had defined the term immersion to mean the extent to which the actual system delivers a surrounding environment, one which shuts out sensations from the 'real world', which accommodates many sensory modalities, has rich representational capability, and so on."

According to Slater's theory, *presence* includes three aspects: the sense of 'being there' in the environment depicted by the virtual environment, the extent to which the virtual envrionment becomes the dominant one – for example that particular participants will tend to respond to events in the virtual environment rather than in the real world and the extent to which participants, after experiencing the virtual environment, remember having visited a place rather than just having seen images generated by a computer. This argument is a discussion of the terms *immersion* and *presence* where presence can be seen as one aspect of immersion. However, both authors do not distinguish well enough between these two terms.

Another framework has been established by Wu et al. (2010) with six aspects to focus on in 3D-teleimmersive environments. As well as the work of Nacke and Lindley (2008) it has a strong reference to the concept of *flow* as presented by Csikszentmihalyi (1991). It assumes that an equilibrium exists between the axes of challenge and ability (see Figure 2.1). This state can be reached with any human activity such as work, music or gaming. This holistic sensation of total involvement is reached through intrinsic motivation. Nacke and Lindley's model simplifies the flow concept and defines immersion with the concepts apathy, anxiety, boredom and flow, where boredom can be seen as the opposite of flow.

Since their test game was based on the first-person shooter Half-Life 2, their results have to be interpreted to be useful for text-based games. Adapting their

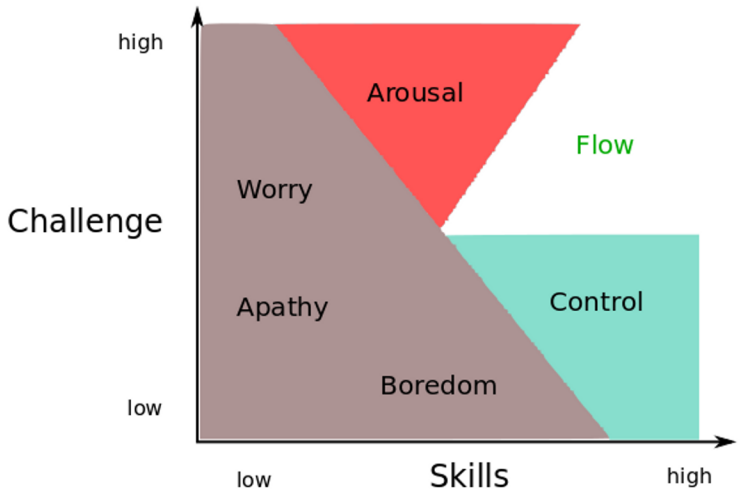


FIGURE 2.1: Visual adaption of the concept of *flow* as presented by Csikszentmihalyi 1991

results gives clues on how to avoid boredom. Many repetitive rooms between interesting points are something to avoid. Further things provoking boredom are not having a winning condition, limited choice of items, an unreasonable high amount of health, seemingly endless supplies throughout the level as well as a lack of surprises.

Nacke and Lindley (2008) do not mention social interaction with other players or how to account for different skillsets. For them, the audiovisual or sensory experience of a game environment is the main parameter for immersion. However, this can also work in a descriptive environment. The suggestions they give out, such as complex and exploratory environments, various opponents and interactive Non-Player-Characters (NPCs), new items as a reward and narrative framing, have to be adapted to be considered for text based games as well.

In conclusion, parameters of immersion have been established with a focus on visual sensations, films and especially in the context of mainly graphical games in the field of HCI. Research on immersion in a non-visually dominated environment is quite rare.

2.2 Playstyles in (Multiplayer) Interactive Fiction

The parameters which are useful to measure do not depend only on the game being analysed, but also on the gameplay supported. Players can adopt different styles while playing text based games. Bartle (1996) defines four types of players that he thinks are common especially in MUDs: achievers, explorers, socialisers and killers. These can be understood as quadrants with axes of acting vs. interacting and players vs. world (see Figure 2.2).

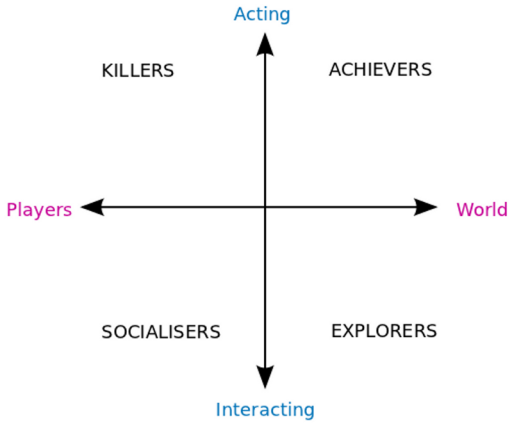


FIGURE 2.2: Playstyles that occur in MUDs. Adapted from Bartle 1996

According to his theory, achievers try to acquire a high ranking in the metrics offered by the world, explorers try to find out many of the possibilites for interaction in the game; socialisers look for recognition by other players, while killers are driven by the damage they can cause. While Bartle states that the playstyle of an individual player might change for the task that they are momentarily concentrating on, they do so in order to fulfill a main goal which is determined by their player type. He sees these categories as fixed, though he does account for the fact that a player can be sorted into a main category and a secondary one they fall back on.

Bartle also shows that different game layouts support different playstyles and their interaction. The test setup used here looks at parameters which are closely related to the gameplay of explorers and, to some extent, achievers. The task is driven by the exploration of the area and successfully finishing the task can give the player a feeling of achievement. There is no killing involved, although there

are NPCs (Non-Player Characters) which can be attacked if the test participants decides to do so. As only one player is on at a time, socialising is non existant. This should be kept in mind when reading the results of the study.

The taxonomy given by Bartle has often been criticised as being too coarse. This is mostly the case, as his concept does not account for actual real life changes in a player's life. Players grow older, their life changes around them and so does their playstyle. For example Karlsen (2004) proposes a new term for MUD-player in reaction to Bartle, which considers all possibilities that such games offer, *media citizen*. With the example of the MUD Discworld[3] he explains different types of activities available to players, such as running player shops, editing newspapers or even engaging in politics as a citizen of a distinct area. In Karlsen's opinion, the only way to make Bartle's categories useful is to see them as descriptions of *player behaviour* instead of *player types*. Following this theory, the test setup is suited to support some of the behaviour Bartle describes in player categories, while acknowledging that a playstyle is highly individual and subject to change.

2.3 Players with Visual Impairment

Blind players can take on any of these playstyles, however they naturally play games that do not rely mainly on visual output. A specifically interesting example is presented by Schreier (2011), where a blind player plays a video game which accidentally provided audio feedback to a level that it is playable by a blind player[4]. Blind players often play audio-based games or text-based games with screenreader support. Since developing universally accessible games is not deemed commercially viable by a majority of game companies (compare Heron 2012 A), blind players are still excluded from many popular games that rely heavily on visual output.

To find out how blind players behave in MUDs, the author conducted interviews (compare Appendix A). The three participants in this small interview round were playing MUDs on a daily schedule, but started playing MUDs at different times (between 18 and 3 years ago).

[3] http://discworld.starturtle.net

[4] The game in question there is Oddworld: Abe's Oddysee, but the player also played The Legend of Zelda by ear.

Their main reason for playing text-based games is their potential for interactive storytelling and roleplaying. One interviewee mentioned that they sometimes also just enjoy the mindless 'hack & slash' features offered by some games. Their setup for playing these games consists of a telnet client combined with a screenreader[5]. The blind player community also provides sound trigger packages for different games, which further assist blind players with their gameplay. These have been specifically mentioned as supporting immersive gameplay:

> **M:** "(...) With the mud client that I use [VIPmud in combination with JAWS], you are able to have sound triggers, so it adds that extra nuance, especially in ship to ship battles."

Concerning modal representation, there is not necessarily a direct link between the representation and the player's immersion. For most players this encoding is perceived individually. The three interviewees responded to that in their own interviews and this is what they said:

> **M:** "(...) [But] I don't imagine touches or smells or anything. If there is an option to smell something, I might think, wow, that is really nicely written, but it doesn't translate to an actual sense being used for me."
> **A:** "I visualize where my character is, how things might look, smell, feel, etc. It's very easy for me to take part as a sighted character among others. My blindness doesn't keep me from visualizing, describing things, etc.(...) If it's intense roleplay, there's more imagining of the sensations my character might feel."
> **C:** "(...) [but] in roleplay games, I visualize quite a bit. The sounds, feelings, even smells sometimes. (...) The exception is during combat. (...) I really don't want to visualize smashing someone to death with a sword."

Potentially irritating features that have a negative impact on the immersive qualities of a game are less often encountered due to the technical setup at home but usually the origin lies in the implementation of the games. One example for this is

[5] In fact, all three of the interviewees used exactly the same setup: VIPMud as a client and JAWS as a screenreader.

information which is only given in form of ASCII-art pictures, another when the display of shortened room descriptions is not supported. The interviewees reported they stopped playing certain games because they were not able to circumvent these problems.

Social factors can cause irritation as well. The lack of help files, support for new players or cooperative administration appears to be a big issue. The implementation of these features can be advised for every text-based online roleplaying game, since they address the whole playerbase.

Navigation by blind players in MUDs appears to rely on active knowledge of connections between known places. One forum had a discussion of this fact[6].

> **User Orin**: "Other people say I should stop bringing this up, that mud navigation is just fine and if you can't memorize areas you suck, but I feel that if sighted people get maps and tools for navigating, we should get those preferably on every mud."

The problem of creating a map that is suitable for blind players is not addressed within the discussion of this study, but appears to be a problem while playing large-scaled MUDs. This is especially the case if the maps are created by the player community[7]. It further adds to the irritation a game can cause and thus is likely a factor that counteracts the immersion for blind players.

Blind players encounter a second layer of obstacles in text based games as well as mainstream computer games. Game developers who are interested in supporting immersion for all of their potential players have to have their possible limitations in mind.

2.4 Games for Visually Impaired Players

Currently there are three types of games available to blind players: inclusive games, universally accessible games and games specifically designed for the blind. These categories are not distinct, since a game specifically designed for the blind can

[6] http://forum.audiogames.net/viewtopic.php?pid=94333#p94033 The quoted note was posted on May 14th, 2012

[7] To see some impressively large examples compare http://daftjunk.com/dw/ showing the layout of several areas of the Discworld MUD.

be interesting to other players as well (compare Real Sound: Kaze no Regret from Hugill 2012) while a game that was not designed with a focus on blind players can be playable for this focus group as well (compare Schreier 2011).

Inclusive games are games which initially target a general audience, but have been made accessible for other users as well. An example for such a game would be the enhancement of 'Guitar Hero' to create 'Blind Hero' which uses haptic cues instead of visual ones, considering that the initial game was already heavily focused on music and rhythm (compare Yuan and Folmer 2008). Inclusive games concentrate on different player groups and enable otherwise not playable games to be played by players with certain disabilities too.

Universally accessible games are designed so that the exclusion of potential players is minimised. One example for such games would be UA chess (compare Grammenos, Savidis, and Stephanidis 2005) or an audio based version of 'Space Invaders' (compare McCrindle and Symons 2000). In order to describe universal accessability in games, certain parameters have been established, for example by Grammenos, Savidis, and Stephanidis (2009). There are also certain companies like RSGames[8] which specifically offer games that aim to be universally accessible.

There are also games that have been specifically designed to target a blind audience. Whereas it was more or less a side effect due to the genre for Papa Sangre[9], there also have been made numerous deliberate attempts at specific designs for blind players based on audio and tactile feedback (compare Targett and Fernstroem 2003, Velleman et al. 2004, McElligott and Leeuwen 2004, Eriksson and Gärdenfors 2004, Wood et al. 2003 or Archambault et al. 2007).

Text based games cannot be subsumed into one of these categories. They are essentially accessible to blind players, but only if they solely consist of text. There unfortunately also exist text-based games that heavily rely on ASCII-Art, for example NarniaMUCK[10]. It is possible to make text based games universally accessible, by permitting certain optional settings for individual players. However, which settings these are and which aid the intent presented here have not yet been scientifically established. The author hopes they can add to a larger set

[8] http://www.rsgames.net

[9] http://www.papasangre.com; for an analysis by a musician compare Hugill (2012)

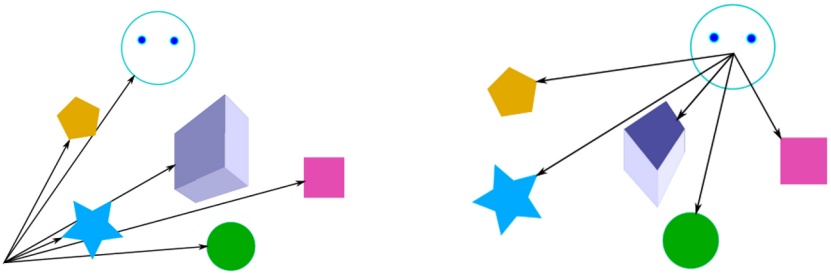
[10] available online at http://narniamuck.org/

of possibilities with this work and show how navigation influences immersion for different player groups and makes text-based games even more accessible to blind players.

2.5 Perception in Navigation

Several different parameters play a role in human navigation in general. It can depend on the representation as well as on the existance of landmarks. Looking into different abilities of perceptive input, there are also significant differences between sighted and blind people. Hence, this topic has been thoroughly researched. While it has not been looked at in the context of text based games, the existing work still provides valuable input for this study.

To put the terms *allocentric* (compare Figure 2.3a) and *egocentric* (compare Figure 2.3b) into perspective, I refer to Klatzky (1998) and Meilinger and Vosgerau (2010). Klatzky defines core assumptions which are important to understand the terms. First, she assumes that "*[a]llocentric and egocentric locational* representations convey the layout of points in space by means of an internal equivalent of a coordinate system". This text does not present a final vision of how this coordinate system looks. She furthermore assumes that the primitive components of each representation differ. *Allocentric heading* is then represented as "the angle of ego's axis of orientation relative to an external reference direction". Furthermore, "[p]oint-to point bearings are not stably defined with respect to the egocentric locational representation but can stably be computed from the allocentric one". The player can then update their representation from sensory input and imagery, although there are limitations. Textual representation can be seen in a broad sense as imagery, since navigation is abstractly represented by exits. Another important point is that "[u]pdating under rotation requires reporting new egocentric bearings from the same station point". In the test setup used for thi study, this is incorporated with the *turn* command, so the player can rotate their avatar in relation to the world and the representation of exits in the egocentric navigation frame is then updated as well.



(A) Allocentric perspective (B) Egocentric perspective

FIGURE 2.3: The principles of presenting something in different perspectives

Meilinger and Vosgerau (2010) created their scheme in reference to Klatzky. Egocentric representations can, in their opinion, be divided into two categories: *sensomotor contingencies*, which "are representations in a perception-action format" and *egocentric coordinate systems*, where "the center of the coordinate systems (...) typically [is] the torso (...) [and] each location is represented by an individual body-centered vector". During movement, however, egocentric coordinates require constant updating, if they are held in working memory. Allocentric representations on the other hand, also can be divided into two categories: *allocentric coordinates*, which are "located and oriented on an object or location other than the navigator" and *perspective-free representations*, where "[s]tructural descriptions offer a way to describe spatial relations in a non-centered way".

Understanding an allocentric versus an egocentric perspective is essential for this work. Since the hypothesis is formed out of theories on how natural navigation is done and how mental models are formed while navigating, the author wants to present further research on understanding the relevant factors.

Following Brunye and Taylor (2008), spatial descriptions can be encoded as a *survey* or a *route*. A survey can be seen as an extrinsic frame of reference with a third-person (allocentric) perspective, while a route description can be seen as an intrinsic frame of reference with a first-person (egocentric) perspective. Both descriptions lead to abstracted and comprehensive *spatial mental models*, although increased experience with the environment creates a more accurate model (compare Noordzij, Zuidhoek, and Postma 2006).

MUDs can provide a map analogy for sighted players by drawing a picture with letters and other characters, however that is of little use to blind players, although some of the games also offer a written survey description to the player. Rooms in text based games need landmarks established in their description in order to support a spatial mental model for the players.

The orientation of an avatar in relation to the room is not provided if an allocentric frame is used for navigation. Münzer et al. (2006) refer to the cognitive process of mental rotation in order to align a map to one's position in an environment. However, the test setup used here does not provide any kind of map to the player in any system. They also refer to the recall of route descriptions from memory as visually dominated. This does not work for blind individuals. They use landmarks just as any sighted person, but these are not visually cued, but rather use other senses such as sounds or smells (compare Appendix A.1.1). The fact that they did not include blind participants in their study also explains why their result is that the developed spatial model is less accurate if information was only presented as a route description and why they understand the spatial mental model created from route descriptions as a survey abstraction.

A useful definition of landmarks has been provided by Sorrows and Hirtle (1999). They see the process of navigation as generally being driven by a goal, like finding a supermarket or, in the context of the study, finding the bathroom. Landmarks can then be seen as a concept organising the environment as well as a navigational tool, where these two principles can overlap and often do. This principle has also been adopted for navigation through hypertext, even before Sorrows and Hirtle described it (compare Dieberger and Frank 1998). A landmark has to show a certain level of significance in both physical and electronic spaces. Singularity is, according to their theory, important for a landmark to be established and recognised by the navigator. They also distinguish visual, cognitive (= meaningful) and structural (= positional) landmarks. In a text-based game, there are only cognitive and structural landmarks given, since the game does not provide images. Cognitive landmarks are presented along with their meaning in room and object descriptions, whereas positional landmarks are presented more indirectly through the room layout.

An individual's mental model is also influenced by the degree of fictionality or literality in a distance estimate's description, as has been shown by Richardson

and Matlock (2007). A fictional description in their understanding involves an active verb such as *go* or *follow* (compare "Follow the path through the garden to get to the pit."), while literal descriptions leave them out and use place verbs such as *be* or *lie* (compare "The pit is behind the garden."). Fictive or actual motion, they assume, induces an ego-moving perspective. They also show how the perceived difficulty conveyed by a description influences the spatial mental model of how to travel a certain distance. Following their theory, it can be established that the language used in room descriptions conveys information that influences the spatial mental model. In order to account for this, hints to nearby rooms were added in the description; however, phrases like "The bathroom is close by." were used in rooms that are inside a building and phrasings like "In the distance there is a dark house." were used in rooms that are supposed to be in the open.

Kosslyn, Reiser, and Ball (1978) describe how the time to analyse an object or several objects in relation to each other increases over perceived distance and size. Hence, an egocentric system influences perception so that the environment is probably perceived as smaller than in an allocentric system. The author accounted for this with certain questions in the navigation questionnaire. An egocentric system also influences the player's mental rotation of the avatar, since the information is given as well and can be changed by actually turning around in the environment. This thought is rooted in the analysis of Shepard and Metzler (1971) about mental rotation of 3D objects, if the presentation is only given in 2D pictures. Abstracted, their work describes how mental rotation takes place in the representation of an object or space in a different dimension than it actually is given.

Loomis et al. (1993) compared the performance in navigational tasks of blindfolded sighted, adventitiously and congenitally blind. They called the use of proprioception and internal cues to sense self-motion *path integration*. Their understanding of navigation in general can be seen as a combination of five processes: sensing the environment, creating a trace of the route, forming a *survey* representation of the layout of spatial features, computing desired trajectories and then executing those trajectories. The two navigational tasks that they used require reproduction, estimation or both as well as computation of a new trajectory. Their results show that congenitally blind subjects had more difficulties at navigational tasks than adventitiously blind or blindfolded sighted participants. However, these

results are non-conclusive. Another result of their studies was that proprioceptive and vestibular cues were inadequate for accurate path integration. They demonstrate how important it is for research in this area to fine tune the experimental setting and avoid *visual bias*.

In further research in navigation by blind subjects, Noordzij, Zuidhoek, and Postma (2006) found out that early and late blinded people can form spatial mental models on the basis of route and survey descriptions, although blind participants had a better performance when they were given route descriptions. Visual memories did not make a significant difference. Spatial representations are, according to them, constructed by blind people as effectively as by sighted people and they performed equally well on the scale model task presented to their test participants. Spatial priming and symbolic distance effects were shown as well. The encoding of the blind subjects appeared to be in the form of local, sequential representations based on routes, wheras sighted people mostly coded spatial information in the form of a more global, externally based representation. As shown later, this leads to the hypothesis that blind participants perform better in an egocentric representation of a virtual world, while sighted players are expected to perform better in an allocentric navigation system.

Chapter 3

Motivation

The topics of Interactive Fiction, Immersion, Navigation and Blind Players have so far only been discussed separately or in pairs, but not all of them together. Academic work referring to MUDs tends to focus on social effects (compare Reid 1994), and if it mentions blind players it is just to note their existence, as can be seen with Montfort and Short (2012)[1]. Other work dealing with IF discusses the principles of creating it (compare, amongst others, Roberts and Wright 2004), develops frameworks for creating text based games (compare, amongst others, Donikian and Portugal 2004, Iurgel 2004, Abawi, Reinhold, and Dörner 2004) or discusses philosophical implications (compare Smith and Bates 1989 or Sloane 1991).

Research into accessability for blind players in video games (compare Heron 2012 A) and how certain disabilities can be handled in game design is available as well. Bierre et al. (2005) even present a list of assistive technologies and how they support individual groups. The previously mentioned implementation of Blind Hero (compare Yuan, Folmer, and Harris 2011) is also driven by the aim to make general games accessible; in this case, especially accessible for blind players.

[1] The only mentioning: 'Portability across a large number of platforms (including small-screen mobile devices and computers being run with a screen reader by blind players) was often considered more important than the ability to craft a specific visual experience[.(...)]'

The problem with games that have been specifically designed for blind players, is that they do not enable equal gameplay for sighted and blind players. Heron (2012 A) claims that:

> "most gamers don't want to be stuck in separate 'gaming ghettos' where their only choices are specialised accessibility games. Disabled gamers, like the rest of us, want to play the best games that are out there."

It is perceived as a stigmatising factor to be forced into playing 'special' games, especially considering that playing computer games is part of everyday socio-cultural life in younger age groups in industrialised nations. The acceptance of universally accessible games, labeled as being so, has not been researched so far. However, the term indicates that there are other games which are not universally accessible. While this is actually the case, and this is characteristic of the majority of games, this is also the problem. The term creates its own 'gaming ghetto' as long as the aim of making games universally accessible is secondary to the perceived economic interest of game companies. This also means that those companies who actually develop universally accessible games are usually smaller and also have a smaller budget for advertising. This and the problem of the term itself cause a lack of awareness of the existence of such games for abled players. This can be seen as analogous to adaptive sports[2], where the athletes themselves slowly diversify to a point where they invite abled sportsmen to compete with them (compare Elliott 2012 and Clark 1996/2011).

Text based games and especially MUDs are still actively played by a loyal community all over the world. They provide a great option of enabling blind and sighted players to play together, without the impairment affecting the gameplay. There even have been blind creators and staff members who were programming for the game or managing it (compare Appendix A.2).

Additionally, as presented above, research for immersion seldom incorporates the possibility of limited representation. An audience that has limited capacities to understand certain modal cues is not especially considered. Furthermore, the au-

[2] I use the term 'adaptive sports' how it is used by Elliott (2012), because it appears to be more inclusive to any kind of disabledness in the understanding that every body is disabled to some extent. The more commonly used term would be 'disabled sports' or even 'crip sports' as used one time by Clark (1996/2011).

thor defined the *visual bias* (see above) that is presented in the majority of studies dealing with navigation. Analysing an essential thing such as navigation in a study of blind players' immersion in test based online roleplaying games, especially since the act of navigation is deemed to be mainly visually cued (compare Münzer et al. 2006), appears to be valuable research that can provide more information not only for immersion, but also for accessability in games, navigation in general and how to further develop text-based games. They are received as one equal genre amongst others (compare Heron 2012 B).

Chapter 4

Design of Research

This chapter introduces the hypothesis and explains the game setup as well as the metrics used. It then describes the setup of the pilot study and how the findings made therein modified the setup of the main study.

4.1 Hypothesis

Survey and route knowledge play a different role in everyday navigation of blind and sighted people. Therefore, these groups are likely to show different reactions to an egocentric or allocentric system of navigation in virtual realities. the author expects that, especially in text based games, the different navigation systems have a direct influence on several parameters of immersion on the two groups (compare Table 4.1).

Blind Players	Sighted Players
+ route knowledge	+/- route knowledge
- survey knowledge	+ survey knowledge
+ egocentric navigation	+ allocentric navigation
+ intrinsical focus	+/- extrinsic/intrinsic focus
- visual landmarks	+ heavy focus on visual landmarks
+ other landmarks	+/- other landmarks height

TABLE 4.1: Parameters of navigation for blind and sighted players – advantages and disadvantages of the two different groups

Blind people are more accustomed to navigation focusing on route knowledge (compare Noordzij, Zuidhoek, and Postma, 2006). So the author expects that they will perform better when confronted with the egocentric system, meaning that they perform better than the sighted control group and perform better in the egocentric system than in the allocentric system. On contrast, sighted people focus more on survey knowledge in their everyday navigational tasks, especially in unknown environments (compare Brunye and Taylor 2008). Therefore, it is expected that they perform better than the blind players in an allocentric system and also better in the allocentric system than in the egocentric system (compare Figure 4.1). This is relevant because only unexperienced players took part in the main study. Furthermore, the game setup is not following the layout of the area as presented by Terry Prattchet in his novels and hence even players who know the books do not have an advantage over other players. If they were familiar with the canon, they were informed that the layout differs.

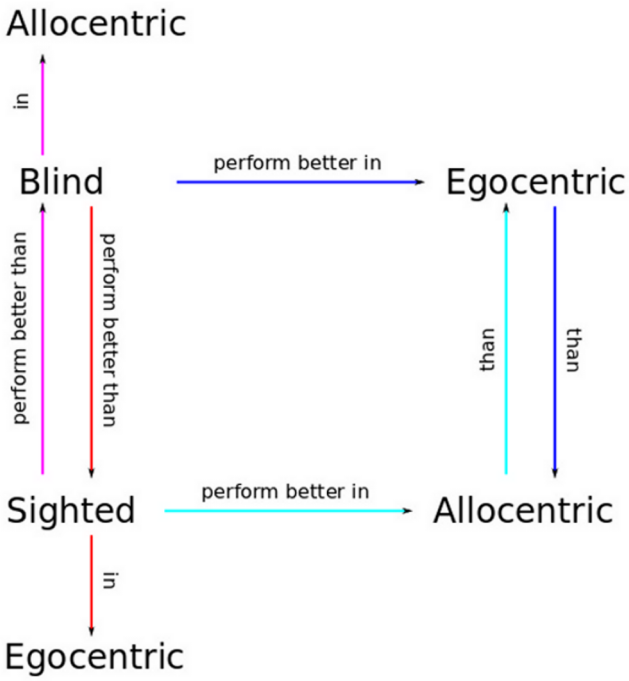


FIGURE 4.1: Illustration of the hypothesis – following a coloured line presents the dependencies

So what can be seen as a good performance? First of all, a good performance will result in a lower number of errors and might also result in less time needed to navigate through a previously explored area compared to the control group. Second, reaction time in a body based localisation task[1] is expected to be longer for those players who dealt with the egocentric system, but is expected to be more exact as well. The author expects blind players to perform slightly better there. The same should be true in an equivalent task with cardinal coordinates for users of the allocentric system. However, sighted players, are expected to perform better there than blind players, since they are accustomed to using these coordinates in everyday navigation. Third, the spatial model that the player creates for the environment is influenced by the navigation system. The author expects that a distance estimate between two points in the environment seen from both directions will be most exact for the sighted players who played with the allocentric system[2].

Due to the familarity with egocentric navigation in real life, the author expects that blind players will show a higher degree of immersion if the egocentric system is presented. The results should be similar for sighted players within the allocentric system. However, the author also expects that the egocentric system increases the feeling of presence in the game environment for any player, due to the distant, bird's-eye view suggested by the allocentric system.

4.2 Game Setup

To be able to test these factors in a self-contained way, the author was looking for an instance in an existing MUD that had a closed story line and did not require the user to have knowledge about the entire game.

The instance the author selected for this research is taken from the Discworld MUD[3], which is based on the Discworld fantasy series by Terry Pratchett. The area contains Death's Domain, an area with about twenty rooms to explore. Furthermore, the area already has a quest located there, which was the starting point for the task description (compare Appendix E.1).

[1] An example would be the description of a localisation and a question where a certain room lies relative to the test subject's position or relative to the world.

[2] This task has to been in context of the work of Kosslyn, Reiser, and Ball (1978).

[3] http://discworld.starturtle.net

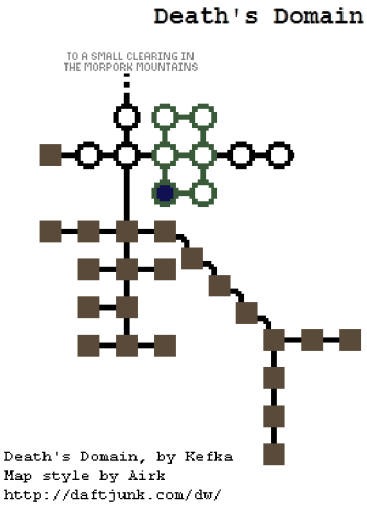


FIGURE 4.2: Original layout of the live game – courtesy of Greg Baatard used with permission – available under http://daftjunk.com/dw/Death%27s_Domain.gif

The original layout of the area (compare Figure 4.2), which is used in the live Discworld MUD, has been modified for this research (compare Figure 4.3). First, the author removed the complete basement with the library in it. This is a core part of the literature referenced by the setup; however, it is not necessary in order to complete the task. To avoid confusion about vertical levels of navigation, the author decided to keep it all to one floor. Furthermore, the author changed the grid layout to allow for shorter walks between adjacent rooms, and the extra room between garden and pit has been removed as well, whereas an extra room between the house and the garden has been added.

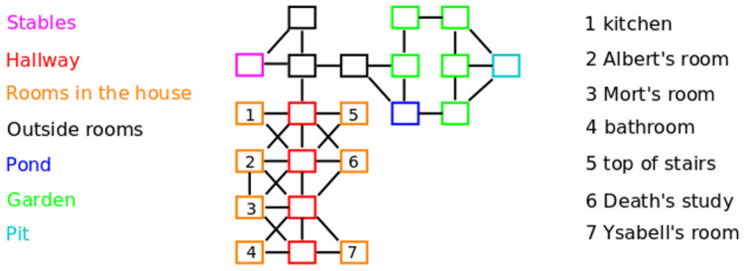


FIGURE 4.3: General layout of the test setup mapped

The image the author got from the Discworld administrative team contains the relevant MUD-wide code as well as the areas 'Ankh-Morpork' and 'Underworld'. The latter contains 'Death's Domain'. In order for the setup to work, the author had to fix known issues, such as false failure messages when a player assembles the fishing rod (compare, for the different task descriptions, Appendix E). Furthermore, the author rewrote the starting room to be more of a learning environment where test participants can get used to the commands they need. It is set up so that the test participants could not leave the room until certain actions were performed, namely, opening the wardrobe. Upon updating the room randomly sets the wardrobe exit to one of the two navigation systems, allocentric or egocentric.

Since the entire area is implemented in an allocentric system, the author additionally implemented the same area in the egocentric system. As well as removing all references to cardinal placements of other rooms nearby in room descriptions, the author changed the descriptions and identifiers of doors, since they referred to cardinal coordinates[4]. However, the author did not want the test participants to have any indicator about allocentric references in the egocentric system, nor give an advantage to the players of the allocentric system. To additionally create equal conditions for blind and sighted players in both systems, the author also disabled the ASCII-Map that is available to sighted players in the original game (compare Figure 4.4). Further changes to the rooms are listed in Appendix B.1.

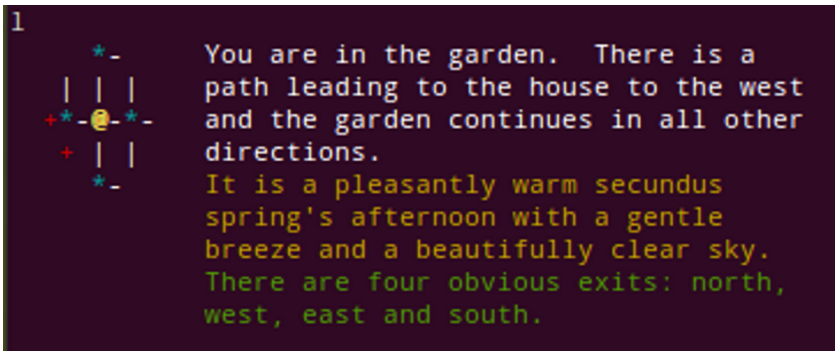


FIGURE 4.4: Example of an ASCII-Map in the original live game. The client used is tintin++ on Ubuntu 12.04. The room description is taken from the original live game.

[4] An example for a door name like that is: 'This is the south door.'.

The author divided the task into subtasks of finding each item, assembling the rod and retrieving the fish again, after it flew into a random room in the house facing the pond. This subtask was added to test whether the players are able to find their way back through an already explored area. The desired action of exploring the area is implicit in the task itself, since the items are to be found in different rooms and the players also have to navigate through the garden to the pit and – with the additional subtask – back.

4.3 Metrics Used

4.3.1 Time on Task

These two metrics are used for the task as a whole as well as the subtasks of finding items. Which task the player is currently concentrating on can not be determined without a doubt, hence the measurement covers intervals between task completions. The author also expects that test participants simultaneously try and achieve several goals at once, for example having in mind that they have to find a certain amount of items and what these are.

The author expects furthermore that the individual subtasks that are related to navigating through the game environment are completed faster the later they are to be completed, indicating that there is a learning curve of navigation in both systems in the short test time. This reflects also the increased speed for navigating through parts that have been explored previously. The steepness of the learning curves is an indicator of how learnable the player found interacting with the game and its navigation system to be and hence, gives an indication of the grade of immersion according to Bowman (1999). The author expects that the learning curve for blind players will be steeper in the egocentric system, whereas it will be steeper in the allocentric system for sighted players.

4.3.2 Audio Recordings

The test participants are asked to use the *think-aloud* technique: they were encouraged to actively talk about the goals of their actions as they play the game. An

analysis of the audio data then assesses how focused they are on the game while playing it.

The audio sections are categorized into *in-game*, *meta-game* and *out-of-game* parts. Silent episodes are recorded as well. In-game comments discuss the actions happening within the story frame of the game, whereas meta-game comments deal with the general structure of the game, the controls and the setup of the software. Mentions of completely unrelated matters or references to other games are out-of-game comments. The percentage of each type of comments is an indicator of the player's involvement.

A sentiment analysis of in-game and meta-game comments is only useful in parts, because immersive feel is not simply attached to good or positive emotions. A frustration that can be dealt with and solved within the game context can be interesting and productive as gameplay since it creates a feeling of challenge and achievement. Hence, the author decided to not include that kind of analysis in this research.

4.3.3 Logs of the Sessions

Every action and every answer is evaluated through logs. These provide an extensive source for objective assessment of the grade of smoothness of the gameplay. The commands are classified as *typos*, *not implemented*[5], *syntax*[6], *wrong command*[7], *look*[8], *movement*, *exploration*[9] and *other*[10]. The movement commands are also assessed as to whether the player moved in cardinal or ordinal directions.

Out of this data the *command error rate* (CER) is extracted by the following formula.

$$CER = \frac{n(typos)/2 + n(wrong) + n(not\ implemented)}{n(total\ commands)}$$

[5] This means, the player tried a command that seemed reasonable in the context, but a possible response was not available in the system.

[6] When a player used the 'syntax' command to check on how to use a command.

[7] The player assessed the situation wrongly or accidentally typed something that did not proceed to the right course of action. An example for a command that is defined as wrong would be, if a player tries to walk or look into a direction that is not available in the location they are in.

[8] Every time the player used the *look* or *glance* commands, except when they used those commands to look into a direction.

[9] Uses of the *look* or *glance* commands to see what is in adjacent rooms.

[10] Every other interaction that made sense in context.

Typo errors are weighted; typos only count half to the error rate, since they are usually fixed within another try. The two types of errors, player-side errors (*typos* and *wrong command*) and game-side errors (*not implemented*) are distinguished by removing the relevant parts in the formula. The logs also allow for an analysis of the movement of a player within the area. How often they visited certain rooms and which routes they chose are thus assessed.

4.3.4 Questionnaires

To retrieve data on the subjective feeling of immersion for the player, the author used questionnaires. They consist of three parts, an Out-Of-Game Questionnaire, adapted from the Immersive Tendency Questionnaire presented by Witmer and Singer, 1998, an In-Game Questionnaire and a Navigation Questionnaire (compare Appendix F).

The first section assesses the general ability of a player to immerse themselves in any kind of activity. It is supposed to work as a normaliser over the questions in the second part, since the feeling of involvement is a highly individual factor.

The second section assesses the awareness of controls and the feel of presence and immersion within the game. It also provides information on how involved the player felt with the task and the gameplay in general. Normalised over the In-Game Questionnaire the following formula then extracts the *Immersion Value* (IV).

$$IV = \frac{Average(Out - Of - Game)}{Average(In - Game)}$$

If the IV is above 1, the feeling of immersion is supported, if it is below, the game does not support more immersive qualities than usual media – at least in the eyes of the subject. The Out-of-Game Questionnaire also contains a question about perceived playtime. The answers tell whether the player still kept record of how much time passed. The formula to put this in relation can tell how far off the player was in their judgement.

$$Playtime\ Difference = \frac{(Perceived\ Playtime\ -\ Actual\ Playtime)}{Actual\ Playtime}$$

A negative value indicates that the time perceived was smaller than the actual time used for playing.

The third section assesses if and how accurate a spatial mental model was created. It is accomplished with simple tasks, where the test participants have to navigate through the world again or explain where rooms are in relation to other rooms. The accuracy of the mental model provides additional data on the grade of immersion, since the author expects that players remember the environment better, if they were more involved.

4.4 Setup of Pilot Study

The author decided to conduct a pilot study with blind and sighted players. Experienced players were included in the pilot study to assess whether experience has an influence on the data produced by the test setup. Furthermore, the pilot study should test whether this data is potentially meaningful. Experienced participants were also expected to act as playtesters of the game setup, since they were able to point out flaws with it better than inexperienced players.

Of the eight test participants each of them had a different combination of the two characteristics blind/sighted, experienced/inexperienced (compare Table H.1). To establish the experience of a potential participant, they were asked to fill out a *MUD Experience Questionnaire* (compare Appendix F.1[11]).

The pilot study has been conducted as a *Between-Subjects* setup[12]. The author expected that priming effects would be developed if each participant encounters both systems. While experienced players are most likely already primed to the more common allocentric system, they are still able to hint at other possible improvements for the game.

The test participants were mostly recruited via online postings or personally by the author. If a test participant did not live near my location, the tests were conducted at distance using a telephone line for the audio recordings. Other op-

[11] Although in the first version there was no notion of Interactive Fiction. This was added after experiences in the pilot study (compare Chapter 4.5).

[12] This means that each of the participants only tested one navigation system (either allocentric or egocentric).

tions were that the author visited the test participant at their house or that they came to my laboratory setup. The task description provided by the Discworld MUD (compare Appendix E.1) has been modified to account for the new task (compare Appendix E.2).

4.5 Findings of Pilot Study and Modification for Main Study

The findings of the pilot study are mainly of a qualitative nature, to see whether the test setup works and the answers given are interesting. Several points were modified after examining the results of the pilot study.

Task Description

The participants in the pilot study showed a lot of difficulty relating with their character in the game. Hence, the author decided to frame the task description with a surrounding story that explains the motivation of the character to solve the task (compare Appendix E.3). The framing also modified the task, since the fish instead was to be taken to Death.

Learning Area

Another finding of the pilot study was that the learning area was not large enough to enable the inexperienced test participants to learn all the required commands and - more importantly - get used to the navigation system. In order to better prepare them for the task, the author included the explanation of the commands listed in Table B.1.

Furthermore, the long description of the wardrobe in the Introduction Room was modified to account for its state, open or closed. The search was then more specific to the couch, since even if a player specified something different (e.g. used *search wardrobe*), the implemented function was always searching through the couch. The search can now be specified for the couch or the wardrobe[13].

[13] If something else is specified, for example *search closet*, which is the general description of the Introduction Room, or no specification is given, the feedback message indicates that the whole room is being searched.

Finally, two rooms were added to the learning area, through which the test participants can get used to the navigation system which has been randomly chosen for them.

Game Environment

In the game environment the test participants had to deal with weather influences. This resulted in lines showing up to the player that they were cold and some of them were worried that they might die from hypothermia. Additionally day and night caused problems: occasionally everything was too dark to see[14]. This was unhelpful, since even with a lit torch, they could see the room they were actually in, but could not look into adjacent rooms to orient themselves and explore where they wanted to go. In order to circumvent these two problems, the author removed all weather effects from the player object and defined permanent day within the game environment.

The room descriptions had to be rechecked so they would not contain any lines that state that the player is in the room. Sentences like 'You are on the path to the garden.' are problematic, if the player was not actually on the path, but merely looking into this direction from an adjacent room. Every occasion where this was the case has hence been rewritten to avoid unnecessary confusion. Additionally the author ensured that in every room that is inside the house the corners, walls, the floor and the ceiling had a description. Participants in the pilot study complained that, when they tried to look at the ceiling, the feedback was 'Cannot find "ceiling", no match.' Further changes to the rooms can be found in Appendix B.2.1.

The very first room in the environment had an additional problem: a description that was misleading to most of the test participants, since it was speaking of two separate worlds, where they only could explore one further. Also the stables, which are adjacent to the first room, are referred to where they were not before.

All items that had to be found, such as the hairpin, the worm-like soul and the bone-onna-string have been changed after the pilot study to also be referrable by short identifiers like pin, worm or string.

The NPCs react if they are asked questions[15]. Lastly, the author modified the

[14] Then, the room descriptions did not reveal more than 'It is dark, isn't it?'.

[15] Listing B.2 and further information in Appendix B.2.2 show how this is implemented.

syntax for fishing to allow for 'fish with rod' (as before) but also for 'fish in pond with rod', since this seemed to be a more natural syntax at least to the native English speakers in the pilot study.

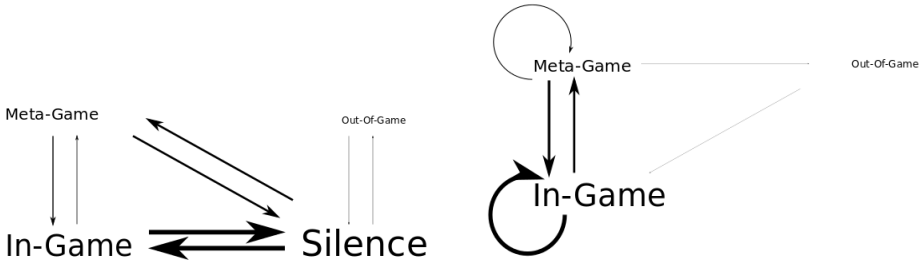
Metrics

Time-on-Task and Task Completion

Only one participant in the pilot study did not finish all the tasks within the test. They were also the only participant who needed significantly more than an hour before they stopped the test (1h 45min). Since the average play time in the pilot study was 44.13min (55min for unexperienced players) with a median of 23.5min (47min), the author decided to set a hard cap where the test participants are supposed to finish the task at one hour.

During the pilot study it became clear, that the time a player needs for finishing a task does not provide any information about the quality of the gameplay and is hence useless as a parameter for immersion. However, learning curves established by intervals between the subtasks are deemed viable.

Furthermore it became obvious, that the test participants had to be encouraged to explicitly state when they finished a subtask[16]. The intervals between navigation processes appear to be promising, since the last navigation task – retrieving the fish from a random room – had a tendency to be solved a lot faster than the first navigation task, where the players have to find items in certain rooms.



(A) All utterances (B) All utterances without *silence*

FIGURE 4.5: Overview of utterances of different categories of the four participants analysed from the pilot study

[16]The raw data of the pilot study can be found on the DVD that came with this thesis.

Audio Recordings

An analysis of the audio recordings according to the categories *in-game*, *meta-game* and *out-of-game* as well as *silence* proved to be fruitful. The analysis of time spent in each of these categories reveals, that it it is interesting how utterances in each category are distributed with and without silence. This has then been included into the data analysis for the main study. Otherwise – as previously established – during the learning area, players have been encouraged firmly to talk about their actions and goals.

Logs

When the author looked at the first logs of PB1E, they found out, that the specific parameters of their test would not work for the main study. Due to their age and a lack of proficiency in English, the author decided to translate the MUD output on the fly during the test and also type in their commands. This not only made the audio data completely useless, but also the logged command input data. Typos, for example, were the author's individual error and they could not say how they influenced the game play. The author decided that for the main study, the participants have to be proficient in English to a level where they can confidently navigate through the game environment. Questions about single words of the vocabulary were allowed and answered during the test, though.

Furthermore the author found out, that the logs created by GnomeMUD[17], the client used for the sighted players, does not record the command input, which makes it hard to determine the type of error, when one occurs. This has been solved in the main study by creating consistent logs with the *snoop* command provided by the original game. This way, the author saw everything that was printed to the test participant's screen and was able to better monitor the sessions.

The log data shows, that the *command error rate* (CER) works as a suitable parameter of immersion although the data given there is – of course – in no way significant, the author decided to keep the analysis. The data furthermore shows that the CER was smaller for the blind player in the egocentric system, showing that that value might indicate a level of immersion according to the hypothesis.

[17] https://live.gnome.org/GnomeMud/

Questionnaires

The MUD Questionnaire was deemed too specific to account for experience in general Interactive Fiction games, too. This was necessary after one participant in the pilot study had been classified as an inexperienced player. While this was true for Multi-User Dungeons, it turned out later that they were rather experienced in single player IF, which influenced their ability to navigate through the game environment.

The author added a field in the statistical data to note which client and screenreader, if applicable, was used for the session. It was already recorded for the pilot study as well, just not in a formalised way.

A brief analysis of the Out-of-Game and In-Game questionnaires showed that the questions created interesting results. Since the IV is above one for all but one test participant of the pilot study, I decided to create a neutral zone between 1 and 1.2, which appears to be more promising to interpret. With the playtime difference as well, every value under 20% either way is seen as normal calculation error; especially since the answers given when asked for perceived playtime are given in five-minute intervals, whereas the recording of the playtime is exact to the minute.

The Navigation Questionnaire has been enhanced after the Pilot Study to include more viewpoints. First, the navigation questions have been created in a way that the test participant has to follow a route and answer individually how much time it would take to personally walk through it. Then, the same route is given but the test participants are asked to tell the number of game rooms[18] they have to walk through. Furthermore, they are not only asked how they can change their mental model from allocentric to an egocentric perspective, but also the other way around.

[18] A game room is one square of the map.

4.6 Main Study

4.6.1 Setup of Main Study

The main study consisted of three stages for the test participants:

- **Preparation** - Test participants are taught the MUD environment. There is no time restriction on this part, since learning time is individual. Before starting, test participants are asked whether they are comfortable with the setup.
- **Game - 1 Hour** - Test participants are asked to fulfill the task within the test setup. They have up to one hour until the test is stopped.
- **Questionnaires** - Test participants are asked to answer the different questionnaires.

Nothing that took place in the preparation time is subject to the analysis. The whole process never took longer than two hours to finish. The tests were conducted in three different ways. Either at the test participants' home, using the author's computer (1 test), the test participants using the author's computer in a laboratory setup (6 tests) or in a remote setting where the test participants were at their home, using their own computers, speaking over the phone during the whole test (5 tests). Clocks were disabled during the test. If the test was conducted in a remote setting, test participants were asked to not check the time at any point. They agreed on the procedure.

4.6.2 Participants of Main Study

Blind and sighted test participants tested the game systems in a between-subjects setup. The author excluded experienced players, since the pilot study showed that there is a bias towards the allocentric system, which is most commonly used, for experienced players. Six blind players and six sighted players, three of each for either the allocentric or egocentric system participated in the main study. Four of them were native english speakers, all of them blind. All non-native speakers had sufficient fluency to play the game on their own[19].

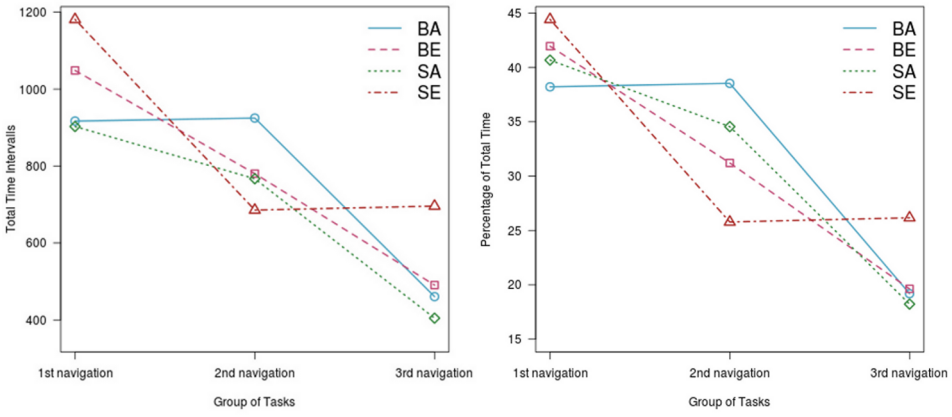
[19]Compare for more information on the test participants Table H.2 and the data of the MUD/IF-Experience Questionnaires on the DVD.

Chapter 5

Results of Main Study

This chapter takes a close look at the results of the main study ordered by the different types of recordings.

5.1 Task Report



(A) Absolut values (B) Relative values

FIGURE 5.1: Navigation Learning Curves – Shown are average of times needed to navigate through an area; in seconds

The task reports recorded time intervals and additional comments that were mentioned throughout the test or were relevant for the study, such as whether the test participant is a native speaker or not. Four of the blind players were native English speakers. All others had at least six years where they had to learn English in school and were native German speakers. The task data reveals that the order, the subtasks were finished in, can be combined in groups of subtasks (compare Table H.3). Each one of these three groups also describes one process of navigation. The first process is finding the objects in the house[1] Even if the tasks were not all done in that order, they were grouped into the first navigation task or *house navigation*. The second process of navigation is *garden navigation*[2], whereas the last process of navigation required the player to go back a *previously explored route*[3].

Figure 5.1 shows that for every group except the blind players playing in the allocentric system the first navigation task still involved getting used to the environment and the use of the navigation commands in general. The second navigation task required the player to navigate through an unknown area, but with more knowledge about the commands. Sighted players in the egocentric system showed the steadiest learning curve. However, blind players in the allocentric system needed more time to get used to the movement commands. The third navigation task used previously acquired knowledge to find one's way back to a previously explored area. Sighted players in the allocentric show the best performance here, closely followed by blind players in the egocentric system. This supports the hypothesis in that blind players are able to navigate more easily in the egocentric systems, whereas sighted players deal better with the allocentric system. Sighted players also performed better than blind players in the allocentric system whereas blind players performed better than sighted players in the egocentric system (compare Figure 4.1). These performances account only for time needed to navigate through the environment; individual differences occur.

[1] Those subtasks were called *bone*, *bathroom* and *ysabell*..

[2] Those subtasks were called *pit* and *rod*, including assembling the rod.

[3] Those subtasks were called *fishing* and *brought fish*, since being able to fish usually included finding the way back to the pond again.

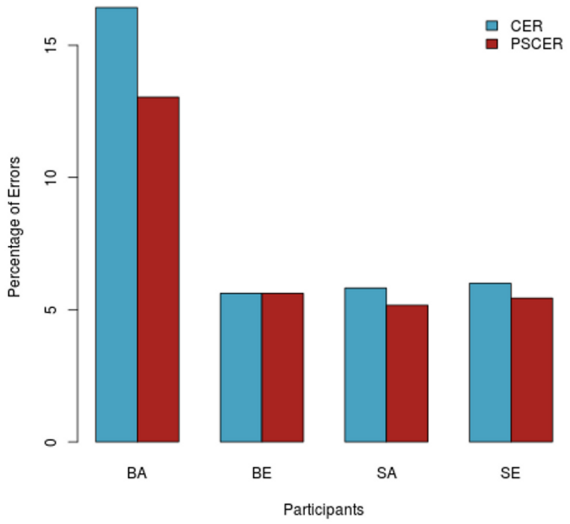
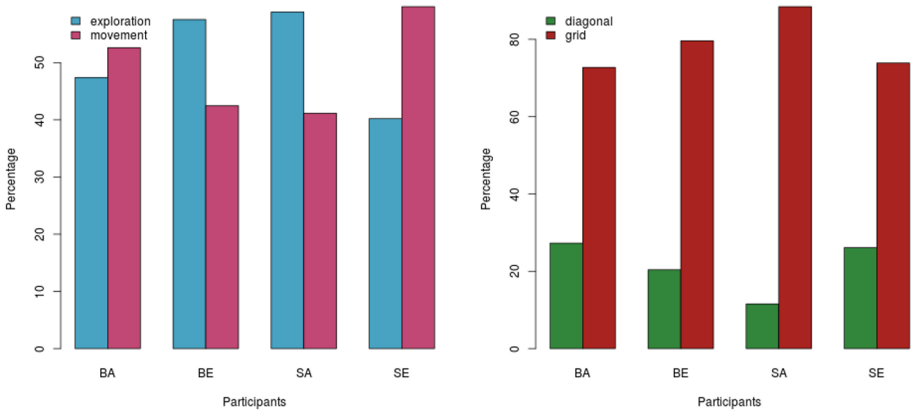


FIGURE 5.2: Command Error Rate (CER) and Player Side Command Error Rate (PSCER)

5.2 Logs

The log analysis (compare Tables H.4 and H.5) shows that blind players in the allocentric system had more problems with the test setup than any other group (compare Figure 5.2). Their Player Side Command Error Rate (PSCER) is twice as high as it is for other groups. Seeing that the total Command Error Rate (CER) in comparison to the PSCER is also higher, it is indicated, that they were also trying to interact with the game on a higher level than presented and were more adventurous in doing so. However, this could also be interpreted in a different way. Since blind players in the allocentric system had so many problems in interacting with the game, they tried many things to get to a point where they do so successfully. In general, the setup appears to have been more problematic for them than for any other group in the test setup.

An analysis of the Movement Exploration Ratio (compare Figure 5.3a) shows that blind players in the egocentric system and sighted players in the allocentric system used exploring commands more often to navigate through the game than



(A) Exploration to Movement Ratio (B) Diagonal to Grid Movement Ratio

FIGURE 5.3: Analysis of Movement vs. Exploration and types of movement extracted from the logs

the other groups. They probably felt more confident with using the commands they were presented with to accomplish their goal. Additionally, they moved through the world along a grid[4] more than the others (compare Figure 5.3b). This indicates that these players used more straightforward paths to navigate through the environment which is also supported by the heatmaps for the individual players as well as the combined heatmaps (compare Appendix I). Their navigation in general seemed to be more goal-oriented than for the other groups. Particularily unfocused movement can be seen in the heatmap of sighted players in the egocentric system (compare Figure 5.4), which has been placed here as an example.

[4] In the allocentric system the directions 'north', 'south', 'east' and 'west' were defined as grid navigation, whereas in the egocentric system the directions 'forward', 'backward', 'left' and 'right' were defined as such.

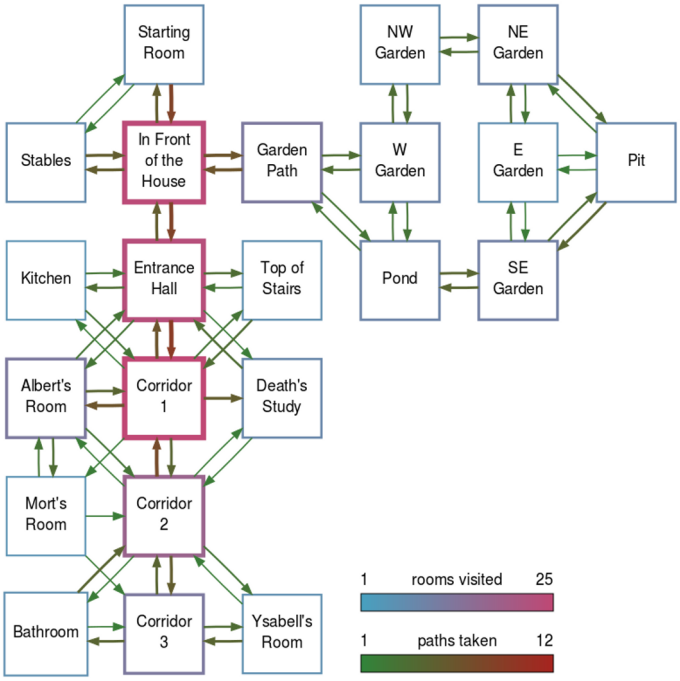


FIGURE 5.4: Heatmap of sighted players in the egocentric system

5.3 Audio Data

The audio data was analysed by only one person and is therefore possibly subjectively biased. This is not perfect, but was unavoidable in the context of this research (compare Chapter 6.4). Furthermore, the audio data for participant B5A was lost after being recorded. This means that there were twelve audio logs analysed in total, although due to data loss only eleven of these were available. Certain comments are noted in the protocols and are discussed further down.

By looking at the values for *in-game*, *meta-game* and *out-of-game* comments as well as *silence* on the part of the participants (compare Tables H.6, H.7 and H.8 as well as Appendix J for visualisations of the data), there was no way to confidently establish a useful pattern that could lead to interesting interpretations. For audio data to be meaningful a bigger group of participants would be required. However, the trend seems to be that players of either group in the egocentric system talked less than the players in the allocentric system, where sighted players in general had slightly more silence in their audio data than the blind players (compare Table 5.1). This could mean that in the egocentric system all players had to concentrate more on what they were doing than in the allocentric.

Participant	In-Game	Meta-Game	Out-Of-Game	Silence
BA	40.54%	18.84%	0.24%	40.38%
BE	16.75%	18.36%	0.77%	64.12%
SA	40.69%	13.46%	0.09%	45.76%
SE	21.65%	7.62%	0.08%	70.66%

TABLE 5.1: Time percentages of categories in the audio data divided over groups

It is also apparent that blind players in the egocentric system used more *meta-game* comments than *in-game* comments. In the other groups usually twice as much time is used for *in-game* comments compared to *meta-game* comments. This data can be interpreted as such, that the blind players in the egocentric system were more interested in the setup than the other players. *Out-of-game* comments hardly occurred in any of the groups; only under one percent of the comments were classified as such.

5.4 Questionnaires

5.4.1 MUD-IF Experience Questionnaire

The MUD-IF Experience Questionnaire was conducted before the tests started to assess how familiar the potential test participants were with text-based games in general. Only one participant of the blind players was familiar with these games in that they recently started playing a text-based game on their smartphone. I looked at the game The Things That Go Bump In The Night[5] and deemed the interaction model different enough from my setup to consider them as test participants.

The other two test participants who had experience with text-based games played them irregularly years ago. They convincingly made it clear that they had no memories besides the general genre. Even though they said that they did not like to play them at the time they were eager to be my test participants and happy to help.

All other test participants did not have any experience with text based games. However, some of them started playing MUDs after their participation in this study.

5.4.2 Out-Of-Game Questionnaire

The average value of the answers in the Out-of-Game questionnaire ranged from 1.91 to 3.27[6], where a smaller value means that the person finds it less difficult to immerse themselves in activities. However, the two end points of this range can also be seen as two outliers. The average values are closer to each other (between 2.64 and 2.70) and the whole test group can hence be seen as almost homogenous with regards to their ability to immerse themselves in general.

5.4.3 In-Game Questionnaire

The data produced by the In-Game Questionnaire is not conclusive. The differences between the groups are too small, ranging from 1.00 to 1.09 where a greater *Immersion Value* (IV) indicates that the game played in the test setup supported the

[5] http://www.textadventures.co.uk/apps/bump/

[6] Individual raw data of each participant can be found on the DVD that came with this book.

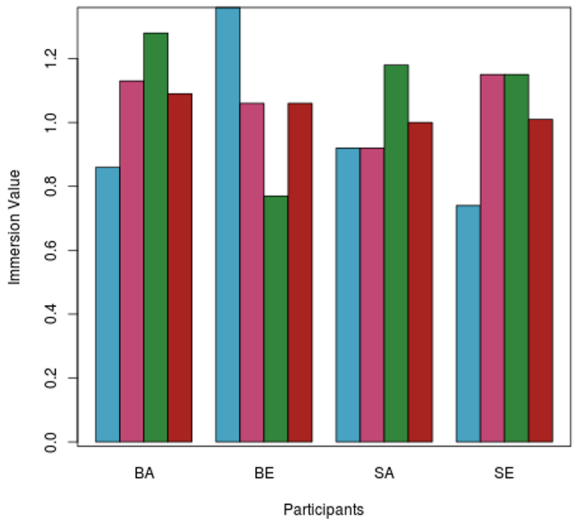


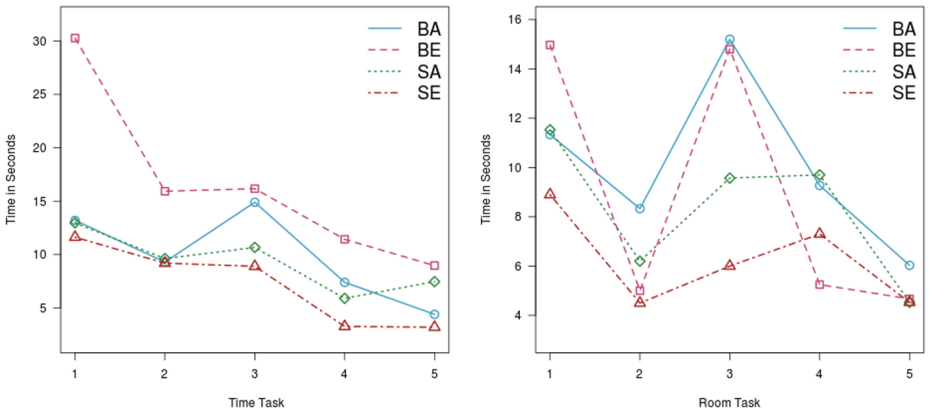
FIGURE 5.5: Immersion Values - The first three bars of each group show the values of the individual participants; the last bar presents the average value for that group

ability of the player to immerse themselves into the game. However, only two participants, B5A (1.28) and B2E (1.36) were above the threshold of 1.2. For these two participants immersion was supported through the game. The two participants with the lowest IVs were B13E (0.77) and S9E (0.74) (compare also Figure 5.5). This could indicate that the navigation system does not have an influence on immersion or, more likely, that a larger group of participants would produce results that are easier to interpret. They could still show that there is no relation between the navigation system and the feel of immersion, although the IV is only one out of several indicators measuring this, and, as previously mentioned (compare Chapter 2.5), a very subjective value.

In the free answer section of the In-Game Questionnaire, however, it is obvious that all of the sighted players in the allocentric system and two out of three of the blind players in the egocentric system gave no answer (compare Table H.9). Two out of three sighted players in the egocentric and all blind players in the allocentric system suggested additional interaction with the game. The average values of the

time estimates show that blind players had more difficulties in assessing the time they spent playing the game. Though, looking closer at the values, it becomes clear that this was only the case for one blind participant in the egocentric system and one blind in the allocentric was way off in their estimate. The values of sighted players in the allocentric system are just weighing each other out in positive and negative wrong estimates, so they were the most time unaware of all participants.

5.4.4 Navigation Questionnaire

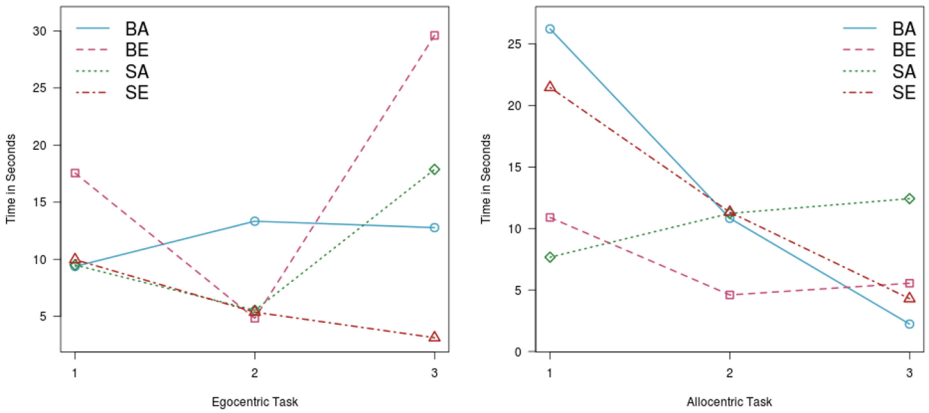


(A) Time on Time Estimation Task (B) Time on Room Estimation Task

FIGURE 5.6: Time on Estimation Tasks presented as group averages

The times needed to answer the time estimation task (compare Figure 5.6a) within the Navigation Questionnaire shows that blind players in the egocentric system took most time to think about their answers. However, they also showed the lowest precision in their estimates (compare Table 5.2). Surprisingly, the highest precision is shown for blind players in the allocentric system. Looking closer at the individual values, it becomes apparent that B5A was not able to do this task at all, so the reference group is smaller than the other ones. This means that the values would have to be confirmed with a larger test group. Sighted players in the allocentric system showed higher precision than sighted players in the egocentric system, as expected. The former also took slightly more time to think about their answers

than the latter. All participants felt slightly more confident in giving a fast answer in their estimation task the later a task was presented. This indicates that they got used to the task itself over time, although some of them also realised that they were asked the same routes more than once.



(A) Time on Egocentric Location Task (B) Time on Allocentric Location Task

FIGURE 5.7: Time on Location Tasks presented as group averages

For the room estimation task, the times needed by the participants to give an answer they felt confident with are closely spaced (compare Figure 5.6b), though here too, participants seemed to feel more confident in answering the later the task was presented. Also the accuracy values – determined from the average distance to the correct answer – lie close together with players of the egocentric system showing a higher value indicating less accurate estimations. These two tasks seem to indicate that an egocentric system lets the player of a text based game create a less accurate model of the actual environment.

The highest number of correct answers in the egocentric task was given by sighted players playing in the egocentric system (compare Table 5.2). They also needed the least time to respond (compare Figure 5.7a). Blind players in general seemed to perform poorly in this task regardless of the navigation system they played in. This indicates that the ability to see provides people with an advantage in these tasks.

However, for the allocentric task, blind players of the allocentric system per-

formed best. This might be because they had to actively hold the allocentric information presented to them in memory due to not being accustomed to it in their everyday lives. Blind players in the egocentric system mostly failed to give an answer at all, B2E even stated that they "couldn't do them. I don't know anything about them"[7]. It is also notable that sighted players in the egocentric system all gave estimates where the egocentric direction *forward* was associated with *north* (compare Table H.12). None of them had a problem in giving answers either, though no information with regards to cardinal coordinates was presented to them during their play. With regards to answers given, it becomes apparent that blind players of the egocentric system only answered about a third of the tasks presented to them in any location task. Sighted players in the allocentric system also answered less tasks compared to those playing in the egocentric system. This indicates that blind players in the egocentric as well as sighted players in the allocentric system did not need to actively hold the area in their memory to navigate through it.

Task	BA	BE	SA	SE
Time Est. Precision	0.2347	0.0015	0.0103	0.0060
Room Est. Accuracy	2.00	2.44	2.60	2.87
Egocentric Loc. Correct	0.33 (6/9)	0.33 (3/9)	0.83 (7/9)	2.17 (9/9)
Allocentric Loc. Correct	2.33 (9/9)	0.17 (2/9)	1.67 (7/9)	1.17 (8/9)

TABLE 5.2: Results in tasks of the Navigation Questionnaire presented as group averages
Precision = 1/Variance(Answers)
Accuracy = Mean Average Distance from correct Answer
Numbers in brackets are (given answers/possible number of answers)

Almost all test participants said that they saw the game in a first person view if they imagined it (compare Table H.11). The only exception there was S9E, who stated, that they imagined the game from both perspectives – first view and third view. While blind players in general seldom had wishes on how the navigation system could change, all sighted players of the egocentric system suggested changes. It is also interesting, that three out of seven suggestions seem to prefer a grid layout over one with all eight directions that were offered by the test setup.

[7] Excerpt from the notes taken while the answers in the questionnaires were given.

5.5 Comments

During the protocolling of the sessions, the author took handwritten notes. Additional notes were taken while analysing the audio data. If sentences were uttered in German, they have been translated when quoted here.

It becomes apparent from these notes that blind players in the allocentric system had the feeling they were in "a maze" and that "you have to remember where you came from" (B5A). Other statements given indicated that players navigated from memory (B4A: "Wait a second, how did I get in here?") and always actively kept track of how their current allocentric setup relates to relative directions (B3A: "I think northeast is the way I came from."). However, B13E – a blind player in the egocentric system – also stated that both systems are the same to them. It is especially notable that this player was extremely joyous upon succeeding in the tasks presented to them.

S6A made many remarks on the scenery, made several joyous comments when finishing subtasks and was in general very much into the game (compare "Am I in the dark soon? Oh, my torch went off. Shit, I won't see anything!"). Sighted players in the allocentric system expressed problems which they felt existed with the navigation[8]. S7A for example said that "navigation isn't easy, but as soon as you have the map in your head...", similar to utterings S8A made, such as "I lost my overview" or "I have absolutely no idea where I am".

However, sighted players in the egocentric system expressed their problems in a more concrete way. For S9E the navigation system seemed to be completely unexpected ("I don't really understand the navigation here yet.") whereas S10E stated that they found "it difficult to remember how I currently relate to the world" and had "the feeling you can go from anywhere to everywhere". The latter statement was even presented twice. "Then I look into that direction and then I see the exits there and then I'm irritated." is another statement that indicates that it required more memory load for sighted players to navigate through the egocentric world.

After the session was finished, the intent of the research has been revealed to interested participants. This is relevant in that B5A made the happy remark, that

[8] As can be seen in the discussion in Chapter 6, this is not always the case compared to other findings of the study and other groups participating in the study.

they "now (...) understand [their] disability so much better". B11E and B13E started playing Discworld after their participation in the test setup and were mildly confused about the allocentric system that is mainly used there after playing the egocentric system in the test setup.

Chapter 6

Discussion and Conclusion

This final chapter discusses the relation of expected versus actual results and how to applicate the research as well as its adequacy. However, there are certain limitations to it that have to be considered for future work.

6.1 Expected vs. Actual Results

Recalling Chapter 2 and 4, the hypothesis held the expectation that blind players can deal better in the egocentric system compared to sighted players as well as compared to when they were using the allocentric system. The expectation for the control group was that sighted players perform better in the allocentric system compared to blind players as well as compared to when they were using the egocentric system (compare Figure 4.1). This was grounded in prior research (compare Chapter 2.5) and in the assumption that the ease of use of a game and the ability to agree with established world parameters influence immersion (compare Chapter 2.1). If a smooth and undisrupted gameplay is to be supported, it was expected that a navigation system modelled of everyday experience supports the immersive feeling for the respective player groups – the egocentric system for blind players and the allocentric system for sighted players.

6.1.1 Navigation

The navigation systems did make a difference as can be seen by the learning curves extracted from the protocols and the Navigation Questionnaire (compare Chapter 5.4.4) as well as by the data analysis performed on the logs (compare Chapter 5.2).

While the time required to complete the tasks was not deemed a fruitful metric after the pilot study (compare Chapter 5.5), the use of time over discrete groups of tasks that each involved one process of navigation provided interesting results (compare Chapter 5.1). BE and SA showed the most linear learning process (compare Figure 5.1). While BA took longer to get accustomed to the navigation processes provided by the allocentric system, SE seemed to stagnate at some point. This has to be seen in context of the other groups. Since this is shown in the graph of the absolute values as well as in the graph of relative values, the average playtime might be an indicator for the playability of a system, however, not one that can be analysed out of context. The results seem to indicate that players find it easier to use a navigation system they are accustomed to in their everyday lives. This supports the theories of Loomis et al. (1993) and Noordzij, Zuidhoek, and Postma (2006), who stated that blind players deal better with the representation of an area given in a *route* description and sighted players deal better with the representation of an area given in a *survey* description. The egocentric system can be interpreted as a route representation whereas the allocentric system represents a survey description.

The performance of blind players playing in the allocentric system (BA) was surprising in the allocentric location task - especially compared to the sighted players in the allocentric system (SA) confronted with the same task. The comments the blind players gave indicate that they actively held the construction of the allocentric world in their memory to be able to navigate through it (compare Chapter 5.5), which would explain their good performance in this task; especially considering that blind players of the egocentric system (BE) performed similar in the egocentric location task compared to BA. The same is true for sighted players of the egocentric system (SE), though not with such a great difference compared to SA. BA also performed best in the estimation tasks, the time estimation task as well as the room

estimation task. However, these results contradict the findings of Noordzij, Zuidhoek, and Postma (2006) and the theory of *spatial awareness* being a parameter of immersion established by Bowman (1998/1999), since BE as well as SA were not able to form more accurate spatial models of the game environment. One theory to explain this could be that the mental model is more accurate the more the player has to concentrate on navigating through the world. If navigation is more natural to the player they do not use the memory resources they have on navigating through the environment, but rather on the task presented to them (compare the heatmaps in Appendix I).

6.1.2 Immersion

Data on immersion has been collected from the protocols as well as an analysis of the logs and the In-Game Questionnaire normalised over the Out-Of-Game Questionnaire.

Since *ease of use* was previously (compare Chapter 2.1.2) established as a parameter for immersion by Bowman (1998/1999), the learning curves of the protocol data (compare Figure 5.1) can also be interpreted as saying that BE and SA had the grounds for more immersive gameplay compared to BA and SE. This has to be said with caution though, because ease of use is only a minor parameter amongst immersive parameters. Also, the logs show that BE and SA were more focused on solving the task than navigating through the world.

Other metrics were the subjective assessment by the players via the In-Game Questionnaire. These results have been normalised with the Out-Of-Game Questionnaire (compare Chapter 5.4.2 and 5.4.3). However, especially in the group average comparisons, the values were non-conclusive. This might have its basis in the fact that while the author tried to create a comfortable setting for all test participants, they most likely were still aware of their surroundings. This awareness might influence their answers due to a general positivity bias where participants want to answer the questions in a perceived right way. Comments like "I am so sorry, but I have to say I didn't relate to my character much" made during the questionnaire sessions revealed that bias. A larger group of test participants might however lead to more conclusive results with the questionnaires.

The audio data reveals that players of the egocentric system in general talked less during their gameplay. While this can indicate that those players were concentrating on their gameplay and navigation because they had to hold a lot of information in their working memory, it can also not be established conclusively with such a small group of test participants, since the variance between the individual test results is too high. The comments made during the sessions indicated, that SA were able to immerse themselves best, since they talked very enthusiastically about the game and their achievements, but so did B13E, while the others of the BE group did not.

All in all the results indicate that an allocentric system supports the immersive gameplay of sighted players more than an egocentric system. For blind players the egocentric system might be better, but the results were not conclusive, so further testing would be needed to establish this. Sighted players also performed better than blind players in the allocentric system, however the difference is rather small. Blind players did better in the egocentric system compared to sighted players by a larger margin.

6.2 Applications of Research

Navigation Systems in Text Based Games

Developers of text based games can use these results to decide whether they want to enhance their game with individual settings for the navigation systems. In offering that, the player could decide on their own which system they want to use and maybe even change for inside vs. outside areas[1]. However, due to everyday priming of cardinal coordinates, players might not actually look for such an option or think about it unless prompted.

These findings can also be used to create gameplay experiences. For example, if game developers want to create an environment in a mainly allocentric system which is harder to navigate for sighted players, but maybe easier to navigate for blind players, this can create interesting game dynamics for players. This has been done already for example in the Discworld game, where certain areas are in the

[1] The effects of navigation systems on the type of area has yet to be discussed, compare Chapter 6.5.

egocentric system under the impression that this creates a challenge - however, the findings of this study indicate that the difficulty only applies to a certain group of players. On the other hand, since this game mostly relies on an allocentric system, the simple change of the navigation system probably affects sighted and blind players similarily because of the cost of switching navigation systems. As seen in the pilot study, both systems can be trained. The experienced sighted player was used to both systems and could easily navigate in both of them as well as switch between them. The experienced blind player playing in the allocentric system also had absolutely no problem navigating through the area, which was unknown to them due to priming. These deliberations should be considered when trying to implement a game that uses both navigation systems.

Educational & Serious Games for Blind Players

Furthermore, these findings can be used for the development of educational and serious games that can aid blind people in learning how to navigate with different navigation systems. Especially for blind children this might be helpful to establish how the different representations can be interpreted and what the connection between those is. This could be accomplished with many changes between the navigation systems at semi random intervals. For example when a player went through an area before, having them confronted with a different navigation system when they have to move through it again. And while this might help blind players to get used to the dominant representation that is used in society, playing such games could also aid sighted people in understanding the other side. Such games hence would probably be most usable for example in integrative schools.

6.3 Adequacy of Research

This research can be made productive for different academic fields, such as research into perception for psychology, research into technological accessibility, as well as the development and design of text based games.

These findings indicate that the accuracy of a mental model of a text based environment depends on the effort used to navigate through the environment. This

accounts moreso for blind players than sighted players. Since the study group was rather small, research in that area could establish whether the tendency found here is actually true and what this implicates.

Furthermore, in terms of accessibility, new approaches can be discussed and researched with regards to navigational software. For example in city navigation applications or digital maps for shopping centers, this study could help direct research into how the representation of the navigation commands and directions works best for groups with different abilities.

Text based games on the other hand offer a great option for truly universally accessible games. The study and research above takes a first brief look into blind players of text based games, however, they offer an environment for different impairments if those are considered when designing the game. Protocols like the MUD eXtension Protocol (MXP)[2] provide great possibilities in creating a truly universally accessible game genre. Navigation systems play a core role in creating these games and the findings give indications for answers on a very basic level that should be considered when designing a text based game.

6.4 Limitations of Work

There are several limitations which were part of this work and influenced the results. However, they could not be avoided at the time and should be considered for future research.

First off, the size of the study group was extremely small. It was especially hard to find interested blind test participants. This came not from the fact that only inexperienced players[3] took part in this study, but also that while the author resides in Germany the game was written in English, which seemed to be intimidating to some potential participants. When they decided to take part in the study regardless, local participants were asked to show a level of proficiency in the English language to be able to play the test game on their own. However, this has not been established with objective criteria. For the future the variety there should be controlled by having a measurement for the language skills, like the Common European Framework

[2] http://www.zuggsoft.com/zmud/mxp.htm

[3] There were quite a few interested experienced or active blind players of text based games.

of References for Languages with their tests that indicate a level of proficiency in a language. Another solution to this could be that the game used is being translated for different participants. However, other problems with differences of meaning that occur while translating a text show up then.

Another limitation was that this research and the tests have only been conducted by one person. There is no control mechanism of how the test sessions were conducted or how data is being analysed like that provided by larger research groups. For example the analysis of the audio data is subject to this problem. The categorisation of comments would be on stronger grounds if the analysis had been conducted by at least two or three different people. Time limitations also prevented the author from doing the audio analysis more than once.

Furthermore, data loss lead to different sizes of study groups being analysed by this data. A similar problem is that the Immersion Value (IV) did not create conclusive results. It might have been better to discuss the questions more instead of adapting them from existing questionnaires. This way they could have been even more specific to text based games. The questionnaires used so far in studies about games are mostly dealing with test sessions of visually dominated games. They do not account for different sets of abilities and seldom provide a full set of questions that can be used for slightly different research. That way a type of normality of test participants as well as tests is created that does not actually work with real life and real science circumstances. It might be an idea for further research to create questionnaires that are fully tested and mathematically analysed and not only work for certain types of games. A possible questionnaire should be built modular so that the researcher can choose the parts relevant to him without loosing the validity of the questionnaire.

Last, it should be noted again, that while the author was trying hard to create a comfortable setup for the test participants, they probably were all aware of their surroundings. They participated in a test and this changes the environment they play in and influences their playstyle as well as their gameplay and the individual experience of playing it. This problem has to be accepted as existing and impossible to circumvent, because it would be unethical to not inform test participants that they are part of a test. These test participants were not aware what exactly was being tested. This is a problem with all observatory research. Furthermore, in their

briefing they were informed that it is about a text based game. They were not aware that the focus was on the navigation system or that another one might exist. They were, however, informed afterwards that this is the case. This means, the study was not conducted in a blind or double-blind setup.

6.5 Future work

Additionally to what has been said throughout Chapter 6.2, future work starts in conducting similar studies where the limitations of this research are eliminated where possible. Other interesting work could be conducted in investigating whether the navigation system has different effects on landscape areas compared to an area which is inside a house. It could be that certain navigation systems support navigation in different types of areas. Furthermore, the effects for the creation of mental models when different navigation systems for different types of areas are used could then be interesting to analyse.

Another area of possible further work is the representation of maps in text format with the support of different navigation systems. Developers or players of text based games tend to create and offer maps for other players (compare for Discworld http://daftjunk.com/dw/ maintained by Greg Bataard). Some of them even offer advanced functionality like searchable maps and route finders. This is mostly done in visual representation. It could be interesting to find out, how a good location and route description of text based maps could work.

Then there are many other possibilities where changes of the text based game might enhance gameplay and make it more interesting as its own genre. For example if navigation is not only possible via look commands, but also smell or navigation via textual audio representation can enrich a text based game where appropriate. A protocol that includes optional sounds might furthermore enhance the game experience, since many players already create their own sound packages.

Text based games provide many different possibilities for research. They can be used as a tool to test certain parameters in a game environment or they can be the subject of research and further development of an unique game genre.

This thesis contributed to research in text based games in general as well as their use for research that is not directly related to them. From the findings established in this thesis, further work can continue. Potential avenues of research have been discussed as well as possible problems researchers can encounter when carrying on on these paths. The work presented here can thus be interpreted as an exploration of a field of research and a new tool for conducting research.

Technologies Used

Game Setup

- Discworld MUDlib – http://discworld.starturtle.net/lpc/about/mudlib.html
- VirtualBox – https://www.virtualbox.org/

Sessions

- GnomeMUD – https://live.gnome.org/GnomeMud/
- Orca Screenreader – https://live.gnome.org/Orca/

Session Recording

Audio Data

- Gnome Sound Recorder – http://library.gnome.org/users/gnome-sound-recorder/
- Skype for Linux – http://www.skype.com
- Skype Call Recorder – http://voipcallrecording.com/

Log Creation

- tintin++ – http://tintin.sourceforge.net/

Data Management

- Libre Office Calc – http://www.libreoffice.org/features/calc/

Visualisations

- R – http://www.r-project.org/
- Inkscape – http://inkscape.org/
- GraphViz – http://www.graphviz.org/
- Python – http://python.org/

Text Creation

- LaTeX – http://www.latex-project.org/
- Latexmk – http://www.phys.psu.edu/ collins/software/latexmk-jcc/
- GNU Emacs – http://www.gnu.org/software/emacs/

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Appendix A

Raw Interviews with Blind MUD-Players

To learn more about how blind players perceive the games they play and how this might differ from sighted players, interviews with blind players have been conducted in March 2012. This appendix shows the raw logs of these interviews.

A.1 Interview with M, conducted March 9th, 2012

Female, 32, playing general computer games and in MUDs since 2001

- **Q:** *first question: What degree of vision, if any, do you have?*
  M: I have a little bit of vision out of the left eye and none in the right. I am able to see colors, but I can't tell details or anything like that and i have to be up very close to see something
- **Q:** *Were you born visually impaired or did you become visually impaired later in life?*
  M: I was born visually impaired. My sight has never improved, but it hasn't gotten worse.
- **Q:** *Which games do you play? Please list computer related and non computer games.*

M: I play muds, which are multi-user dungeons, both rp and non-roleplay related. I also play browser games like kingdoms of Loathing, Core Exiles, and Sryth. I play some computer games such as castaways that can be played with others online, and I also do collaborative story writing. do you need more specifics?

Q: *I never heard of collaborative story writing, could you please expand on that?*
M: I prefer doing one-on-one roleplays that take place either by using email or dropbox, where I can add my part at the end of the document. Basically, its like someone co-authoring a story, but having direct responsibility of their individual characters as well as building on the story as a whole. Ror example, I have done some roleplay in an old west setting. I play a character named Mirand, and my friend has one named Hawk. We write for our respective characters, but we also write about the setting, bring in side characters, etc. It's a little slower than rapid fire roleplay on say a mud, but it's also rewarding and a lot of fun if you have a good writing partner. we each take a bit of the story, write our part, and then put it at the bottom of the document so that the other person can write their response.
Q: *ok. thank you for the clarification.*

- **Q:** *The next question is: How often do you play these games?*
  M: I do the collaborative story writing and mudding every day. I dont play the browser based ones as much, though
  Q: *How often do you play the browser based ones in comparison?*
  M: hmm, about once a week or so.

- **Q:** *Which text based computer games do you play?*
  M: I play star conquest and project bob.
  Q: *Are they both Multi-User Dungeons?*
  M: they are

- **Q:** *ok. Why do you play these MUDs?*
  M: I play them because first and foremost I crave games with interaction. Star conquest is a roleplaying game with a pulp science fiction feel, taking

place in space. project bob is a hack and slash game with a lot of rpg style mechanics, like rare loot, random equipment drops, and you still have to work in a team environment sometimes to get some things accomplished.

- **Q:** *What exactly then makes you log in into these MUDs and what discourages you?*
  M: I log in to get to know people and to roleplay if it is an rp oriented one. Sometimes, if I am stressed out and want to relax, I log in to de-stress and just relax. I have control over almost anything that happens in these games. I don't log in if I'm too busy, or if it's a huge time sink and I feel like people there might be irritating. But nothing really discourages me from playing.

- **Q:** *What is your technical setup for playing text based computer games? Which software do you use?*
  M: I use a client called Vipmud, which is a mud client designed by and for the visually impaired. and I have a screen reader, Jaws, that reads the text in synthesized speech

- **Q:** *Which features in text based computer games are potentially irritating for you?*
  M: Games which rely solely on ascii maps in order to get around are very annoying. If I cannot easily turn off the prompt, I probably will not play. I also like to be able to shorten the descriptions of rooms. I don't particularly like eating, drinking, or rent in games, either.

- **Q:** *When you play text based computer games, how do you perceive them with your senses?*
  M: Hmm, I am trying to figure out how to answer this. In the example of star conquest, it is a roleplay game. So I envision the world in my mind. I envision her reactions, her mannerisms, and the settings that are around her. With the mud client that I use, you are able to have sound triggers, so it adds that extra nuance, especially in ship to ship battles.

Q: *You configured the sound triggers yourself, so they are suitable to the environment? I mean suitable to the environment you are playing in.*
M: I didn't configure these particular triggers, others who play this game created a sound pack that works with the vipmud client.
Q: *Can you provide me with a link to it, please?*
M: but I can configure the volume, and such. I'm just not the most technical of people, so I enjoy the fruits of others' hard work.
http://www.nerdball.net/2011/12/15/star-conquest-vipmud-sound-pack-v0-30-public-link/
Q: *thank you very much. We are almost through.*

- **Q:** *My next question is: Which senses do you imagine being active while playing a text based computer game? That means: Do you imagine touches or sounds or smells that aren't actually there?*
  M: Hmm, that's a tough question. I imagine being able to see the details of my character and the settings around her, especially if they are detailed well. I know that if I see food in a text based game, it's probably going to make me even more hungry than I may already be at that point. But I don't imagine touches or smells or anything. If there is an option to smell something, I might think, wow, that is really nicely written, but it doesn't translate to an actual sense being used for me.
  Q: *So you would appreciate increased representation of sensual experiences?*
  M: Hmm, I like it when games have descriptions of various items written out. If there is a flower and they write a description of how it feels or how it smells, I can envision that, but if I inhale, I doubt that I will ever really get its scent. But I know that it is different for other people

- **Q:** *Are you aware of the controls you are using while playing text based computer games?*
  M: How do you mean?
  Q: *For example the keyboard or the commands that are available to you.*
  M: Oh, yes, I am very aware of them, but they are pretty much second nature now

Q: *Can you elaborate on that? (If not, this is no problem.)*

M: well, for example, in the science fiction game, I have to be aware of my coordinates, coordinates of other ships, how damaged the ship is, etc. While constantly flying around a sector described as a grid. It was very hard at first, but now all of those commands are second nature

Q: *What was hard at first? The representation of sectors as a grid? or the combination of all of these parameters?*

M: All of it. when to move, how to avoid having other ships hit you, how to understand what coordinates to move to? All of that was challenging

Q: *what made you stick to the game regardless?*

M: the roleplay, patient people, and the other systems, like mining, being able to gun on those ships, reading and writing books...it's just a really fun and immersive game

- **Q:** *Have you ever held an administrative position on a MUD?*

  M: Do you mean as staff? or a player elected position?

  Q: *both in the end.*

  M: I have staffed on several muds. but on star conquest, I have been elected as space defense captain of our alliance, and that is an rp position

  Q: *Do you like that position? As in: Do you enjoy the role you are holding there.*

  M: Oh, I like it a lot. it's fun and challenging. I never thought I'd be able to pilot ships, especially combat ones. There is a lot of strategizing, preparing for invasions, getting people to work together. it's a fun role

- **Q:** *How did this role change your gameplay experience? If it did that is.*

  M: There was more responsibility that my character had to take on. Checking reports, having access to special commands like communicating with every ship owned by our alliance at the same time, being seen as a role model for cadets and the like.

- **Q:** *Thank you. My last question would be: How do you envision the perfect game for you? Note that this can be a text based computer game, any computer game or even any game.*

  M: The perfect game for me would be an online game that would have text and graphics for those who are either low vision or fully sighted. It would involve complex world building, indepth crafting systems that give opportunities to do tasks like farming, baking, weaponsmithing, embroidery and the like. it would also have a complex ecosystem, with crafts and the actions of others having a direct effect on the world around them. There would be many, many skills for physical combat, including archery and jousting. There would also be lots of complicated magic systems to learn and pets and familiars. It would all be in a wonderful package where blind people could play with their sighted peers and not have to worry about accessibility.

  Q: *Thank you so much.*

A.1.1 Additional Talk about Navigation, conducted April 27th, 2012

Q: *How do you navigate in real life and through MUDs?*

M: well, irl it is by routes. and there are sensory hints too. like downtown, there is this fountain that is almost always on, If I go past it I know where I am going... but not every landmark is a visual one at all. I mean obviously if you are sighted, it's going to be. I bet if you walked past a restaurant that you normally frequent, you would know it because of the food that is cooked there. if you walked past it with your eyes closed, or if you were blindfolded and noone told you where you were going, I bet you would totally know where you were if you passed that restaurant without anyone needing to tell you. Because for you, landmarks would be visually dominated, but once you take that sense out of it, all of a sudden your nose is going to be like 'hey brain! familiar place!' muds? once i know where something is in relation to something else, I usually don't forget. it's like connecting the dots.

A.2 Interview with A, conducted March 11th 2012

Female, 30, playing in MUDs since 09/2004, other computer games since 2009

- **Q:** *Thank you so much again for participating. What degree of vision, if any, do you have?*
  A: I have light perception, and can tell where light comes from, but it's not enough to see shapes or things, more like shadows.

- **Q:** *Were you born visually impaired or did you become visually impaired later in life?*
  A: I was born premature. My loss of vision was very early on-in the first three months of my life. I had some sight till I was five-large print, close-up objects, etc.

- **Q:** *Which games do you play? Please list computer related and non computer games.*
  A: On the computer, I play several MUDs and one MOO: Star Conquest, New Worlds, Xyllomer, Geas, Project Bob, Aardwolf. (Not all at once, but over time I switch between these). I've also played several games that were coded especially for blind players, not multi-user–troopanum, Egg Hunt, and on a client coded for blind users that is multi-user, battleship, yahtzee, uno, 1000 miles. Off the computer, I love cards: gin rummy, Bingo, table Bingo, Solitair, I think I've played some others.

- **Q:** *How often do you play games? Please differentiate between computer related and non computer games.*
  A: Computer games, daily or almost that, dependingon time schedule. non-computer games, not as often, a few times a year maybe.

- **Q:** *Which text based computer games do you play? If you play different types for example, Multi-User Dungeons or single player Interactive Fiction, please note the type of each game. Otherwise just state the category.*
  A: Xyllomer (MUD, LPC, roleplay encouraged). Geas (MUD, LPC, roleplay required). New Worlds (MUD, LP, roleplay required). Aardwolf (MUD, ROM, hack and slash). Project Bob (MUD, ROM, hack and slash, roleplay optional). Star Conquest (MOO, roleplay required). All but SC are medieval/fantasy, whether RP-focused or not. They're all text-based.

- **Q:** *Why do you play (the previously stated) text based computer games?*
  A: I enjoy writing a story in real-time. There's something about the roleplay aspect that draws me in, and it's helped me improve my own writing style, as well as my freedom to express creativity. The hack and slash games are more just for fun or doing something that doesn't require focus. Also, sometimes I play them because I want to work at my own pace, without feeling like I have to keep up with others, since even on the RPI games, there is combat, and on a couple of them, levels, etc. I also enjoy the challenge of learning new games, keeping up with people as best I can when I'm up for it.

- **Q:** *What makes you log in into text based computer games, what discourages you?*
  A: What discourages me is griping players, drama that doesn't have a purpose, petty conflict, and power-hungry game admins. It's why I switch between games sometimes-I need a change in group dynamics, and certain game admins I'm more comfortable with. What attracts me to games is the depth of the code, friendly staff and admin, helpful players, good roleplayers/writers.

- **Q:** *What is your technical setup for playing text based computer games? Which software do you use?*
  A: My MUD client is one that was coded by a blind man specifically for the visually impaired. It's called VIPMud. I run a windows XP system here with my screen reader, JAWS.

- **Q:** *Which features in text based computer games are potentially irritating for you?*

  A: Lack of well-written help files, or help files altogether. A system that isn't intuitive, or that doesn't give good information on basic features, and advanced ones.

  Q: *What do you define as intuitive there?*

  A: A syntax that isn't explained well. A feature that isn't clearly defined or implemented without any written indication of such.

  Q: *Do I understand it correctly that you wish for helpfiles to have a summary section and a more detailed section for those who want to know more?*

  A: Yes. It would be helpful. I don't necessarily support metagaming in all games, but sometimes, knowledge of how things opporate is helpful. And other times, simply understand anything in a game, regardless of what it is, goes a long way. I don't mean technical understanding, just an explanation in general.

- **Q:** *When you play text based computer games, how do you perceive them with your senses?*

  A: When I roleplay, it's like when I read a book. I'm there, except I'm not there, and my characters "tell me" how they want to be played. I just get a sense of how to play the character/s, and I follow that. I visualize where my character is, how things might look, smell, feel, etc. It's very easy for me to take part as a sighted character among others. My blindness doesn't keep me from visualizing, describing things, etc.

- **Q:** *Which senses do you imagine being active while playing a text based computer game?*

  A: Any or all of them, depending on what I'm doing. If it's intense roleplay, there's more imagining of the sensations my character might feel. In hack and slash, not so much.

  Q: *How does it change when you play hack and slash type of games?*

  A: I'm not a part of what is going on. I'm aware of how I might roleplay the character/s, of what they may or may not kill, for instance, but I'm not actually roleplaying the character. I'm not telling a story.

- **Q:** *Are you aware of the controls you are using while playing text based computer games?*
  A: Hmm. Controls?
  Q: *yes, commands and keyboard setup itself*
  A: I'm usually pretty good at picking up commands and knowing what needs doing at any given moment. Unless I'm confused about syntax or whatever, then I ask.

- **Q:** *Have you ever held an administrative position on a MUD, elected by other players or as staff?*
  A: I was a builder/programmer on another MOO I didn't mention, called miriani. I was only in the position for a year, and it ended very badly.

- **Q:** *What role was that and how did this role change your gameplay experience while playing the game? If you prefer not to answer this because of how it ended, that is fine.*
  A: I mostly built a couple areas, and created some stores that sold various things–I love doing that type of work. I never grasped the programming aspect very well. It didn't change my gaming experience all that much, I just learned some of what went on behind the scenes, but I still played as I always had.

- **Q:** *How do you envision the perfect game for you? Note that this can be a text based computer game, any computer game or even any game.*
  A: A fair environment. Admin who listen to their players, take bugs or possible bugs seriously, a place where trouble-makers or disrespectful people aren't tollerated. Definitely a roleplay environment of some sort. oh, and clear rules to outline where admin can and cannot use their power. No lording over players unjustly or abusing their coding priveleges.

A.3 Interview with C, conducted March 13th, 2012

Female, 36, playing MUDs since 1990, other computer games since 1994

- **Q:** *What degree of vision, if any, do you have?*
  C: None at all. I have prosthetic eyes, so not even light perception

- **Q:** *Were you born blind or did you become blind later in life?*
  C: I became blind somewhere around 18 months of age, due to cancer of the retinas.

- **Q:** *Which games do you play? Please list computer related and non computer games.*
  C: Oh goodness. Well I don't do a lot of games off of the computer. occasionally cards, checkers, scrabble, but those are few and far between. On the computer, I'm very active in muds, moos and the like. I also play several games run by a company called rsgames, things like a thousand miles, monopoly, battleship, things like that. I'll pretty much try any game that's accessible if I can.

- **Q:** *Are the games done by rsgames specifically targeted at blind players?*
  C: Well, they're designed to be playable by either blind or sighted. They have a downloadable client that works with screen readers, and also a web client that anyone can use.

- **Q:** *How often do you play games? Please differentiate between computer related and non computer games.*
  C: Computer games, usually at least some every day. Off the computer, um. Once a month, if that.

- **Q:** *Which text based computer games do you play? If you play different types for example, Multi-User Dungeons or single player Interactive Fiction, please note the type of each game. Otherwise just state the category.*
  C: Now days the purely text based games I play are either muds or moos. As far as which ones, right now the ones I"m active on are aardwolf, star conquest, new worlds, project bob, and xyllomer. I've played many others in

the past, and I do tend to go through phases where I'm more active on one than another, but those are the main ones I go between. Although I do have a solitaire game on my computer that's pretty much pure text, just with a couple of sound effects.

- **Q:** *Why do you play (the previously stated) text based computer games?*
  C: Hmm. It depends on the game. Some of them are hack and slash, just kill things type of games, and those I play mostly if I just want to do something mindless. I do enjoy the challenge of making progress, too. But others are roleplay enforced games. Those still have an element of that making progress, the competition and working together aspects, but they also allow me to roleplay, to tell a story so to speak and I really do enjoy that.

- **Q:** *What makes you log in into text based computer games, what discourages you?*
  C: Do you mean like, day to day? Or do you mean what draws me to some game over another one?
  Q: *both aspects.*
  C: Ah ok. Well, When I log into a text based game I'm generally looking for a few things. Something to do, since currently I don't have work. INteraction with others either in just working to a common goal, or the roleplay, story telling aspect. I also enjoy creative writing, and some of the games I play allow me to write descriptions and things like that. If I'm feeling really really tired, or emotional, I probably won't go to a roleplay game because it's harder to focus on the story then.

- **Q:** *What is your technical setup for playing text based computer games? Which software do you use?*
  C: I use a mud client called vipmud that's designed specifically for the blind, and interacts with my screen reader.
  Q: *Which screen reader do you use?*
  C: I use jaws for windows, mostly, although I also have access to ne called system access

- **Q:** *Which features in text based computer games are potentially irritating for you?*

  C: Well, the obvious answer to that is ones that use ascii pictures or colors to convey important information with no other way to get the information. Another is games that do not allow a way to turn off the room descriptions so that I can choose when to see them. I've actually chosen not to play a game because of one or both of those things. On a less technical level, I get very irritated with games where there is little help given to newbies, or where the administrators treat their players rudely

- **Q:** *When you play text based computer games, how do you perceive them with your senses?*

  C: Hmm. Well on a hack and slash game I just go with the words and don't really imagine much, except for picturing the area I'm in so I can know where I need to move next. How I do that is hard to describe, it's like I build a mental map in my head of the area and where I am in it. but in roleplay games, I visualize quite a bit. The sounds, feelings, even smells sometimes. I try to get as much into my character's head as I can. The exception is during combat. One roleplay game I play there is still a lot of combat and I really don't want to visualize smashing someone to death with a sword, hehehe

- **Q:** *Which senses do you imagine being active while playing a text based computer game?*

  C: Oh. Well like I said before, during roleplay, pretty much all of them. But during combat or hack and slash games, I don't really imagine as much except that mental mapping, which is less a sense and more just, keeping track

- **Q:** *Are you aware of the controls you are using while playing text based computer games?*

  C: Controls? How do you mean?

  Q: *for example the keyboard setup per se as well as the commands you are using to navigate in your environment*

  C: I would say I'm definitely aware of them, yeah. Some do become almost second nature, but I'm still aware of what I'm doing and how I'm doing it.

- **Q:** *Have you ever held an administrative position on a MUD, elected by other players or as staff?*

  C: I have. I've been staff on a few games, and more recently I was a sort of semi staff member on new worlds. The position I held wasn't technically an admin, but I had a few commands that allowed me to deal with problem players if the staff weren't around.

- **Q:** *How did this role change your gameplay experience while playing the game?*

  C: Well, this position was also an in character one, so it was a bit complicated. I would say that in many ways it enhanced the game play experience, by adding something to it. But when I had to leave roleplay to deal with some problem player, it could be disrupting.

- **Q:** *How do you envision the perfect game for you? Note that this can be a text based computer game, any computer game or even any game.*

  C: Definitely a game with interactions with others. Preferably with both text and sound effects, lots of customization. I like a lot of ability to be creative both in play and in creating the world, and an environment that allows for different playing styles but does not allow the bullies to just run over everyone else. I've seen that happen on games before and I've left them because of it.

Appendix B

Modifications on the Game Environment

The game environment that was made available by the Discworld team was modified before and again after the pilot study. This appendix shows further changes to those mentioned in the main body of the text.

B.1 Modifications before Pilot Study

I modified the room descriptions in order to provide landmarks in the garden and generally try and achieve about the same length of the description of every room. I also made a point of enabling the player to reference every noun that is mentioned in the room description with the 'look' (or 'examine') command. Every other noun which was then mentioned in these so called 'add_items'[1], but not in the room description, has been further described. This provides the player with an interactive world where they can interact with the things hinted at (compare Listing B.1) at a basic level. Objects that provide an option for further interaction have been enhanced to support the expected courses of action, like sitting on a chair.

[1] Due to the name of the function that achieves the previously described task.

```
void setup(){
  (...)
  //roomdescription
  set_long( "This is the bathroom.  There is a huge grindstone in the "
            "corner that looks a little excessive for sharpening the "
            "razor next to it, a medicine cabinet begging to be rifled "
            "through, along with a bath.\n" );
  (...)
  //add_items
  add_item( "bath",
            "This is the bath tub that Albert, Ysabell and Mort use.  "
            "A yellow rubber duck sits on the side.  There is some "
            "polish next to it that Death uses." );
  add_item( "polish",
            "A small case of \"Wonder skull polishing wax\", you can "
            "see that it has been used a bit.  Its advertising slogan "
            "appears to be:\n  \"Are you dead?  If so, you don't want "
            "those bones of yours to look bad, so why not spiff them "
            "up with Wonder skull polisher, you will never look "
            "better.\"\n" );
  (...)
}
```

LISTING B.1: Example of enhancing a room with add_item

B.2 Modifications after Pilot Study

B.2.1 Doors

The doors in the inside rooms also have been changed in their determinate. When a player in the pilot study setup looked at all doors, for example in the room of Death's study, they were presented with three different 'the door to Death's study'. Since the determinate 'the' indicates uniqueness, which is not actually given in the whole game setup, I changed it to 'a door to Death's study' and subsequently for all doors that were affected.

B.2.2 NPCs

I later realised that I forgot to include a response to the generally common greetings, which made this feature hidden to most of the test participants of the main study. Listing B.2 shows how NPC responses are implemented with the example of Death himself. It should be noted, that it is not the case, that every NPC speaks in capital letters only, but for Death this is a reference to the books by Terry Prattchet.

```
void setup(){
  //general setup
  (...)
  //responses to keywords
  add_respond_to_with( ({ "@say", ({ "help" }) }),
                       "say NOTHING CAN HELP YOU.  THIS IS ALL SO "
                       "INEVITABLE.  DOESN'T IT MAKE YOU THINK, "
                       "TOO?" );
  add_respond_to_with( ({ "@say", ({ "bathroom" }) }),
                       "say I USE IT FAIRLY REGULARILY.  IT'S RIGHT "
                       "DOWN THE HALL OPPOSITE OF YSABELL'S ROOM.  "
                       "WE PUT HER ROOM THERE IN ORDER TO TEACH HER "
                       "SOME CLEANLINESS.  YOU SHOULD ALWAYS POLISH "
                       "YOUR BONES FROM TIME TO TIME." );
  //more responses to other keywords
  (...)
  //random actions performed by the NPC
  load_chat( 10,
  ({ 1, ":inspects a note.",
     1, "'I WONDER WHETHER THE FISH WILL BITE.",
     1, ":stares off into the distance.",
     1, ":taps on the desk with his bony index finger.",
  }) );

}
```

LISTING B.2: Example of responses an NPC gives to a player when certain keywords are said

B.3 Commands Changed

Command	Explanation
exits	Showing all available exits in one line
look <direction>	Looking into a direction -> presents a long description of adjacent room
glance <direction>	Looking into a direction -> presents a short description of adjacent room
get <item>	Retrieving an item that is lying on the floor
say[to <person>]	Talking to NPCs and (technically) other players
turn <direction>	Realigning the character with the world

TABLE B.1: Commands that have been additionally explained in the Newbie Area of the main study

Appendix C

Structure of Further Tests Derived from Pilot Study

The author wants to share points they deemed as important when conducting the pilot study. Some of the structure can be applied for further research about text based games or research that utilises them.

Which Participants to Choose

To establish whether the experience with text-based games a potential test participant might have is harmful for your test results or not, it is important to conduct a small pilot study. This assesses if and how experience plays a role in the test setup and whether or not it should be avoided. In this case, the priming for one navigation system showed in the pilot study, hence, experienced players were excluded. However, in other cases, for example the representation of different modalities, the experience of a player might not play a role or even be helpful. Especially in research with blind players, it should be considered, that potential test participants are rare and with excluding experienced players, it is very difficult to find enough participants for a study that match the previous established criteria.

The Pilot Study as Playtest

Pilot studies should furthermore be conducted with experienced and inexperienced players alike. Especially when testing games, the pilot study functions as a playtesting runthrough of the game and the test setup alike. The step of playtesting is often used in game development and it should not be forgotten when designing a test game for research purposes, especially when the game is being changed to account for certain parameters which are tested.

Size of Test Groups

There is no golden rule of the size a test group should have and it heavily depends on the metrics that are used to establish differences of effects when differences of parameters exist. For example quantitive data is only useful if there are at least ten participants or better twenty for each category. Comparing this to the three participants of each category and a total of twelve participants, the suggested group of test participants would then be a lot larger. Otherwise the numbers are highly individual and patterns in the data that are seen can only indicate possible directions for answers of the research question. This explains why the Immersion Values were not conclusive in this study.

This is – of course – not a complete guide on how to conduct tests for research in text based games. However, since these were important points when establishing the test setup for this research, they were included for further references.

Appendix D

Welcome Text

This text has been used to welcome the participants and introduce them to the test setup.

Welcome!

Thank you for participating in this test. You can stop the game as well as the whole test at any time. (It does actually make sense to still fill out the questionnaires afterwards, in case you didn't finish the game.) If you have any questions during the test, you can always ask your supervisor; however, they might not always give you an answer. If you experience problems, please contact them immediately.

Your data will be dealt with confidentially. Your name will not be recorded at all, we use a pseudonym in the game and an encoded identifier for the questionnaires. The data will only be used for the purpose of this research.

Next to the questionnaires, we will also log your test session and record audio data. For the audio recording we would ask you to think out loud during the test, this means, actually talk about what you are doing and why and what your goals are in doing so. If you disagree on any of these procedures, please inform your test supervisor.

We hope you have fun!

Appendix E

Task Descriptions

The original quest description has been slightly modified for the pilot study and again heavily modified for the main study. The changes are put next to each other in this part of the appendix to make them obvious.

E.1 Original Quest Description

The original description of the task[1] 'Fish Bone Collector' is available in a restricted area on the webpage:

> Solution:
> This quest takes place in Death's Domain. Get a hairpin from Ysabell's room, dental floss from the bathroom, a bone from the corridor, a worm-like soul from the pit. Twist hairpin into a hook, tie string to bone, attach hook to bone-onna-string, bait rod with worm-like soul, go to a pond in the garden and fish with the rod.

[1] Discworld calls these type of tasks 'quests'.

E.2 Pilot Study

Find your way around Death's Domain. While you are doing so try and finish the following task:

Get a hairpin from Ysabell's room by searching the carpet, dental floss from the bathroom by searching the cabinet, a bone from the corridor and a worm-like soul by searching the pit. Twist the hairpin into a hook, tie the floss to the bone, attach the hook to the bone-onna-string and bait the rod with a worm-like soul, go to a pond in the garden and fish with the rod. Wait for events to unfold.

E.3 Main Study

You are a young student at the Unseen University. As is common with young students (meddling with magical forces they should not yet attempt), something went wrong with that supposedly easy light spell you attempted and you find yourself in Death's Domain. You have heard of Albert Malich ending up here similarly but unlike him, you don't want to stay.

Death makes you the following offer: If you catch him a bony fish from his pond, he will let you go. However, his fishing rods do not seem very durable, so he cannot provide you with one. He looks at you sternly as he instructs you. He tells you about bones that lie around in the corridor and that he has no strings; however, there might be dental floss in the cabinet of the bathroom. Due to the cabinet being such a mess you will need to search a bit for it.

'FURTHERMORE,' he says with a soundless voice you can only hear in your head, 'THERE MIGHT BE A HAIRPIN IN YSABELL'S ROOM. SEARCH HER CARPET, SHE'S GENERALLY NOT VERY TIDY.' He instructs you with some further information on how to assemble the rod. The trick appears to be to twist the hairpin three times so it forms a hook, then tie the floss to the bone. Next, attach the hook to the bone-on-a-string and then bait the rod with a worm-like-soul. This wormthing can be found by searching the pit behind the garden. 'BRING ME THE FISH AND YOU ARE FREE TO GO. BUT DO SO IN A TIMELY FASHION IF YOU WANT TO LEAVE AGAIN.' You had better be going!

Appendix F

Questionnaires

This part of the appendix shows the different questionnaires used in the pilot study and the main study.

F.1 Interactive Fiction (IF) and Multi-User-Dungeon (MUD) Experience Questionnaire

- Age _____
- Which types of digital games do you play?
  - at all _____
  - regularily _____
- Have you ever played a game of IF or on a MUD? yes$_{\bigcirc}$ no$_{\bigcirc}$

  If the answer was no, you can skip the rest of the questionnaire now.
  - Which one(s)? _____
  - When did you play them?

    _____

– When did you last login to a MUD or play a game of IF?

_____

– Which game was that?

_____

– How often do you play IF or on MUDs?

once a day$_{\bigcirc}$ once a week$_{\bigcirc}$ once a month$_{\bigcirc}$ less$_{\bigcirc}$

F.2 Questionnaires for Pilot-Study

Statistical Data

- Age _____
- Occupation _____
- Gender female$_{\bigcirc}$ male$_{\bigcirc}$ prefer not to answer$_{\bigcirc}$
- If applicable:
  1. Became Visually Impaired/Blind at the Age of _____
  2. Degree of Impairment

     visual impairment$_{\bigcirc}$ high grade visual impairment$_{\bigcirc}$ blind$_{\bigcirc}$
  3. Cause of Impairment

     accident$_{\bigcirc}$ illness$_{\bigcirc}$ other$_{\bigcirc}$

Out-of-Game Questionnaire

- I can easily switch my attention from the task in which I am currently involved to a new task.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer$_{\bigcirc}$
- I frequently get emotionally involved (angry, sad, or happy) in the news stories that I read or hear.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer$_{\bigcirc}$
- I feel well today.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer$_{\bigcirc}$

- I rarely become so involved in a book that people have problems getting my attention.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I currently feel mentally alert.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I rarely find myself identifying with the characters in a story.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I feel physically fit today.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I am not good at blocking out external distractions when I am involved in something.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I concentrate well on enjoyable activities.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I concentrate well on disagreeable tasks.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I sometimes become so involved in something that I lose all track of time.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

In-Game Questionnaire

- I had the feeling that the environment was responding to my actions.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- Navigating through the world felt natural to me.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I forgot about the events ocurring around me that were not related to the game.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I didn't have to think much about what commands to type.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I didn't feel that the feedback the game gave me for my actions was consistent.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- The system reacted to my actions as expected.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I often felt lost in the game.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I felt like I was personally in the game environment.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I identified with my character in the game.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I noticed external distractions while playing.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I found playing the game interesting.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I didn't find playing the game challenging.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- Would you have preferred other interaction such as audio, images or touch feedback?

  yes○ no○

- If yes, what and why? _____

  _____

- In your opinion, how long did you play?

  Answer: _____

Navigation Questionnaire

Imagine for the following questions that you are actually in the world and performing the actions yourself:

- Imagine you stand in front of Albert's room, facing the door straight ahead of you. How long would you think it would take you to get to the pit, where you found the worm-like soul?

  Answer: _____

  Time: _____

- Imagine you now want to go to Death's study. How long would you think it takes you until you are in front of his door?

  Answer: _____

  Time: _____

- You are standing in front of Death's study, facing the door. In which direction is the bathroom in?

  Answer: _____

  Time: _____

- And in which direction are the stables?

  Answer: _____

  Time: _____

- When you imagine the whole game environment, are you doing so from a first person or a third person view?

  Answer: _____

  _____

- Would you have preferred a different way to navigate through the world? If so, what would that be?

  Answer: _____

  _____

Thanks a lot for your assistance!

F.3 Questionnaires for Main Study

Statistical Data

- Age _____
- Occupation _____
- Gender female○ male○ prefer not to answer○
- If applicable:
  1. Degree of Impairment

     vi○ high grade vi (legally blind)○ blind (functionally blind)○
  2. Became Visually Impaired/Blind at the Age of _____
  3. Cause of Impairment

     accident○ illness○ other○
- Client Used: _____
- Screenreader Used: _____

Out-of-Game Questionnaire

- I can easily switch my attention from the task in which I am currently involved to a new task.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer ○

- I frequently get emotionally involved (angry, sad, or happy) in the news stories that I read or hear.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer ○

- I feel well today.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer ○

- I rarely become so involved in a book that people have problems getting my attention.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer ○

- I currently feel mentally alert.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer ○

- I rarely find myself identifying with the characters in a story.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer ○

- I feel physically fit today.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer ○

- I am not good at blocking out external distractions when I am involved in something.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer ○

- I concentrate well on enjoyable activities.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I concentrate well on disagreeable tasks.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I sometimes become so involved in something that I lose all track of time.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

In-Game Questionnaire

- I had the feeling that the environment was responding to my actions.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- Navigating through the world felt natural to me.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I forgot about the events ocurring around me that were not related to the game.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I didn't have to think much about what commands to type.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I didn't feel that the feedback the game gave me for my actions was consistent.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- The system reacted to my actions as expected.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I often felt lost in the game.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I felt like I was personally in the game environment.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I identified with my character in the game.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I noticed external distractions while playing.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I found playing the game interesting.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- I didn't find playing the game challenging.

  strongly agree ○ ○ ○ ○ ○ ○ strongly disagree || no answer○

- Would you have preferred other interaction such as audio, images or touch feedback?

  yes○ no○

- If yes, what and why? _____

  _____

- In your opinion, how long did you play?

  Answer: _____

Navigation Questionnaire

For the following questions, imagine that you are actually in the world and performing the actions yourself:

- You're standing in front of Albert's room in the first corridor room, facing the door straight ahead of you. How long - in time - do you think it would take you to get to the pit, where you found the worm-like soul?

  Answer: _____

  Time: _____

- Now you're standing by the pit, and you want to go to the stable. How long - in time - do you think it would take you until you are there?

  Answer: _____

  Time: _____

- Standing inside the stable you are wondering, what Mort might be up to. How long - in time - would it take you until you are in his room?

  Answer: _____

  Time: _____

- You have to go back to the pit. How long - in time - do you think it would take you until you are there?

  Answer: _____

  Time: _____

- You want to go from the pit back to Death's study, How long - in time - do you think it would take you to get in front of his door, in the first corridor room.

  Answer: _____

  Time: _____

I will now guide you through the same route again. This time I want to know how many rooms are between the start and end point. Please count the starting room and the destination room as well. Try to give the correct answer as fast as possible.

- You're standing in front of Albert's room in the first corridor room, facing the door straight ahead of you. How many rooms would you have to walk through to get to the pit?

  Answer: _____

  Time: _____

- Now you're standing by the pit, and you want to go to the stable. How many rooms do you have to walk through until you are in the stable?

  Answer: _____

  Time: _____

- Standing inside the stables you are wondering, what Mort might be up to. How many rooms do you have to walk through until you are in his?

  Answer: _____

  Time: _____

- You have to go back to the pit. How many rooms will you walk through?

  Answer: _____

  Time: _____

- You want to go from the pit back to Death's study, how many rooms would you have to walk through until you are right in front of his door in the first corridor room?

  Answer: _____

  Time: _____

Now two general questions to give you a pause.

- When you're imagining the whole game environment, are you doing so from a first person or a third person view?

  Answer: _____

  _____

- Would you have preferred a different way to navigate through the world? If so, what would that be?

  Answer: _____

  _____

Now four final tasks:

- You are standing in front of Death's study, facing the door. Which direction is Mort's room in? Please answer in terms relative to your body. (That means that Death's study would be forward.)

  Answer: _____

  Time: _____

- And in which direction is the kitchen in?

  Answer: _____

  Time: _____

- Where, do you think, Albert's room lies?

  Answer: _____

  Time: _____

- You are in the room outside of Death's house, in which direction is the kitchen in now? This time, please answer in cardinal directions like north, south, northeast and such.

Answer: _____

Time: _____

- And where is the room on top of the stairs?

  Answer: _____

  Time: _____

- Where would you locate the entrance hall?

  Answer: _____

  Time: _____

Thanks a lot for your assistance!

Appendix G

Task Report for Main Study

- Start: _____
- bone: _____
- bathroom: _____
- ysabell: _____
- pit: _____
- rod: _____
- fishing: _____
- brought fish to death: _____
- end: _____
- time: _____
- comments: _____

Appendix H

Study Data

This part of the appendix shows more of the study data that is referenced in the main body of the thesis text.

H.1 Overview of Participants of Pilotstudy

Identifier	Blind/Sighted	(Un)Experienced	Allo-/Egocentric
PB1E	Blind	Unexperienced	Egocentric
PB2E	Blind	Experienced	Egocentric
PS3E	Sighted	Unexperienced	Egocentric
PS4A	Sighted	Unexperienced	Allocentric
PB5A	Blind	Unexperienced	Allocentric
PS6E	Sighted	Experienced	Egocentric
PS7A	Sighted	Experienced	Allocentric
PB8A	Blind	Experienced	Allocentric

TABLE H.1: Characteristics of participants in the pilot study

H.2 Statistical Data

Average Age	Egocentric	Allocentric	
Blind	24.33	31.00	27.67
Sighted	24.67	24.00	24.33
	24.50	27.50	26

TABLE H.2: Average age of test participants shown over the groups

H.3 Protocols

Participant	1	time	2	time	3	time
BA	2/3 bone	449.43	different	354.5	2/3 ysabell	222.36
BE	bone	406.77	2/3 ysabell	193.07	2/3 bathroom	448.80
SA	bone	467.60	2/3 bathroom	314.3	2/3 ysabell	121.07
SE	2/3 bone	947.00	bathroom	116.47	2/3 ysabell	117.73
	4	time	5	time	6	time
BA	2/3 pit	404.33	rod	411.20	fishing	99.07
BE	2/3 rod	357.2	2/3 pit	423.13	fishing	242.13
SA	2/3 rod	311.07	2/3 pit	456.00	fishing	127.50
SE	rod	170.03	pit	515.67	fishing	217.13
	7	time	playtime			
BA	brought fish	361.60	2400			
BE	brought fish	248.57	2500			
SA	brought fish	277.23	2220			
SE	brought fish	478.93	2660 height			

TABLE H.3: Orders of task and time intervalls (given in seconds)

H.4 Logs

Participant	total	typo	ni	syntax	wrong	look	other
BA	138	7.33	4.67	0.67	14.33	8.67	25.67
		5.31%	3.38%	0.48%	10.39%	6.28%	18.60%
BE	148.33	6.67	0	0	5	1.33	16
		4.49%	0.00%	0.00%	3.37%	0.90%	10.79%
SA	154.67	6	1	0.67	5	10	26.67
		3.88%	0.65%	0.43%	3.23%	6.47%	17.24%
SE	180.67	5.67	1	1.67	7	8.33	31
		3.14%	0.55%	0.92%	3.87%	4.61%	17.16%

TABLE H.4: Log Analysis I – showing occurrences of command types except movement and exploration – ni [not implemented]

Participant	expl	move	ratio	diagonal	straight	CER
BA	36.33	40.33	0.90	11	29.33	16.43% | 13.04%
	26.33%	29.23%		27.27%	72.73%	
BE	68.67	50.67	1.36	10.33	40.33	5.62% | 5.62%
	46.29%	34.16%		20.39%	79.61%	
SA	62	43.33	1.43	5	38.33	5.82% | 5.17%
	40.09%	28.02%		11.54%	88.46%	
SE	50.67	75.33	0.67	19.67	55.67	6.00% | 5.44%
	28.04%	41.70%		26.11%	73.89%	

TABLE H.5: Log Analysis II – Showing occurences of movement and exploration, the ratio of exploration over movement, what type of movement occured and the CER – expl [exploration], move [movement], CER [Command Error Rate]

H.5 Audio Data

Participant	In-Game	Out-Of-Game	Meta-Game	Silence	Total
BA	772.5	359.0	4.5	769.5	1905.5
	40.54%	18.84%	0.24%	40.38%	
BE	442.0	484.7	20.3	1692.3	2639.3
	16.75%	18.36%	0.77%	64.12%	
SA	886.7	293.3	2.0	997.3	2179.3
	40.69%	13.46%	0.09%	45.76%	
SE	542.7	191.0	2.0	1771.3	2507.0
	21.65%	7.62%	0.08%	70.66%	

TABLE H.6: Absolute and relative distribution over time of different comments extracted from the audio logs

Participant	In-Game	Meta-Game	Out-of-Game	Silence	Total
BA	110	50	1	108	269
	110.00%	50.00%	1.00%	108.00%	
BE	103	84	4	169	360
	103.00%	84.00%	4.00%	169.00%	
SA	154	65	1	143	363
	154.00%	65.00%	1.00%	143.00%	
SE	103	50	1	104	258
	103.00%	50.00%	1.00%	104.00%	

TABLE H.7: Utterances of the different speech categories as average values for the groups

Participant	i->m	m->i	i->o	o->i	i->s	s->i	s->m	m->s	m->o	o->m	o->s	Total
BA	27	23	0	0	81	87	23	26	1	1	0	269
	10.04%	8.55%	0.00%	0.00%	30.11%	32.34%	8.55%	9.67%	0.37%	0.37%	0.00%	
BE	10	7	0	0	93	96	71	72	3	3	1	356
	2.81%	1.97%	0.00%	0.00%	26.12%	26.97%	19.94%	20.22%	0.84%	0.84%	0.28%	
SA	32	42	0	1	120	110	32	22	0	0	0	359
	8.91%	11.70%	0.00%	0.28%	33.43%	30.64%	8.91%	6.13%	0.00%	0.00%	0.00%	
SE	23	22	0	0	76	79	27	26	1	1	0	255
	9.02%	8.63%	0.00%	0.00%	29.80%	30.98%	10.59%	10.20%	0.39%	0.39%	0.00%	
	i->i	i->m	m->i	i->o	o->i	m->m	m->o	o->m	Total			
BA	69	40	34	0	0	10	1	1	155			
	69.00%	40.00%	34.00%	0.00%	0.00%	10.00%	1.00%	1.00%				
BE	61	41	41	0	0	41	4	4	192			
	61.00%	41.00%	41.00%	0.00%	0.00%	41.00%	4.00%	4.00%				
SA	90	60	61	1	1	4	0	0	217			
	90.00%	60.00%	61.00%	1.00%	1.00%	4.00%	0.00%	0.00%				
SE	59	41	42	0	0	7	1	1	151			
	59.00%	41.00%	42.00%	0.00%	0.00%	7.00%	1.00%	1.00%				

TABLE H.8: Transitions first with and then without the *silence* category shown as average values for the groups

H.6 Questionnaires

Participant	add. feedback?	what	perceived playtime	actual playtime	difference
B3A	yes	audio to get more immersive environment	40min	33min	21.21%
B4A	yes	audio, would make it more interesting	30 min	31min	-3.23%
B5A	yes	much easier to interact with the environment with feel/-sound	no feel	56min	n/a
B2E	yes	audio, cause that makes me feel like I'm in the environment more	45min	26 min	73.08%
B11E	n/a		40min	40min	0.00%
B13E	n/a		60min	59min	1.69%
S6A	no		30min	41min	-26.83%
S7A	no		60min	36min	66.67%
S8A	no		15min	34min	-55.88%
S9E	yes	maps for better navigation, sound for atmosphere	45 min	44min	2.27%
S10E	no		30min	37min	-18.92%
S12E	yes	more feedback, sometimes it just said 'what'	60min	52min	15.38%
BA			35.00 min	40.00 min	8.99%
BE			48.33 min	41.67 min	24.92%
SA			35.00 min	37.00 min	-5.35%
SE			45.00 min	44.33 min	-0.42%

TABLE H.9: Answers given in the free answer section of the In-Game Questionnaire

	Out-Of-Game													
Parti-cipant	1	2	3	4	5	6	7	8	9	10	11	Average		
BA	2.33	3.67	2.00	3.33	2.00	2.33	2.67	3.67	1.33	4.17	2.00	2.68		
BE	2.00	2.00	2.33	3.67	1.33	3.33	2.67	5.00	1.33	4.00	2.00	2.70		
SA	2.33	1.67	1.67	3.33	5.00	2.67	1.67	3.67	1.67	3.67	2.00	2.67		
SE	2.00	3.67	1.67	3.33	2.00	4.00	1.67	3.67	1.33	4.33	1.33	2.64		
	In-Game													
Parti-cipant	1	2	3	4	5	6	7	8	9	10	11	12	Average	IV
BA	2.67	3.67	2.67	3.00	1.00	2.33	3.67	4.00	4.67	2.67	2.00	2.67	2.92	1.09
BE	2.00	3.00	2.67	2.33	1.50	1.67	3.67	3.67	4.00	3.67	2.00	4.33	2.83	1.06
SA	1.33	3.00	1.67	4.00	2.33	2.00	3.67	1.67	2.33	3.33	1.33	4.67	2.61	1.00
SE	1.67	4.33	2.67	1.33	2.00	2.00	3.33	3.00	2.00	4.00	1.33	4.00	2.64	1.01

TABLE H.10: Out-Of-Game Questionnaire – answers 4, 6 and 8 were calculated with reverse values; in line with best practises for Likert Scale statements, the positive and negative emphasis is varied statement to statement
In-Game Questionnaire - Answers 4, 5, 7 and 10 were calculated with reverse values
IV [Immersion Value]

Participants	view	additional navigation	comment
B3A	first	grid layout with buttons; point directions	
B4A	first	no	
B5A	first	can't imagine a different one	
B2E	first	no	takes a long time to give the answer
B11E	first	arrow keys	
B13E	first	I'm not sure, really. I wish there was a way of obviously remembering where things are - like written maps	
S6A	first	no	
S7A	first	arrow keys	
S8A	first	no	
S9E	both	orienting with the help of objects, mixture for story	
S10E	first	yes, something like 'go to bathroom'	
S12E	first	fixed portals at relevant places	

TABLE H.11: Results from the Navigation Questionnaire in the free answer section

	Egoc. Task			
Participant	time 1st	time 2nd	time 3rd	correct answers
BA	9.37	13.33	12.77	0.33
BE	17.55	4.83	29.60	0.33
SA	9.50	5.53	17.87	0.83
SE	9.97	5.37	3.13	2.17
	Alloc. Task			
Participant	time 1st	time 2nd	time 3rd	correct answers
BA	26.23	10.83	2.20	2.33
BE	10.90	4.60	5.55	0.17
SA	7.67	11.23	12.43	1.67
SE*	21.47	11.33	4.30	1.17

TABLE H.12: Results from the Navigation Questionnaire
Section Egocentric Location Task
Section Allocentric Location Task
* encoded the other way around

	Time Est.										
Parti-cipant	1	time	2	time	3	time	4	time	5	time	precision
BA	90.0	13.20	75.0	9.30	112.5	14.90	100.0	7.40	97.5	4.40	0.2347
BE	400.0	30.27	180.0	15.93	260.0	16.17	500.0	11.43	540 .0	8.97	0.0015
SA	500.0	12.97	340.0	9.63	320.0	10.67	380.0	5.90	360.0	7.47	0.0103
SE	400.0	11.63	360.0	9.20	230.0	8.90	500.0	3.27	500.0	3.20	0.0060
	Room Est.										
Parti-cipant	1	time	2	time	3	time	4	time	5	time	average mean distance*
correct	7		6		6		9		7		0.0
BA	5.0	11.33	4.7	8.33	4.7	15.20	6.3	9.27	5.7	6.03	2.0
BE	4.3	14.97	3.7	5.00	4.3	14.80	5.3	3.75	4.7	6.93	2.4
SA	3.7	11.53	3.3	6.20	4.0	9.57	5.7	9.70	5.4	4.53	2.6
SE	9.0	8.90	6.0	4.50	4.3	6.00	8.0	7.30	8.0	4.53	2.9

TABLE H.13: Results from the Navigation Questionnaire
Section Time Estimation Task – Answers given and time needed to give them are both presented in seconds
Precision = 1/Variance(Answers)
Section Room Estimation Task – Answers given in number of rooms, time given in seconds
* Average Mean Distance = average distance from the correct result

Appendix I

Heatmaps

The heatmaps shown here show how the players of the different groups moved within the game environment.

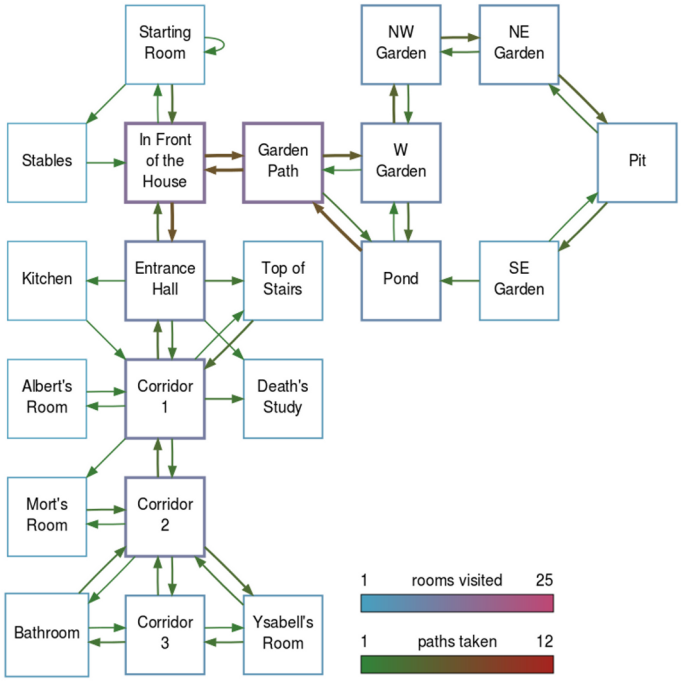


FIGURE I.1: Heatmap of blind players in the allocentric system

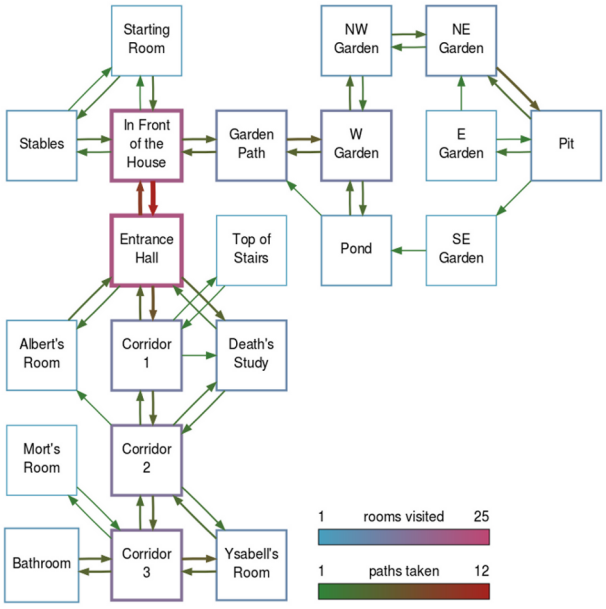


FIGURE I.2: Heatmap of blind players in the egocentric system

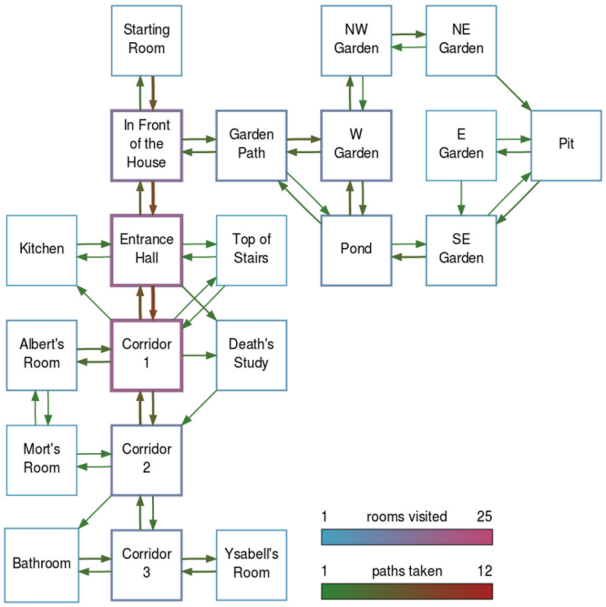


FIGURE I.3: Heatmap of sighted players in the allocentric system

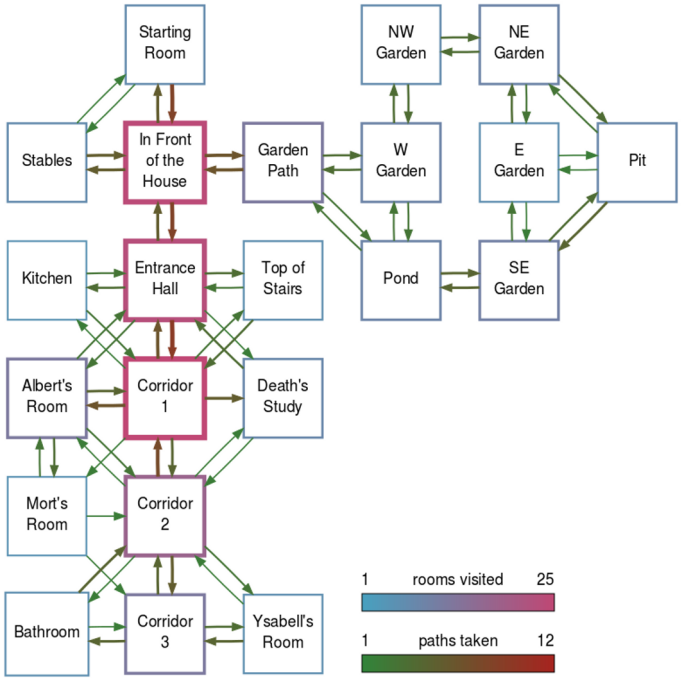
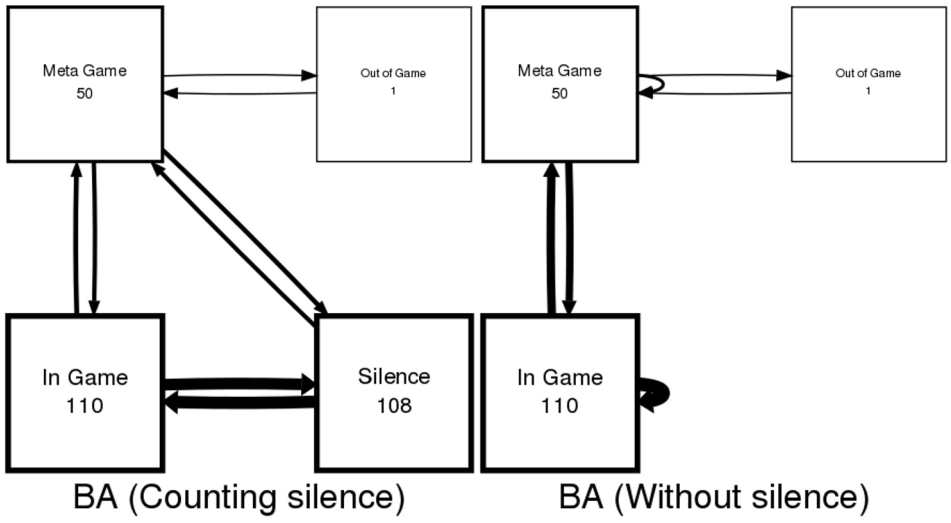


FIGURE I.4: Heatmap of sighted players in the egocentric system

Appendix J

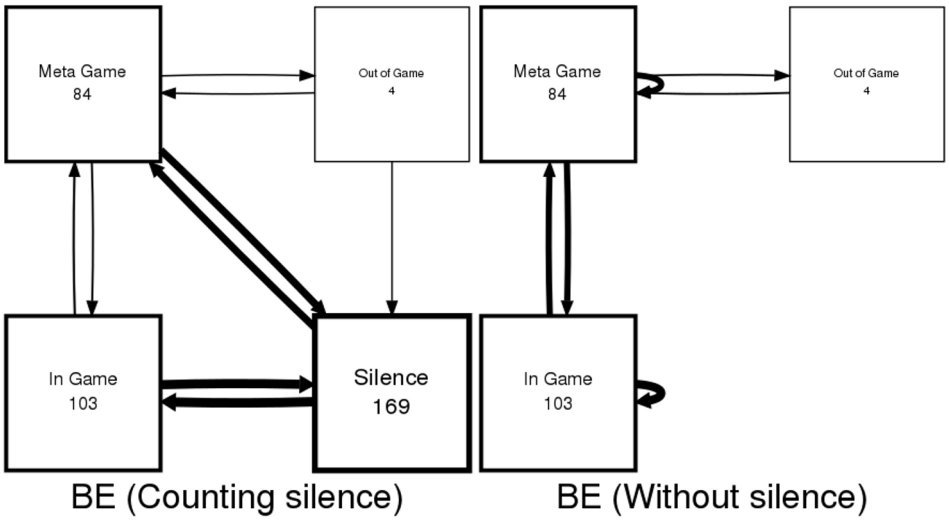
Visualised Audio Data

The following graphs show the occurences of different categories of speech in the audio data as well as the transitions between them.



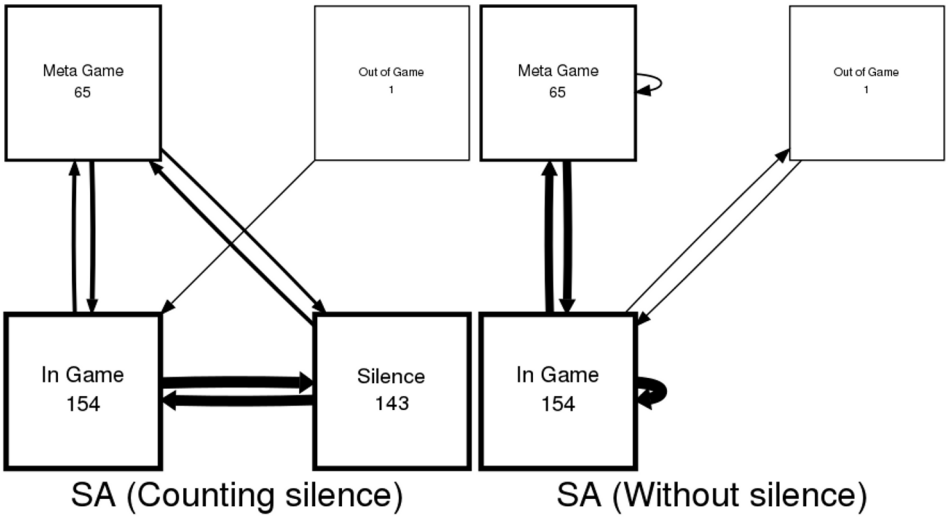
(A) All utterances (B) All utterances without *silence*

FIGURE J.1: Utterances and transitions of blind players in the allocentric system shown in total values



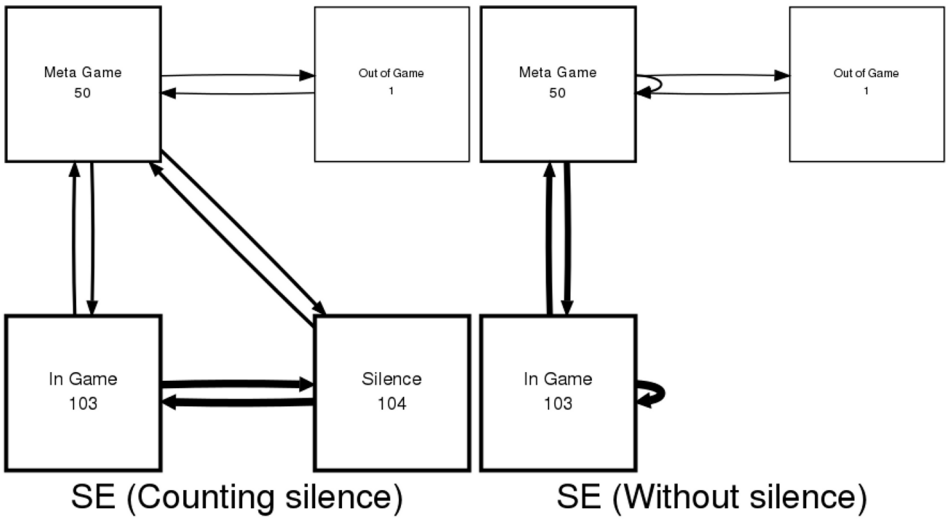
(A) All utterances (B) All utterances without *silence*

FIGURE J.2: Utterances and transitions of blind players in the egocentric system shown in total values



(A) All utterances (B) All utterances without *silence*

FIGURE J.3: Utterances and Transitions of sighted players in the allocentric system shown in total values



(A) All Utterances (B) All Utterances without Silence

FIGURE J.4: Utterances and Transitions of sighted players in the egocentric system shown in total values

Declaration of Academic Honesty

I confirm that this work is original and that any passages or diagrams that have been copied from academic books, papers, the Web or other sources are clearly identified by the use of quotation marks and the references are fully cited.
I certify that, other than where indicated, the work attached is solely my own work and does not breach the University Regulations regarding plagiarism.

Weimar, the 10th of September 2012

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Katharina Spiel