SUPPORTING THE USER EXPERIENCE OF RUNNING WITH MIXED REALITY STORIES

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to Brian and Anne

ABSTRACT

Mixed reality stories (MRS) are stories designed to create a mixed reality experience with particular activities, such as running. A wide commercial success of a mixed reality stories designed for running suggested that such a format could provide unique benefits compared to other kinds of mixed reality systems. Yet little is known about how the user experience of running with mixed reality stories can be supported. This thesis aims to address this problem.

To reach this aim I conducted three empirical qualitative studies.

Study 1 explores the experience of running with an existing commercially successful mixed reality story. In this study, 11 participants ran with the MRS for three weeks and reported on their experience via semi-structured open-ended interviews before and after the trial, along with keeping a running diary throughout the study. The study helped to evaluate which aspects are most significant for constructing the user experience of MRS, how runners balance different aspects on the go, the importance of participants' attitudes towards running, and also indicated that MRS format is different from both conventional audiobooks and traditional mixed reality systems.

Study 2 focuses on how creative writers address running when working on the stories. During this study, three writers created three distinct stories with different approaches to connecting the physical and virtual worlds. Semi-structured discussions with the writers, along with the analysis of the stories they created helped to understand the differences between the approaches they used, and how writers repurpose familiar story mechanics for addressing running.

Finally, Study 3 examines how runners perceive mixed reality stories. In it, 36 participants completed 45 runs with the three MRS created in the previous study. Similarly to Study 1, their experience was captured via semi-structured open-ended interviews after their runs. The findings of the study introduced four stages of story perception and revealed how such perceptions depend on participants' personal relationships with running. Moreover, Study 3 validated, clarified, connected and extended findings from the first two studies, thus bringing the thesis to closure.

Overall, this thesis addresses the gap in our understanding in how the user experience of running with mixed reality stories can be supported by clarifying how MRS are different from both traditional stories and other mixed reality systems, and how they enhance running by providing welcome distractions and by changing the meaning of the running. It suggests how runners balance different aspects of a complex experience by voluntarily engaging when it suits them. Finally, it breaks down the three most significant aspects of the MRS experience—running, story and MRS elements—to provide more understanding of how they work, and suggests how these insights could be used in practice.

DECLARATION

This is to certify that

1. the thesis comprises only my original work towards the PhD except where indicated in the Preface,

2. due acknowledgements have been made in the text to all other material used,

3. the thesis is less than 100 000 words in length, exclusive of tables, maps, bibliographies and appendices.

Aleksandr Kan, 12 November 2019

The following is a list of peer-reviewed publications arising from the time of my candidature. Both publications were integrated into the thesis; the published versions are also attached in the appendix.

Kan, A., Gibbs, M., & Ploderer, B. (2013, November). Being chased by zombies!: understanding the experience of mixed reality quests. In *Proceedings of the 25th Australian Computer-Human Interaction Conference: Augmentation, Application, Innovation, Collaboration* (pp. 207-216). ACM.

Kan, A., Ploderer, B., & Gibbs, M. (2014, December). Mixed reality stories: how creative writers integrate virtual and physical realities. In *Proceedings of the 26th Australian Computer-Human Interaction Conference on Designing Futures: the Future of Design* (pp. 115-118). ACM.

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1 INTRODUCTION

1.1 BACKGROUND

Imagine a runner at a university campus. For an observer, she looks like any other runner who listens to music or an audiobook during her workout. And yet, she is different. She is running away from a mysterious monster. She needs to get to a cabin by the lake, where it is safe, or at least safer. She is running through a dark forest, but with that, she is *also* running on campus under bright daylight. The monster roars in the back. She needs to get to the cabin quick. There is no lake on the campus, so she thinks of something that might act as a proxy for the lake—and runs there.

Described above is a snippet of the experience of running with a *mixed reality story* (MRS). These are stories that are explicitly designed to enhance particular activities, such as running in this case, by creating a mixed reality experience for the user.

Mixed reality stories support a broader trend in Human-Computer Interaction research: technology blending in with our everyday lives (McCarthy & Wright, 2004). As computers became smaller, cheaper and, as a result, more pervasive, they moved first from work environments to our homes, and then from desks to our pockets (Benford, Magerkurth, & Ljungstrand, 2005), now moving onto the wrists and other body parts as wearable accessories[1]. And with that, they change the way we do things outside the desks and change our relationships with everyday activities (McGonigal, 2011).

[1] e.g. *Apple Watch*, https://www.apple.com/au/watch/

Mixed reality systems do that by augmenting our physical environments with virtual elements (Benford & Giannachi, 2011). They blend physical and virtual spaces together, merge time and create additional roles for the user to take on (Benford, Giannachi, Koleva, & Rodden, 2009). As a result, it becomes possible to chase virtual runners by actually running through city streets (Benford et al., 2004) or even catch a pokémon at a local park[1].

Yet, mixed reality stories are different from most mixed reality systems developed and studied to date. Instead of using technology to deliver realistic 3D objects or accurately map virtual spaces onto physical ones, MRS employ technology to deliver stories created for specific activities at the exact time when people are doing these activities. These stories, in turn, create the perception of mixed reality.

This thesis is about the user experience of running with mixed reality stories.

1.2 PROBLEM

My personal interest in mixed reality stories started back in 2012 with *Zombies, Run!*[2], a mobile app that provides a post-apocalyptic story for runners to listen to on the go. The app was designed to support physical exercises, which was a direction gaining popularity at the moment due to the growing availability of mobile phones and wearable fitness trackers (Mueller et al., 2011). The approach, however, was different: unlike the other exertion commercial apps and research prototypes *Zombies, Run!* did not try to blend virtual places together with any real-world locations[3], nor was it relying on virtual points and badges to make running feel more rewarding (Deterding, Dixon, Khaled, & Nacke, 2011). It felt different from running with a regular audiobook or a podcast too: *Zombies, Run!* was clearly designed to be experienced during a run and invited the runner to take on a role of a fictional hero on a mission.

Zombies, Run! managed to attract public interest even before it was released, raising more than five times its target goal on Kickstarter over the course of the campaign[4]. This was followed by a successful launch in the Apple iOS App Store[5], leading the app to become the highest grossing app in the Health and Fitness category in the first weeks after its release (Chatfield, 2012). The success was not short-lived: as for the end of

[1] https://www.pokemon.com/us/pokemon-video-games/pokemon-go/
[2] https://zombiesrungame.com/
[3] e.g. *Ingress*, https://www.ingress.com/
[4] https://www.kickstarter.com/projects/sixtostart/zombies-run-a-running-game-and-audio-adventure-for
[5] https://www.apple.com/au/ios/app-store/

2018, more than six years after the iOS release, the story is seven seasons in, and still receiving new missions. The story attracted a prominent fan community, one of the fan fiction authors was even invited to join the writing team for Season 2 (Alderman, 2013). Some famous writers, including Margaret Atwood, contributed their missions (Hon, 2015). The story world of *Zombies, Run!* expanded beyond the main app, spilling into spin-off apps, such as *Zombies, Run! 5k Training*[1] and even a board game[2].

Hence, *Zombies, Run!* was not only different, it was also successful in its approach. Nevertheless, it is still unclear what made *Zombies, Run!* work, and how to design more mixed reality stories like this, for running and for other activities. While there are separate studies of *Zombies, Run!* (e.g. Southerton, 2013; Witkowski, 2013) and similar story-centric mixed realities (e.g. Marshall & Benford, 2011), there is no holistic understanding of the user experience of such mixed reality stories; an understanding that would allow researchers and practitioners design the next generation of mixed reality stories.

1.3 AIM

The problem, which became the starting point for this thesis, is the lack of understanding of the user experience of running with mixed reality stories. Consequently, the aim of the thesis is

to examine how to support the user experience of running with mixed reality stories

By addressing this aim, I intend the thesis to provide a significant contribution in three different ways: on theoretical, practical, and research design levels.

On a theoretical level, an expected impact of this thesis will be to develop a holistic understanding of the user experience of running with mixed reality stories, and in doing so extend the growing number of work on the user experience with mixed realities.

On a practical level, an expected impact of this thesis will be to offer practical insights for researchers and practitioners to use when creating their own mixed reality stories.

[1] https://itunes.apple.com/au/app/zombies-run!-5k-training/id566596422
[2] http://www.zombiesrunboardgame.com/

Finally, on a research design level, an expected impact of this thesis will be to advance the techniques of mixed reality stories analysis for the purposes of Human-Computer Interaction research (as opposed to the purposes of theatrical or performance studies).

1.4 SCOPE

While *Zombies, Run!* is the most prominent and the most successful example of a mixed reality story, the format of a story-centric mixed reality does not have to be limited to audio-only stories, nor does it have to be limited to running. Yet, studying the user experience of a whole variety of mixed reality stories designed for a range of different activities would be unfeasible. Thus, it was essential to constrain the research scope. The scope of this thesis is limited in two ways.

First, **this thesis focuses on the experience of solo outdoor running**. As mentioned before, technology affects more and more aspects of our everyday lives (McCarthy & Wright, 2004), and thus mixed reality stories have the potential to meaningfully support different kinds of activities beyond running, such as learning a new language or doing household chores.

Still, running provides a convenient starting point for the research of mixed reality stories. Running is cheap and accessible: it does not require extensive training or expensive equipment. Furthermore, focusing the thesis on outdoor running would allow studying the effects of MRS in relation to a variety of physical environments; this aspect could be lost, for instance, with focusing on a household activity.

I also decided to focus on solo running. This decision went against an opposite trend in exertion games research focusing on encouraging sociality, mainly because of its potential benefits for mental health and overall wellbeing (Mueller, Agamanolis, & Picard, 2003). Nevertheless, the experience of running alone is significantly different from running with someone, which in turn is different from the experience of running in a group. Essentially, those are three different activities that come with different design requirements. Hence, it seemed reasonable to first focus on solo runs and suggest expanding onto social runs in future research projects.

In a similar vein, I focus on the running experience itself, rather than its potential health benefits. While I still plan to discuss health benefits—if they are mentioned by the participants in relation to their experience with running—the exact number of calories burnt, or kilometres covered is outside the primary interest of this project.

Second, **this thesis focuses on fictional mixed reality stories of a particular format**. By the time this thesis started, *Zombies, Run!* had already achieved its initial success. Nevertheless, it is important to note that even though *Zombies, Run!* is the most commercially successful and popular MRS to date, its format is not necessarily the most

effective for supporting running: a more effective format might simply not have been available to the runners yet. Moreover, it might be the case that different MRS formats work best for different runners.

Still, I argue that *Zombies, Run!* provided a valuable opportunity to do an initial exploration of the MRS experience with a commercially successful case, rather than a research prototype. Thus, I decided to focus on *Zombies, Run!* and other mixed reality stories of a similar format, and then compare findings in order to analyse the similarities and differences. This would also allow me to focus on comparing different stories rather than comparing different stories and different story formats simultaneously. Moreover, this backed up my decision to focus solely on running: a mixed reality story for any other activity would be different from *Zombies, Run!* in both story and activity, and thus would have made comparisons more complicated.

While limiting the scope in such ways was necessary, I still hope the insights generated by the thesis are going to be useful to designers and practitioners of MRS beyond this particular format, as well as MRS designed for other activities than running.

1.5 OVERVIEW OF THE THESIS

1. Introduction

This chapter presented the problem that motivated this thesis and set an aim, addressing this problem: *to examine how to support the user experience of running with mixed reality stories*. After that, this chapter identified the boundaries of the thesis; limiting the scope to focusing on the experience of solo outdoor running on one side, and to focusing on fictional mixed reality stories of a format similar to *Zombies, Run!* on the other.

2. Literature Review

Chapter 2 introduces the main literature relevant to the thesis. It starts with breaking down the project aim into five research branches: mixed realities, running, stories, user experience and mixed reality stories. Literature in each direction is reviewed in its relation to Human-Computer Interaction (HCI). Chapter 2 then identifies the gaps in the current literature. Chapter 2 also introduces the main research question for the thesis: *How can the user experience of running with mixed reality stories be supported?*

3. Research Design

Chapter 3 starts with breaking down the main research question into three sub-questions, each designed to guide its own study:

RQ1: What is the current user experience of running with mixed reality stories?

RQ2: How do storytellers address the user experience of running when writing mixed reality stories?

RQ3: How do runners perceive mixed reality stories while running?

This chapter situates the thesis in the field of existing HCI research and consequently aligns the project with constructivist epistemology and interpretivist theoretical perspective. The chapter then justifies the choice of the grounded theory methodology, and the use of particular methods for data collection and analysis. Chapter 3 concludes with an overview of all three studies.

4, 5, 6. Studies

The next three chapters are dedicated to the three studies accordingly, and are structured in a similar manner to each other. Each chapter starts with a corresponding research sub-question, which in turn establishes the objectives of each study. Then each chapter outlines the design for the studies, describing the process of preparations and participant recruitment for the study, as well as data collection, and data analysis stages. Next, the chapters introduce the findings that emerge from each study. This is followed by the discussion section that situates the findings within the existing literature. The following section acknowledges the limitations of each study. The final section briefly summarises the most important findings of each study.

Chapter 4 'Exploring the Experience of Running with Mixed Reality Stories' describes a study of the current experience of running with commercially successful mixed reality story *Zombies, Run!*. This study involves 11 runners using the MRS for three weeks. Each runner was interviewed before and after the trial period. They were also asked to keep a brief audio diary after each run reporting on their experience in the moment. The main findings of the study describe how the running and the story form the overall user experience of MRS, and how runners use voluntary engagement to balance different aspects of the experience. Moreover, they suggest that some aspects of MRS beyond the story itself might also contribute to the overall experience. Finally, the findings indicate that MRS format is different from both traditional audio-stories, and from other mixed reality systems.

Chapter 5 'Creating Mixed Reality Stories for Running' describes a study of the writers' process behind the creation of three new MRS. Workshops for writers, as well as two follow-up discussions, were organised for the writers in order to gain insight into the creative process of writing stories for running. The scripts that emerge from this study were also analysed. The findings from Study 2 provided insight on how writers deal with the specifics of MRS format, and how they repurpose the familiar story mechanics for running.

Chapter 6 ‘Understanding the Perception of Mixed Reality Stories’ describes a study of runners’ perception of the mixed reality stories created during Study 2. In this study, 36 runners had 45 runs with three mixed reality stories created during Study 2. As with Study 1, semi-structured open-ended interviews were organised with participants after their runs. This study introduces four stages of story perception and demonstrates how runners alter their workouts by engaging voluntarily. Study 3 also validates, clarifies, connects, and extends findings from Study 1 and Study 2.

7. Discussion

Chapter 7 integrates the findings from the three studies together and ties them back to the literature reviewed earlier in Chapter 2. Overall, this thesis clarifies the format of mixed reality stories designed for running and suggests that its experience is different from running with audiobooks or running in mixed reality performances. It also deconstructs three most significant aspects that constitute the user experience of MRS: running, story and MRS elements outside the story. The chapter then describes the main limitations of the project, the practical implications of this thesis, and suggestions for future work. It concludes with a summary of the main contributions of this thesis.

8. Conclusion

Finally, Chapter 8 brings the thesis to a conclusion.

2 LITERATURE REVIEW



2.1 Structure of Literature Review

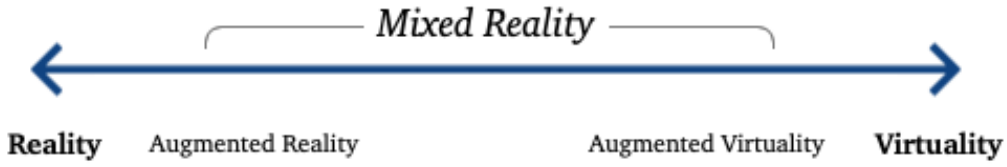
The previous chapter defined the aim of this project. This chapter provides an overview of the literature that is relevant to the purpose of reaching the aim. The chapter breaks down the aim into five topics (Figure

2.1): mixed realities (2.1), running (2.2), stories (2.3), user experience (2.4) and mixed reality stories (2.5). The concluding section of the chapter summarises the gaps identified in the literature and proposes the research question to guide the thesis (2.6).

2.1 MIXED REALITIES

2.1.1 Definitions

A little more than two decades ago Milgram & Kishino (1994) presented 'virtuality continuum'. By that time both virtual and augmented realities were established as research fields, and thus grew a need for a clarification of the relationship between the two notions. Milgram & Kishino (1994) noted that the term 'virtual reality' is often used in regards to the environments that are not designed to immerse a person in a virtual world entirely, and proposed a taxonomy based on virtuality continuum to clarify the differences (Figure 2.2).



2.2 Virtuality Continuum[1]

On one end of the continuum lies the real environment, free from any digital augmentation, and on the other end rests pure virtuality: an artificially created world, that can exceed the bounds of physical reality and redefine 'the physical laws ordinarily governing space, time, mechanics, material properties, etc' (Milgram & Kishino, 1994). Between the two extremes is the area of *mixed reality*, which consists of two halves: *augmented reality* and *augmented virtuality*.

In the original paper, Milgram & Kishino (1994) already noted that in the future the distinction between 'augmented reality' and 'augmented virtuality' can become blurry, as technology advances and it will become harder to separate between virtually-augmented realities and reality-augmented virtualities. Mixed reality thus was meant to become the primary term to describe the area of the virtuality continuum between the real and the virtual.

This issue of distinguishing between augmented reality and augmented virtuality has never come to be though, as the term 'augmented virtuality' did not gain prominence in the future research literature. The term augmented reality—which was coined two years prior to Milgram & Kishino's virtual continuum paper (1994) by Caudell & Mizell (1992)—however, did take off, and to this day is widely used alongside with 'mixed reality'.

[1] Redrawn from Milgram & Kishino, 1994.

In addition to ‘augmented reality’ and ‘mixed reality’, game studies also use the term *pervasive games* to describe the blending of physical and virtual elements in games. Pervasive games are often meant to be played outdoors via wireless mobile devices (Benford et al., 2005). Thus, in game studies ‘mixed reality’, ‘augmented reality’ and ‘pervasive’ can refer to the same kind of games, with ‘mixed reality’ and ‘augmented reality’ being overarching synonymous descriptors, and ‘pervasive’ referring to a specific subset of mixed/augmented reality games.

Adding to the number of similar notions from the game studies literature, there are also *alternate reality games*. As Milgram & Kishino (1994) mentioned, it is possible to create virtual worlds that work differently than our physical world.

Alternate reality games toy with that idea by blending physical and fictional worlds. There are no limitations to how the fictional world can manifest itself. Sean Stewart, one of the practitioners, who make alternate reality games, says: ‘the story is not bound by medium or platform: we use text, video, audio, flash, print ads, billboards, phone calls, and e-mail to deliver parts of the plot’ (2008).

While alternate reality games is relatively new and still evolving form (Kim, Lee, Thomas, & Dombrowski, 2009), a prominent game researcher and practitioner McGonigal noted a certain trend happening with alternate reality games, which is using fictional worlds for enhancing the existing experiences in the physical world (2011, pp. 124–126). As a prominent example, she describes *Chore Wars*: an alternate reality game that aims to make doing chores around the house more fun and even competitive (McGonigal, 2011, p. 119).

Furthermore, there is the case of the far end of the virtuality continuum: fully virtual reality. Milgram & Kishino (1994) write that virtual reality environment ‘is one in which the participant-observer is totally immersed in, and able to interact with, a completely synthetic world’. At the moment Milgram & Kishino (1994) defined—referring to the Oxford English Dictionary—real objects as ‘any objects that have an actual objective existence’ and virtual objects as ‘objects that exist in essence or effect, but not formally or actually’.

Nevertheless, today the discussion on mixed realities expanded from focusing on visual objects to experiences. Consider for instance sounds in virtual reality games: are those sounds real since sounds waves exist objectively or are those virtual since they exist on the virtual reality end of the continuum? Or think of a player wearing a virtual reality helmet: if the said player falls in their living room while trying to jump, the consequences of that falling will be real, even if the game exists entirely in the virtual reality. Moreover, what if the player feels hungry while being immersed in a virtual world, would that experience be real or virtual?

Thus, I argue that the 'virtual reality' end of the continuum is actually unreachable, leaving all practical research in the area of mixed reality[1]. As Weiser (1993) put it: '[Virtual reality] has the goal of fooling the user—of leaving the everyday physical world behind. This is at odds with the goal of better integrating the computer into human activities since humans are of and in the everyday world'.

The examples above reveal the increasing complexity of the relationships between physical and virtual. Benford & Giannachi write that 'mixed reality performances may simultaneously occupy multiple points along this continuum by combining many real, virtual, augmented reality, and augmented virtuality environments into complex hybrid and distributed performance stages' (2011, p. 3), while also pointing out that Milgram & Kishino's (1994) original concept of virtuality continuum does not easily accommodate for such stages, 'nor does it sufficiently describe the complex relationships between virtual and real'.

In fact, Milgram & Kishino (1994) foresaw themselves the possible shortcoming and suggested that going forward, the term *hybrid reality* might be useful 'as a way of encompassing the concept of blending many types of distinct display media.'

In the end, mixed reality, augmented reality, augmented virtuality, virtual reality (that is still not quite virtual, as it turned out), alternate reality, hybrid reality all revolve around one idea: a vision, best described by Weiser (1991) in his seminal essay 'The Computer for the Twenty-First Century'. There Weiser imagines a world, in which computers become invisible and pervasive; they just disappear in the environment, 'weave themselves into the fabric of everyday life until they are indistinguishable from it'. Thus, our day-to-day reality becomes mixed.

While in some cases it might be useful to distinguish between all of the terms mentioned in this section, for the purposes of this thesis I will predominantly use 'mixed reality' unless directly quoting from the works of others. Yet, I hope, this section demonstrates that while I focus on just one of the terms, the inspiration and insights come from a broad range of interconnected research strands, many of which do not employ the term 'mixed reality', while describing virtually the same notion.

2.1.2 Audio-Centric Mixed Realities

In mixed realities, the physical environment blends together with the virtual environment. Typically, the two environments blend via visual displays, e.g. a mobile phone overlaying digital information over an image of the physical world. This approach is so commonplace, it has become part of the definition for many researchers working in

[1] Due to that reason, I avoid using 'real' in opposition to 'virtual' in this thesis (with the exception for direct quotes), using instead 'physical — virtual' dichotomy.

the area, e.g. ‘We define Augmented Reality (AR) as a real-time direct or indirect view of a physical real-world environment that has been enhanced/augmented by adding virtual computer-generated information to it.’ (Furht, 2011, p. 3). While Milgram & Kishino (1994) and Azuma (1997) note that different types of mixed realities exist, and that they can include, for instance, sounds, both of them also focus on virtual images and graphic displays in their descriptions of how physical and virtual come together.

Yet, mixed realities are not limited to visual displays, and for the mixed reality designers there are two main reasons to go beyond them. First, employment of other inputs, such as sounds or tactile sensations, can be used to strengthen immersion and make mixed reality feel more believable (Billinghurst, Clark, Lee, & others, 2015). Second, it allows the creation of more complex and rich experiences. Benford & Giannachi (2011) bring up an example from Gold to demonstrate what it can work like: ‘baby doll (or toy block) might look like a familiar remnant of childhood, but it is really only one of a thousand distributed nodes which control the functioning of the whole house’ (p. 6).

Among the other major ways to create a blended environment is the use of audio. Mixed reality researchers generally refer to audio as a way of supporting visual props, for instance: ‘a wiring schematic might be projected onto see-through goggles, aligned (via head position sensor) with the physical cable ducts, allowing a technician to easily lay wires. Augmented audio reality extends this notion to include sonic effects, overlaying computer-generated sounds on top of more directly acquired audio signals’ (Cohen, Aoki, & Koizumi, 1993). Härmä et al. (2004) add that the experience of audio in mixed realities is subjective and that the criteria for a perfect augmentation should base on the user’s personal judgment of whether they are able to identify if the sound source is part of the virtual environment or not. As Härmä et al. note themselves, this test ‘is closely related to the classical Turing test for artificial intelligence’ (Turing, 1950).

There are three main applications behind audio-centric mixed reality research.

The first one is accessibility since audio provides an opportunity for people with visual impairment people to experience mixed realities (Ekman, 2007). This area explored particularly well in the domain of audio-games (IDGA, 2004). Ekman (2007) and Liljedahlm, Papworth and Lindberg (2007), however, call for more research of audio-centred mixed-realities for players without visual impairment, as these kinds of environments potentially provide benefits and interesting experiences for a much larger audience, most importantly they are much safer for casual outdoor use as they do not require looking at the screen, thus freeing the sight and providing more freedom of movement. Liljedahl et al. (2007) demonstrate that such audio-centred mixed realities are still capable of ‘giving a rich and full-blown gaming experience’.

The second application is audio-guides in general, and museum guides in particular. While the regular audio-guides are common, they also come with a number of inconveniences and most worryingly can interfere with social interactions for visitors group by secluding visitors into personal ‘audio bubbles’. Thus, researchers are interested in providing more control and creating audio-guides that mix into the natural audio

environment, instead of replacing it (Aoki et al., 2002; Eckel, 2001; Kusunoki, Satoh, Mizoguchi, & Inagaki, 2007).

A third application is the case of augmenting the city sounds with a portable audio-playing device. The portable audio ascent started with the introduction of Sony Walkman[1] in 1979, a now classical cassette player that paved the way for mobile digital audio-playing devices, such as iPod[2] in 2001 and iPhone[3] in 2007 (Van Krevelen & Poelman, 2007). Bull (2000) calls Sony Walkman the first genuinely mobile consumer technology and points out that the player did for urban spacings what radio did to home spacings before. Portability, the revolutionary quality of the device, allowed the creation of a mixed urban audio-environment, in which the listeners experience both the pre-chosen audio and uncontrollable city sounds while establishing connections between the two (Du Gay et al., 2013). The control over personal audio turns thus into a way to control the personal relationship with the urban environment (Thibaud, 2003).

While these applications are promising, the use of audio for the creation of mixed realities is still mostly unexplored and rare (Chatzidimitris, Gavalas, & Michael, 2016; Higa, Nishiura, Kimura, Shibata, & Tamura, 2007). To date, the topic remains a potentially fruitful direction for mixed reality research since it allows for the creation of mixed reality systems that are easier and cheaper to implement, and that do not create a visual distraction.

2.1.3 Research Agenda

The first mixed reality systems started to appear in the late 1960s (Sutherland, 1968), yet to date, the research on mixed reality systems has focused predominantly on technological aspects with little consideration for people's experiences with such systems (e.g. Azuma et al., 2001). For the bigger part of its research history, mixed reality (and similar concepts) were defined and seen through the technological lens.

Consider, for instance, the definition Milgram & Kishino (1994) used for augmented reality, which already has 'computer graphic objects' incorporated: 'any case in which an otherwise real environment is "augmented" by means of virtual (computer graphic) objects'; or this definition from Furht, also referring specifically to computer-generated images: 'Augmented Reality (AR) refers to a live view of physical real world environment whose elements are merged with augmented computer-generated images creating a mixed reality' (2011, p. vii). Or this definition from a survey of mobile augmented reality systems that treats 'dynamic 3D objects' as essential:

[1] https://en.wikipedia.org/wiki/walkman
[2] https://en.wikipedia.org/wiki/ipod
[3] https://www.apple.com/au/iphone/

We define a mobile AR system as the one which:

- Combines real and virtual objects in a real environment;
- Runs in real-time and mobile mode;
- Registers (aligns) real and virtual objects with each other;
- The virtual augmentation is based on dynamic, 3D objects (e.g. interactive, deformable virtual characters) (Papagiannakis, Singh, & Magnenat-Thalmann, 2008).

Steuer warns against such a technology-centric approach, as it limits our understanding of what mixed reality can be like, thus capping the creative potential of mixed reality designers (Steuer, 1992, p. 75). Instead, Steuer suggests to define mixed reality in terms of human experiences, and for him the gateway to do that is the notion of presence, which he defines as 'the sense of being in an environment' and the notion of telepresence, which he defines as 'the extent to which one feels present in the mediated environment, rather than in the immediate physical environment' (Steuer, 1992, p. 75). Thus, the goal of mixed reality is to create the experience of telepresence, and that definition deliberately omits any mention of technological particulars.

Still, most research on mixed realities is focused on technology rather than human experiences (Azuma et al., 2001; Azuma, 1997; Billinghurst et al., 2015). In 2008 Zhou, Duh, & Billinghurst meta-reviewed ten years of prior research presented at the International Symposium on Mixed and Augmented Reality (ISMAR and earlier IWAR), International Symposium on Mixed Reality (ISMR) and International Symposium on Augmented Reality (ISAR) conferences, the premier conferences in the field of that time (2008). Zhou et al. found that more than three-quarters of works are dedicated to one of the top five research areas:

1. Tracking techniques (20.1%, i.e. 63/313);
2. Interaction techniques (14.7%);
3. Calibration and registration (14.1%);
4. AR applications (14.4%);
5. Display techniques (11.8%).

When research literature mentions human factors, it mainly happens in the context of people's biological and psychological limitations that can break the illusion of immersion in a mixed environment (Drascic & Milgram, 1996). Such limitations include, for instance, latency, depth perception, adaptation, fatigue, eye strain and so forth (Azuma et al., 2001): mismatches of different kind break the illusion of a blended environment.

Another frontier of human issues used to be social acceptability (Furht, 2011) since using mixed reality outdoors required people carrying a computer with them at times where computers were bulky and uncommon. This issue has not entirely gone away

today, yet became less prominent as computers become both increasingly mobile and widespread. In metropolitan areas, it is not uncommon now to see people absorbed by their mobile devices.

In 2005 Swan & Gabbard surveyed twelve years of work on augmented reality, virtual reality and wearable computers. Their survey showed that out of 266 papers just 38 were concerned with at least some aspect of Human-Computer Interaction (HCI), and just 21 described a formal user study (overall that is less than 8% of paper). Similarly, later meta-review by Dünser, Grasset and Billinghurst (2008) revealed that the situation had not changed much with just estimated 10% of works that featured user evaluation in one form or another.

It is no wonder that the previous body of work is so heavily focused on technological aspects of mixed realities. The creation of augmented and virtual environments still requires a considerable amount of computational power, and research is required for both optimisation of old and testing the new ways of creating those environments (Van Krevelen & Poelman, 2007).

Nevertheless, the research focus has been shifting for the last decades, and the current trajectory suggests it is moving from being technology-centric towards understanding human experiences with the technology. Billinghurst et al. (2015) identify four phases of mixed reality research:

> 1. Pre-80's: Experimentation: Early experimentation that help define the concept of Augmented Reality and show the types of technology require;
>
> 2. 1980's…mid-90's: Basic Research: Research into enabling technologies such as tracking, displays, and input devices;
>
> 3. mid-1990's…2007: Tools/Applications: Using AR enabling technologies to develop early applied and explore interaction techniques, usability, and design theory;
>
> 4. 2007…present day: Commercial Applications: Widespread AR available in a number of application areas such as gaming, medicine, mobile and marketing.

Benford & Giannachi note that mixed reality experiences not only become more widespread, yet also more complex in both their construction and in what aspects of our lives they aim to augment (Benford & Giannachi, 2011). Hence, their main point of criticism of Milgram & Kishino's (1994) original taxonomy is that it does not consider these complex mixed reality experiences that can simultaneously occupy several points on the spectrum.

These complex experiences are also highly subjective, as the aim of mixed reality systems is to create the feeling of presence in the augmented world (Steuer, 1992, p. 75), and it is impossible for mixed reality designers to account for all the individual subjective

perspectives (Billinghurst et al., 2015). Benford & Giannachi also note that the growing complexity of mixed reality systems brings more aspects of people's personal lives into the experience, which increases the subjectivity (2011, p. 4). Moreover, Zhou et al. (Zhou et al., 2008) note that this complex subjective experience is bound to create an emotional response, yet still, little work has been done towards understanding the emotional aspects of user experience.

Billinghurst et al. (2015) suggest that one of the reasons these complex subjective experiences have not been extensively studied is that little is known yet in regards to how to effectively evaluate mixed reality experiences, 'how to properly design experiments, choose the appropriate methods, apply empirical methods, and analyse the results'. The same reasoning was driving Benford et al. (2009) in their research of mixed reality performances, one of the first extensive research on hybrid experiences people have with mixed reality.

2.2 RUNNING

Running has been of interest to HCI researchers for a long time due to its potential health benefits and accessibility relative to other physical activities that might require learning a set of rules or purchasing special equipment. Nevertheless, there are still many essential aspects of the running experience that have been not been explored in the current discourse within HCI. Thus, this section is split into two parts. The first subsection unpacks two main reasons why running is currently interesting to HCI research: the sense of well-being and the use of running as a natural interface. The subsection also warns about potential safety implications. The second subsection focuses on the aspects of the running experience that seem underexplored to date, and provides examples of how some of the similar aspects are covered outside HCI.

2.2.1 Running in the existing HCI Literature

Running for Health and Well-Being

Importance of Physical Exercise

Regular physical exercise is vital. It not only comes with expected benefits for physical health (Weinberg & Gould, 2014), but also it provides a number of benefits for mental health, such as improving learning and cognitive performance (Cotman & Berchtold, 2002; Hillman, Erickson, & Kramer, 2008). Studies also reveal that exercising together can facilitate new and strengthen existing social relationships among the participants (O'Brien & Mueller, 2007; Ratey & Hagerman, 2008; Weinberg & Gould, 2014), which in turn also contributes to overall well-being (Mueller et al., 2003). These benefits are

shown to persist in older age as well (Chakravarty, Hubert, Lingala, & Fries, 2008), making physical exercising important for people of all ages.

Not only exercising is beneficial, but also the lack of physical activity is also detrimental to health. For instance, the sedentary lifestyle is one of the primary causes of obesity, especially in children (Hillman et al., 2008). Research shows that obesity is a growing issue, particularly in the developed countries (Hersey & Jordan, 2007). As of 2015, the prevalence of overweight was 16.4% for Australian children and 21.9% for adolescents; the prevalence of obesity was 7% for children and 17.2 for adolescents (Hardy et al., 2017).

Some argue that technology is partly to blame for the decline in physical exercise (Epstein et al., 2008; Hillman et al., 2008). Most of the time that previous generations of kids were spending on physical activity is now spent sedentary, in front of television or computer screen: watching shows, browsing the internet or playing video games (Rideout, Foehr, & Roberts, 2010). Nevertheless, technology, and video games in particular, can also provide a possible solution for addressing the lack of physical activity (Pasch, Bianchi-Berthouze, van Dijk, & Nijholt, 2009).

The emergence of various activity trackers, such as Apple Watch or FitBit[1], is an example of how technology can promote physical activity. This approach has proven to be beneficial for many wearers of such trackers, even after years of use (Fritz, Huang, Murphy, & Zimmermann, 2014).

Exertion Interfaces

Activity trackers, however, only provide data about the physical activity, along with some limited motivation, in the form of reminders or digital achievement badges, that in reality might not be that successful at motivating (Juul, 2011; Munson & Consolvo, 2012). While some users are drawn to these devices just because they love new gadgets (Rooksby, Rost, Morrison, & Chalmers, 2014), for many others those features might not be enough to encourage to exercise. Thus, some researchers and practitioners wonder if augmenting the activity itself with technology might bring more people on board.

HCI and game researcher Florian 'Floyd' Mueller is one of the most prominent explorers of this approach. He notes that while designers usually aim to decrease the amount of physical effort required for the use of technology, there is a trend in the opposite direction, mainly for promoting health and well-being (Mueller et al., 2003). Such interfaces that 'deliberately require physical effort' Mueller et al. (2003) call *exertion interfaces*. Mueller (Mueller et al., 2011) focuses specifically on games as he sees them as 'buoyant genre for exertion systems'.

Sinclair, Hingston & Masek (2007) highlight three significant types of exertion interfaces used in commercial digital games: exercise bikes, foot operated pedals and motion

[1] https://www.fitbit.com/

sensors. Moreover, in ten years since Sinclair's review yet another major platform emerged, which is internet-connected mobile phones that allow taking exertion games out from the home to the streets and public places (Viana, Viana, Trinta, & de Carvalho, 2014).

While the first exertion games date back to the 1980s, it is only in the 2000s, with the appearance of more accurate and compact motion sensors, that exertion games established themselves as a distinct research branch. The primary motivation behind the research is the concern over the rising rates of obesity (Sinclair et al., 2007): as physical exercise is proven to be the most effective way to avert obesity (Ross et al., 2004), researchers explore how technology could encourage physical activity instead of increasing sedentary time (Consolvo, Everitt, Smith, & Landay, 2006).

Exertion games differ in their approach to promoting physical exercise. Mueller, for instance, often finds inspiration in existing sports games, such as table tennis or boxing and then modifies the games with technology, creating sports-like games that would be not previously possible, such as table tennis for three players, with each of them playing at a separate table (Mueller, Gibbs, & Vetere, 2009). Consolvo et al. (2006) advise not only to provide isolated high-intensity exertion bursts, yet also to encourage 'opportunistic physical activities', such as taking stairs instead of a lift or making a detour to walk more. Following a similar goal, Lin, Mamykina, Lindtner, Delajoux, & Strub (2006) created an exertion game Fish'n'Steps, which encourages players to take more steps by linking the overall count to the growth of a virtual fish. Studies demonstrate that such exertion games can indeed lead to increased physical activity, at least in the short-term (Mueller et al., 2011; Sinclair et al., 2007).

Running is part of the broader trend of encouraging physical activity for health and well-being. As an aerobic exercise, regular running can provide the physical, cognitive and social benefits. On top of that, running has some advantages over other exercises, such as swimming or playing sports. Running not only has some unique benefits for health that cannot be achieved with other types of exercising (Williams, 2012), it also does not require special skills, dedicated field or expensive equipment; some would argue that even running shoes are optional (McDougall, 2016).

Thus, it is no surprise that researchers employ running for various exertion games. For instance, in one of the most prominent examples, *Jogging over a Distance* Mueller et al. (2010) yet again investigate an opportunity to connect geographically separated players, in this case, runners from Australia and Europe, by letting them hear and communicate with each other on the run via headset. In addition to that, *Jogging over a Distance* allows runners of different fitness levels to play together by using their target heart rates (that can be different for each runner) to calculate whether one is 'ahead' or 'behind'. If, for instance, one runner achieved their target goal, while the other has not, the first runner would hear the second one as if they are behind, regardless of their actual physical position. Such system makes it possible to run together for people who could not do that before either due to geographical distance or difference in physical capabilities.

Running as a Natural Interface

Health benefits is the most substantial reason why HCI researchers employ running for their studies, yet there is also another main reason, which is to explore new ways of interacting with computers and possible novel experiences that it creates.

As computers get smaller and cheaper, they also get become ubiquitous: computers assume radically different shapes, take on new roles, and more objects in our lives become computerised (Weiser, 1991). With that, new ways of interacting with computers are needed, especially since the recent technological advancements also open up many new opportunities for experimentation.

The exploration of how we can interact with computers is, of course, as old as computers themselves. The mainstream user interface evolved from punch cards in the early beginning, to a command line in the 1950s, to a graphical user interface (GUI) in the 1960s, to a natural user interface now (Liu, 2010). *Natural User Interface* (NUI) marks the shift away from specialised devices for interaction, such as keyboards, mice or gamepads towards the focus on natural human capabilities, such as touch, voice, facial expressions and motion (Liu, 2010). This shift can potentially make computers accessible to even more people, while also providing new capabilities and use-cases (Wigdor & Wixon, 2011, p. 5).

Video games provide a particularly fruitful ground for this kind of research. One of the early examples of interface 'naturalisation' in video games is *Dance Dance Revolution*[1], a dance game that invited players to dance with their whole bodies on a special mat. Then came *Nintendo Wii*[2], that introduced a controller that allowed gamers to play with their natural arm swings and punches in a variety of games, such as tennis, bowling and boxing. Finally, *Microsoft Kinect*[3] took the trend one step further, removing the requirement for a dedicated controller with a system that tracks full player's body movement real-time. As Kinect's marketing slogan put it: 'You are the controller'.

Again, running and walking are part of a larger research trend, focusing on body-centric design and interaction (Dourish, 2004; Klemmer, Hartmann, & Takayama, 2006). This part is essential to NUI studies since people across the world are already using technology while walking and running; thus, there is a need to understand better how we can enhance these interactions (Marshall & Tennent, 2013). For instance, for people running with cassette players it was impossible to swap cassettes on the go; then, with digital MP3 players, runners could switch playlists but had to interrupt the workout in

[1] https://en.wikipedia.org/wiki/dance_dance_revolution
[2] https://en.wikipedia.org/wiki/wii
[3] https://en.wikipedia.org/wiki/kinect

order to do that; today runners can change to a different playlist with just a voice command, without disrupting their activity.

Another direction is the use of moving from place to place itself as a control. This approach is adopted in a number of location-based games, such as *1831 Riot* (Reid, Hull, Cater, & Clayton, 2004) that required players to move within a particular area to discover different parts of an audio-play, based on actual riots that happened there. Or as *Pacmanhattan*[1], which let runners (dressed as Pac-Man) to collect virtual 'dots'; in this scenario, running does not merely unlock new content but also changes the outcome of the game.

Bianchi-Berthouze, Kim, & Patel (2007) report a significant correlation between active physical movement and higher levels of engagement. Merely replacing traditional controls in an existing digital game can drastically change the experience (Berkovsky, Freyne, & Coombe, 2012). This does not mean, however, that natural body-centric interfaces are always superior. Wigdor and Wixon (2011) warn that the very descriptor *natural* can be misleading by creating an impression that any system, which employs body movement or voice control, would instantly be experienced as more natural than a system that requires mouse and keyboard. Nevertheless, natural user interface is not just any interface that uses natural input, but rather an interface 'that makes user act and feel like a natural' (Wigdor & Wixon, 2011, p. 14). In addition, Norman (2010) reminds that gestural interfaces have been around for a long while, with first descriptions of such interfaces dating back to 1960s. Still, to this date, gestural interfaces did not replace all other forms of interaction with the computer, all because they too can be prone to mistakes, confusing, and simply inconvenient in many situations.

Safety Considerations

Regardless of the reasons to employ the activity, any involvement of outdoor running requires a careful consideration of potential safety issues.

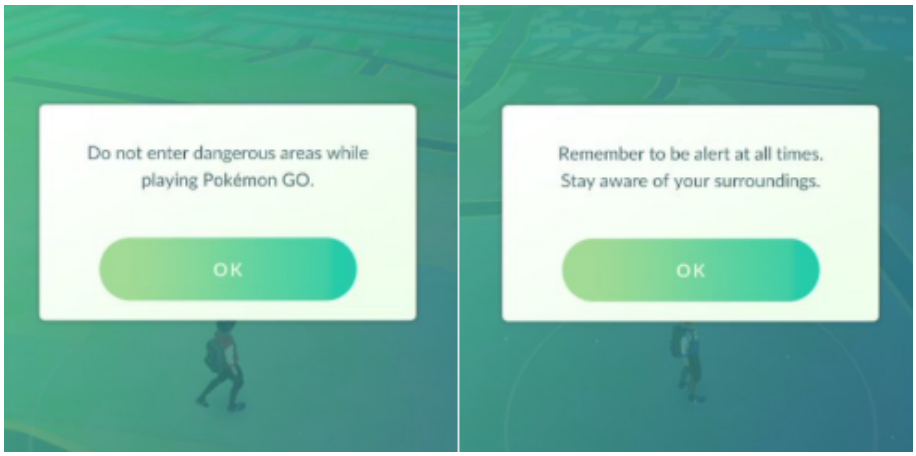
First, there are threats inherent to any exertion activity, such as overexercising and higher risks of injury (Mueller et al., 2011). Second, there are threats related to running as an outdoor activity: in urban areas runners often have to navigate around traffic; at night time there is a high risk of tripping over or accidental trespassing (Ballagas, Kuntze, & Walz, 2008). Finally, there are social risks as well: for instance, some people are conscious about how they run and do not want to be seen, especially by acquaintances or colleagues (Marshall, Benford, Pijnappel, & others, 2016).

Generally, technology for outdoor running use sounds for delivering information to the user: this way runner does not have to look at the screen while on the go (e.g. Ekman, 2007). Yet the use of audio can be problematic too. Loud music can obstruct some

[1] http://www.pacmanhattan.com/about.php

critical urban sounds, such as car signals or bystanders warning about some danger. Runners can also mistake realistic artificial sounds for actual urban sounds and vice versa (Chatzidimitris et al., 2016; Härmä et al., 2004). On top of that, running by itself is an intense activity and listening to something while running might make the runner inattentive to what is happening around (Marshall & Benford, 2011). Marshall & Tennent (2013) also argue that mobile interfaces traditionally designed for 'stop-to-interact' model, which does not reflect that people today increasingly use their devices while involved in other activities, including running. The 'stop-to-interact' model comes with cost at convenience and safety, and needs to be thoughtfully reconsidered.

On the 6th of July 2016, Niantic released a mixed reality game *Pokémon Go*. In less than a week, reports of people being injured while playing the game started to appear. People allegedly broke collar bones, sprained ankles (de Graaf, 2016) and were also lured into unsafe locations (Yuhas, 2016). Later, a special website appeared, dedicated to counting *Pokémon Go*-related injuries and deaths around the world[1] (At least '17 deaths and 56 injuries' as of December 2018). In the forthcoming updates, *Pokémon Go* included more safety warnings into the game (e.g. Figure 2.3), yet has not modified the actual gameplay for increased safety. With *Pokémon Go* being mainly a mainly walking game, it is not unreasonable to assume that at that scale a running game would possess even higher risk.



2.3 Safety warnings in *Pokémon Go*

[1] http://pokemongodeathtracker.com/

2.2.2 Complexity of the Running Experience

Personal Experiences with Running

Previous subsections briefly described the current uses for running in HCI. Running, however, by itself can be a deep and meaningful experience. Still, the review of running literature in HCI reveals that running is often treated as a monolith universal activity. There is a distinction between performance and amateur runners, and there is an acknowledgement that running can be a social experience; yet little discussion in the current HCI literature goes beyond that. In this subsection, I cover some insights from a number of essays and books written by runners, along with the interviews conducted with runners. Hopefully, that would help to highlight some of the aspects of running experience that might be overlooked in the current research.

Age

An internationally acclaimed writer and an experienced runner himself Haruki Murakami (2009) begins his book on running with a reflection on his age. Murakami is a performance runner, meaning that he tracks and aims to improve certain aspects of his running (when he started writing the book, the main goal was increasing the distance of his workouts):

> Running day after day, piling up the races, bit-by-bit I raise the bar, and by clearing each level I elevate myself. At least that's why I've put in the effort day after day: to raise my own level. I'm no great runner, by any means. I'm at an ordinary—or perhaps more like mediocre—level. But that's not the point. The point is whether or not I improved over yesterday. In long-distance running the only opponent you have to beat is yourself, the way you used to be. (pp. 9, 10)

Murakami knows, however, that while his performance may improve compared to the previous day, he might never be able to achieve his all-time best again:

> My peak as a runner came in my late forties. […] Things continued at that stable plateau for a while, but before long they started to change. I'd train as much as before but found it increasingly hard to break three hours and forty minutes. […] Frankly, this was a bit of a shock. What was going on here? I didn't think it was because I was aging. In everyday life I never felt like I was… (p.11)

Guttman (2001) notes that reaching the peak can be particularly severe for athletes, even goes as far as calling the experience a 'metaphoric death'. While many aspects of our ageing are elusive or subjective, running performance is objective and certain. This might be particularly hard to deal with for people with a prominent 'runner's identity'. Murakami (Murakami, 2009), fortunately, is able to find solace in his 'writer's identity':

'…the peak for artists varies considerably. Dostoyevsky, for instance, wrote two of his most profound novels, *The Possessed* and *The Brothers Karamazov*, in the last few years of his life before his death at age sixty. Domenico Scarlatti wrote 555 piano sonatas during his lifetime, most of them when he was between the ages of fifty-seven and sixty-two' (p. 11). Murakami (2009) knows that ageing has changed the meaning of running for him, yet still (at the time of writing) he does not know what exactly that change is:

> I started seriously running and am now rigorously running. What this might mean for me, now that I'm in my late fifties, I don't know yet. But I think it's got to mean something. Maybe not anything profound, but there must be significance to it. Anyway, right now I'm running hard. I'll wait till later to think about what it all means. (Putting off thinking about something is one of my specialties, a skill I've honed as I've grown older.)
>
> […]
>
> Even if my time in races doesn't improve, there's not much I can do about it. I've gotten older, and time has taken its toll. It's nobody's fault. Those are the rules of the game. Just as a river flows to the sea, growing older and slowing down are just part of the natural scenery, and I've got to accept it. It might not be a very enjoyable process, and what I discover as a result might not be all that pleasant. But what choice do I have, anyway? In my own way, I've enjoyed my life so far, even if I can't say I've fully enjoyed it.

Gender

Similarly to age, gender can also significantly affect runner's experience.

Historically women had had harder times accessing running facilities and competition. It was not until 1960 when women's races longer than 800 meters were included in the *Olympic Games*, and it is only in 1984 when women's marathon was also included (Menzies-Pike, 2017). Menzies-Pike (2017) also covers stories of women that were crashing men's races throughout the twentieth century: from Violet Piercy running a marathon course in England in 1926 to Kathrine Switzer running the *Boston Marathon* in 1967. Still, the history of women's running is not well documented, especially of women running for pleasure.

Today women's experience with running continues to be different, as Hamilton, Kita, & Smith's (2016) survey for *Runner's World* demonstrates. The online survey of 4670 runners (2533 women and 2137 men) revealed, for instance, that three times more women than men (63% and 23% accordingly) look for a safer place or route, where they will be less likely to encounter a potentially dangerous stranger; more than four times women look for places where they would less likely receive unsolicited attention (41% and 9%). Women are much more likely to take additional steps for better safety, such as run with a phone, warn someone about where are they going and when should be

coming back, run only in daytime and run with other people. Women are concerned about running in large cities, because of the higher chances to experience harassment; yet women are also concerned about running in rural areas, because in case that uncomfortable interaction happen, it is more likely for women in rural areas to face their harasser again and again.

While reporting on the survey, Hamilton et al. (2016) note that every young female runner has to 'find her own personal tipping point between feeling safe and comfortable, and feeling like she's "giving in" to harassers'. For one runner in New York City finding that point means debating internally, whether she wants to go for another run, after enduring unsolicited attention during her work commute: 'Do I really want to go out there? Do I really want to go deal with this?' For a Boston-based runner that means, deciding if she would wear something more comfortable or something that could deflect the potential harassers: 'Can I suffer through four miles in a shirt? Yes? Okay, I wear a shirt. Can I do it for eight miles? No, that's not best for my training'. And for a runner in South Lyon, Michigan it means in no way adjusting her running routine: 'If I cover up or stay inside, then I'm only cowing to the people who seek control over women. This behavior is not okay, and I believe we need to stand up to it'. Regardless of how the individual women choose to run, it is clear that their experience is coloured by their gender; as Witkowsky (2013) in her autophenomenographic study of *Zombies, Run!* notes:

> …as a mature woman, running alone, the following elated experiences regarding exploration cannot be disentangled from an awareness of being 'a woman' alone in public space, and navigating through areas (and experiences) that have otherwise been felt or marked as risky.

Culture

The meaning of running also differs from culture to culture. Ronkainen, in her auto-ethnographical work, describes her experience of moving from Finland to China through the lens of her running identity (Ronkainen, Harrison, & Ryba, 2014).

The move completely broke Ronkainen's running routine. She did not want to run indoors on a treadmill, yet she also struggled to find a new place to run. In addition to that, she could not escape feeling different from most people around her. Thus, the two themes emerging in her reflection are control and isolation:

> In the city I am a total foreigner, I do not understand the people, their habits, their way of thinking, and their meanings. Some people stare at me, I am the different one, I cannot communicate, I have no way to access their realities.
>
> […]
>
> I can only get to the mountains with people who know how to get there.

> […]
>
> …the big city feels alienating for me. I could not connect with myself or anyone else.
>
> […]
>
> In the city I am a total foreigner.

However, things start to change for her, when she shifts her cultural perspective towards running:

> …my starting point was the worldview I had learned in the interaction with my subculture. When I had become immersed into the cultural practices of running, I had internalized the dominant understanding of running that involved surveillance of the running intensity and distance to provide optimal results in performance. […] Nonetheless, the more fundamental breakdown of the training routine in Beijing revealed the importance I had given to the 'confession of the training plan', the belief in the saving power of doing everything according to the program
>
> […]
>
> When I observed my situation from a Zen Buddhist perspective, an alternative discourse that I came to study in China, the running project showed itself in a different light. Who was this self that was mastering the running and where did the control arise from? […] Buddhism places great importance in dissolving anxiety through detachment to the grasping, desiring self. […] From the perspective of Buddhist philosophy, the problem with my running project was grounded in a more general problem of having a self.

While Ronkainen et al. (2014) painstakingly investigates adopting a perspective on running from another culture, Michael Gladwell, a non-fiction writer and a self-identified 'running junkie', simply observes how different reaction is to him running in another country, Jamaica in his case:

> I remember a couple of years ago going for a run on these little side roads and all these people shouting out to me, tons of them, just cheering me on, encouraging me. They have no idea who I am or what I'm doing there. The idea of someone out there running is so central right now in Jamaican culture that they're like, 'Good for you!' Cars would slow down and people would wave and honk their horns. And it's not that I was the only person running, it's just that running was something you celebrated. It was kind of fantastic, actually. (Sticker, 2013)

Solitary Running

In addition to encouraging physical activity, some exertion games also promote sociality, which is particularly prevalent in Mueller's work (e.g. Mueller et al., 2011); in fact, strengthening social bonds is one of the leading research goals behind most of his work. Mueller argues that games and sports have traditionally provided many opportunities for socialisation, and sees how technologies often fail in comparison because designers do not usually consider encouraging socialisation as a goal. Some technology, such as video calling, might be useful for scheduled or necessary socialisation but not good at supporting spontaneous and casual interactions. Other technology, such as activity trackers, might inspire discussion after the workout but not good at promoting social bonding while partaking the activity (Mueller et al., 2003).

Consolvo et al. (2006) recognise three classes of social influence in exertion games: social pressure to outperform other players; social support and recognition from peers; communication between players and the ability to explain their performance. Mueller's work also explores creating opportunities to do something together for people that are physically apart (e.g. Stevens, Thorogood, O'Brien, Wulf, & others, 2007). For instance, one of the participants was able to play tennis again with her friend who had relocated a few years earlier. Mueller et al. note that such games not only encourage a player to socialise more often, but the nature of that socialisation is also different too. A game can be an ice-breaker for strangers who have just met and can also help the player see their colleagues in a different light; as one participant of Mueller's (2003) pre-study survey put it: '…you can see other sides of people […] not the researchers, but the human beings, if not animals, that laugh, move around, jump, scream'.

Along with the emphasis on sociality put by some HCI researchers, it is also important to note that for many people running is enjoyed most as a solitary experience.

Murakami (2009) genuinely enjoys solitude, and running for him is time when he can be alone: 'I'm the kind of person who likes to be by himself. To put a finer point on it, I'm the type of person who doesn't find it painful to be alone' (p. 13).

He recognises that lack of sociality might come at cost:

> In certain areas of my life, I actively seek out solitude. Especially for someone in my line of work, solitude is, more or less, an inevitable circumstance. Sometimes, however, this sense of isolation, like acid spilling out of a bottle, can unconsciously eat away at a person's heart and dissolve it. (p. 16)

Nevertheless, Murakami still finds his solitary runs essential:

> The desire in me to be alone hasn't changed. Which is why the hour or so I spend running, maintaining my own silent, private time, is important to help me keep my mental well-being. When I'm running I don't have to talk to anybody and don't have to listen to anybody.

> All I need to do is gaze at the scenery passing by. This is a part of my day I can't do without. (p. 14)

Joyce Carol Oates (1999) sees solo runs as helpful, if not necessary, to her writing. In her essay on running (titled 'To Invigorate Literary Mind, Start Moving Literary Feet') she makes parallels between running and writing, and details how the former informs the latter:

> The structural problems I set for myself in writing, in a long, snarled, frustrating and sometimes despairing morning of work, for instance, I can usually unsnarl by running in the afternoon.
>
> […]
>
> I find myself running in a place so intriguing to me, amid houses, or the backs of houses, so mysterious, I'm fated to write about these sights, to bring them to life (as it's said) in fiction. I'm a writer absolutely mesmerized by places; much of my writing is a way of assuaging homesickness, and the settings my characters inhabit are crucial to me as the characters themselves. I couldn't write even a very short story without vividly 'seeing' what its characters see.
>
> Stories come to us as wraiths requiring precise embodiments. Running seems to allow me, ideally, an expanded consciousness in which I can envision what I'm writing as a film or a dream.

Fifteen years later, in an interview (2014), she is still certain that her running is essential to her writing:

> …when I run up that hill—I'm not making this up—I feel that there will be ideas waiting for me, it's like they're waiting for me up in that place. So I run up there. If I just sat in a room it wouldn't be the same thing.

Marshall, Benford, Pijnappel et al. (2016) argue that exertion games are social by their nature. Unlike controller-based games, exertion games are more revealing of player's actions and intent. Thus, designers need to consider how a player wants or does not want to be seen, and how potential accidental or non-accidental bystanders are going to experience the spectacle (Downs, Vetere, Howard, Loughnan, & Smith, 2014; Marshall et al., 2016). On top of that, Marshall et al. (2016) remind that doing any kind of physical activity in public can also be embarrassing. Exertion by its nature is performative, and some people more than other are conscious about the 'performance'; about their bodies and capabilities. This issue might be particularly pressing for people who are just starting to exercise (Yim & Graham, 2007), and if running is mainly promoted as a social activity, that might stop them from participating altogether.

Meaning

All of the above is not intended to be a comprehensive list of aspects that define the overall running experience. Instead, I would argue it illustrates how subjective and personal running experience can be. To one person running is a way to enjoy solitude; another runs in search of inspiration for her stories; to the third person her uncompromised running is a statement on women's freedom.

To Menzies-Pike (2017), along with other people featured in her book *The Long Run*, running has become a way to deal with loss, as she discovers how the physical pain—that can be managed—helps to soothe the overwhelming emotional pain:

> If there's any analogy to be drawn between marathon running and enduring grief, it shouldn't turn on one great exhausted clash of will against circumstance. It should accommodate a million training runs, aches and doubts, stops and starts, setbacks, tiny advances, odd connections, and, ultimately, not triumph, but joy and renewal.

It is not that running by itself has many meanings, it is that running is akin to a vessel that people fill in with the meaning they need.

Menzies-Pike (2017) writes: 'Stories about running are often like this, in that they're about something else. They are tales of shape shifting, of the desire to shed one skin and step into another'. Murakami (2009) notices a similar effect: 'One thing I noticed was that writing honestly about running and writing honestly about myself are nearly the same thing'.

Trajectory of the Running Experience

While discussing the complexity of running, it is important to emphasise that running experience is not monolith. In the current literature, the experience is often seen as two discrete states— 'running' and 'non-running'—and in order to promote healthier lifestyle, we just need to encourage people to switch from 'non-running' state to 'running' more often. There is, however, so much more to running experience than just a fast movement from one place to another.

Benford et al. (2009) suggest that one way of understanding such complex experiences might be seeing them as *trajectories*. While they focus on trajectories in the context of interaction with technology, I argue it would be useful for designers to first break down running trajectory as it exists now, and only afterwards explore how this current trajectory can be supported or even enhanced with the use of technology.

For instance, running is a repetitive activity, thus requiring **scheduling and management**. Runners need to balance their work and family responsibilities when choosing time for their runs; there are safety considerations, particularly prevalent among women; and of course, there is also personal preference. While Oates (1999)

runs to deal with the writer's block, Gladwell (Crane, 2017) feels the opposite way: that running can take away from his writing:

> I never run in the morning. I just think it's a waste of the morning. The morning is the best writing time, the best thinking time. At the end of a long day, when you're tired, I find running is the thing that brings you back to life. Something to look forward to as well.

Thus, researchers and practitioners need to consider how people schedule their runs and what design decisions might affect their plans. Nevertheless, this important aspect is almost entirely missing from the current HCI research. While many participants of *Jogging Over a Distance* (Mueller et al., 2010) study ran multiple times, the issues of scheduling fell out of scope for that study. Similarly, in Marshall & Benford's (2011) work, participants could run with the poem multiple times, yet all of the attempts were constrained within one day: running with an intense interactive poem was not meant to be a regularly scheduled experience.

Aside from scheduling, there are also other parts of running experience outside the actual workout, such as **preparations** (for instance, buying running gear is also part of the running experience) or **reflection**. Woźniak, Knaving, Björk, & Fjeld (2015) mark the latter as a particularly common issue with the current technology. While sensor-equipped portable devices can provide a lot of data regarding any particular workout, they do not necessarily help to tell a story about the run. Woźniak et al. (2015) note that running often puts people in a specific mental state that does not allow runners to memorise much from their runs; that mental state is especially common for long races. Thus, they conclude, researchers need to gain more understanding on how to design for better recollection, and what additional data technology could provide to help with the issue.

More interestingly, there are also trajectories within any particular running workout. For instance, the experience of starting a run is different from the experience of running the last hundred meters to the goal; and what runners need at the beginning of their run might be different from what they need by the end of it (e.g. Tenenbaum et al., 2004).

There is also an internal **rhythm and pacing** in every run. For Murakami (2009), it is the rhythmical, repetitive nature of running that is essential for creating the special running state that he enjoys: 'No matter how mundane some action might appear, keep at it long enough and it becomes a contemplative, even meditative act' (p. 4). The running rhythm also keeps reminding him of the rhythms in other parts of his life: 'to keep on going, you have to keep up the rhythm. This is the important thing for long-term projects. Once you set the pace, the rest will follow' (p. 7).

On top of that, there are **transitions** (Benford et al., 2009). Transitions from planning a run to preparing, from preparing to warming up, from warming up to starting running. Transitions between the workouts and between different parts inside of a run. What that means regarding designing technology for running is yet unknown.

Supporting the Running Experience

Summarising the experience of designing various exertion games, Mueller et al. (Mueller et al., 2011) warn against focusing the design primarily around the potential health benefits. Focusing on health first unnecessarily limits the potential of exertion games (Marshall et al., 2016). Moreover, Marshall et al. (2016) warn against using exertion as a 'Trojan horse', as this approach implies that exertion cannot be fun on its own and can be considered only as an unavoidable barrier on the way to a healthier life. On the other hand, if designers make an exciting and engaging exertion game, the health benefits will follow as a consequence (Mueller et al., 2011).

Marshall et al. (2016) do advise creating a temporal trajectory for designing more engaging exertion games. They, however, discuss trajectories in the context of creating novel experiences. Thus, in *Jogging over a Distance* (Mueller et al., 2010), runners were able to jog together, despite being geographically apart; moreover whoever gets 'ahead' was not based on absolute performance but on the performance relative to each runner's target goal. Neither of those would be possible with regular running. While the goal, in this case, was encouraging and supporting social interactions (Mueller et al., 2010), Marshall & Benford (2011) deliberately decided to avoid aiming for any particular health or social benefits, and instead explored the possibility of creating an intense and novel experience with running, also impossible without the use of technology.

I, on the other hand, argue that starting with an existing trajectory of running might help designers better understand what that activity means to different people, what challenges they face and what aspects of it can be enhanced.

For instance, Marshall et al. (2016) go as far as advising their students to start with a multiplayer version first. This advice, however, goes against the insight from such runners as Murakami (2009) and Oates (1999), who actually prefer their runs best as a solitary experience. Hence, if researchers always strive to design exertion systems with an emphasis on sociality, they risk leaving such runners aside.

This is not to say the opposite: that research should focus on running only as a deep solo experience. I argue that there are different types of running experiences, and to each experience there are different parts of it on the running trajectory. Moreover, choosing to optimise for one kind of run will likely make it less appealing for runners with other priorities. For example, during the design process of *Jogging Over a Distance*, Mueller et al. (2010) discovered that making sociality the main design goal would also make the experience worse for performance runners. In fact, runners themselves already make similar choices, knowing that optimising their runs for performance goals might make it

harder to find running mates, as they would have to have matching capabilities and aims.

Thus, my argument is that there should be different technology and different games, supporting different types of runners, runs and parts of the running trajectory. The current focus on health, sociality and novelty is still too limiting for such a deep and meaningful experience that running can be. Woźniak et al. (2015) suggest that HCI research is only starting at this route of understanding running and that more understanding of the current running experience is needed in order to unlock the full potential of what technology can do.

Urban Walking with Music

While there is not yet a substantial body of research investigating what technology might mean for augmenting running experience, a lot more has been done in a related context: the of understanding how technology (in this case a portable music player) changed the experience of urban walking (e.g. Bull, 2000; Du Gay et al., 2013; Thibaud, 2003). In this subsection, I will briefly cover three major themes—*control*, *rhythm* and *hybrid walking*—emerging from that branch of research, in hope that they can inform the future running research in HCI.

Control

The first major theme in research on urban walking with portable music players is control. The control over the audio-environment empowers walkers; it allows them to create a feeling of their own personal space; to orchestrate, in a way, the city around them (Bull, 2005). For instance, after walking through a particularly noisy part of a city, a walker can simply rewind to listen to what they just missed. Thus, an act as small as rewinding to the previous track may contribute to the overall feeling of being in control of the city experience (Thibaud, 2003).

It is not just the ability to play, pause and switch tracks: the walk itself changes when the music is on. For instance, walkers may take detours and deliberately increase the walking distance from one place to another just so they could finish listening to the playlist, or avoid particularly noisy areas, or find an area where they could perform a ‘dance-walk’, following the rhythms of a song. Or the opposite, walkers may take shortcuts and rush to the point of destination, just because the battery of their player is running low or because they want to get there by the time the song ends (Thibaud, 2003).

A city walker with a music player simultaneously experiences two temporalities: one of walking and another of music. The walker may switch the music off entirely when needed; yet there is also a way to balance both audio-environments by controlling the volume or taking just one earpiece out. The latter became a social convention even for when the music is off: this way the walker demonstrates that they are open to social communication (Thibaud, 2003).

Control became more important with the introduction of portable MP3 players, as now thousands of songs became available at walkers' fingertips. It is even more important today, with the appearance of music streaming services that let walkers pick any song out of millions in the catalogue[1]. Having a larger musical collection results in having even finer control, allowing walkers both to have the right music at the right moment and also to not have to listen to the 'wrong' music when it does not fit the mood (Bull, 2005).

Rhythm

Cities have their own rhythms: the openings and closings of schools, shops and offices, people's recurring routines, the schedules of public transports and, of course, the city soundscape created by the combination of the above (Degen, 2010). It is these specific rhythms—the 'sidewalk ballets' of comings and goings (Jacobs, 1961)—that create a sense of the city (Degen, 2010). A walker may disappear into that rhythm, become a part of it (Wunderlich, 2008).

Then there is walking itself, which is a naturally rhythmic activity, performed step by step. We adjust our inner bodily rhythms according to the environment around us. For example, when walking on a sidewalk where people move slowly, we also tend to slow down (Wunderlich, 2008). Moreover, the very act of moving fast might even be considered offensive at times, for instance, if running in a church or a cemetery. There is a risk in falling out of sync with the surrounding rhythms.

And finally, there is music. In the way that music rhythm affects body rhythm during physical exercise (e.g. Edworthy & Waring, 2006; Karageorghis & Priest, 2008; Tenenbaum et al., 2004), it also affects walkers' inner rhythms (Edensor, 2012), sometimes synchronised with the urban rhythm. And sometimes it creates a dissonance with the environment, for instance, when fast, intense music plays while the walker is standing at an intersection waiting for the traffic light to turn green. Similarly, some music might encourage listeners to do a 'dance walk' in places where it is not appropriate (Thibaud, 2003).

Hybrid Walking

Sony Walkman—the first wildly successful portable player—was intended to be a social device, allowing two people to listen to music together (Bull, 2000). As it quickly turned out, however, the most significant strength of Sony Walkman was the opposite: in supporting the solitude that might be experienced by a walker wearing headphones, allowing them to create an 'individualised soundworld' (p. 2).

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[1] e.g. *Apple Music*, https://www.apple.com/au/apple-music/

The portability of Sony Walkman was revolutionary, as it allowed people to take their own private audio-environment out into the streets. These music players did not replace the city soundscape entirely but instead blended into it, creating an enhanced mixed soundscape that is both personal and public (Du Gay et al., 2013). Just as radios transformed living rooms, portable players transformed city spaces (Bull, 2000).

It is as if Sony Walkman unlocked the audio-layer of the city. It shifted the focus in social sciences from the visual paradigm to audible. As it turned out, 'The city is also to be heard and not only to be seen' (Thibaud, 2003). Moreover, it then also transformed the visual landscape of the city by encouraging walkers to create new connections between what they hear and what they see. Thibaud (2003) found that these relationships are also significantly influenced by juxtapositions of music and visuals found in popular movies and television series: what walkers once heard and saw on screen they re-experience, once they either hear or see something similar.

Music affects but does not destroy the listener's experience of the surrounding urban soundscape. There is also no switching between urban walking and music experiences. Instead, they exist together, simultaneously, blended into an experience both familiar and novel. The experience of the city becomes the experience of technology, while still preserving the experience of the city.

The research on city walking with portable players is generally not concerned with the health benefits of walking, nor the social opportunities; in fact, such research leans towards the aspect of solitude experience during urban walking. Nevertheless, it proves that walking with technology can still be a rich and meaningful experience. It demonstrates the potential in exploring the experience of running in a similar way: not as a new experience but as an old one, enhanced.

2.3 STORIES

2.3.1 Definitions

We are natural storytellers (Abbott, 2008). We organise our past experience in the form of stories (Bruner, 1991, p. 4), we communicate by telling stories, and we make stories up to educate or entertain others. It is because stories are so universal and essential to our lives that they are hard to define.

Abbott (2008) defines *narrative*[1] as 'the representation of an event or a series of events' (p. 12). For Abbott, 'event' implies an action. Thus, an example he gives, 'My dog has fleas' is not a narrative, yet merely a description of the dog; 'My dog was bitten by a flea', however, is. While in some definitions at least two events are required in a narrative (e.g. Bal & Van Boheemen, 2009; Barthes, 1966), Abbott argues that it is the capacity to represent a single event that forms the essence of a narrative. A narrative with a singular event constitutes a minimal 'building block' that can be used for the construction of more complex narratives (p. 12).

Crawford (2012) argues against Abbott's (2008) definition because it is too inclusive and allows as the definition of a story something that does not feel like one. A very basic example of such a story can be: 'A prince left a castle. The prince came back the next day'. These sentences fit Abbott's definition of a story, yet they break generally held cultural expectations of what a story is. Crawford himself refuses to settle on a particular definition of a story, saying that they are 'complex structures that must meet many hard-to-specify requirements'.

On the contrary, Zimmerman (2004) argues the opposite: that it is useful to keep the definition as open as possible. Such an open definition would invite us to think of new types of stories, and also see narratives where we traditionally would not. As this thesis will hopefully demonstrate, there is indeed usefulness in broadening our understanding of stories, and thus I use Abbott's definition of a narrative.

2.3.2 Audience Perception of Stories

We do not experience stories exactly as they were intended by the authors, with the exception of only the shortest and simplest stories (Abbott, 2008). We build our own perception of a story, coloured by our own life experience, 'we overlook things that are

[1] In this thesis I use 'narrative' and 'story' as interchangeable synonyms. While academics (including Abbott) often distinguish between the two, the differences are not significant for the purposes of this thesis.

there and put in things that are not there' (p. 79). As Abbott writes: 'without our willing collaboration, the narrative does not come to life' (p. 79). In other words, stories need their audience to become complete:

> When a work is produced, the creative act is only an incomplete, abstract impulse; if the author existed all on his own, he could write as much as he liked but his work would never see the light of day […] The process of writing, however, includes as a dialectic correlative the process of reading, and these two interdependent acts require two differently active people. […] Art exists only for and through other people. (Sartre, 1967, p. 27)

The co-creation of stories happens even if we do not make an explicit effort. It is natural for us to be complete the stories we experience (Abbott, 2008, p. 6). While the co-creation of stories happens regardless, authors still might be purposefully designing their stories to facilitate co-creation. The most common way to do that is the use of ambiguity.

While we might not always notice them consciously, stories are filled with ambiguous gaps (Abbott, 2008, p. 83). Imagine a story with the following couple of sentences: 'Sarah started walking to the nearest post office. It was busy when she arrived'. It is actually unclear how Sarah got to the post office: the reader knows only that she started walking, and it is still possible that after a bit of walking Sarah took a bus to shorten the trip. The author, however, can still rely on a reader's likely assumption that Sarah walked all the way. Gaps like those (cuts) are particularly common in movies: that is why it is possible for us to jump from scene to scene, while still perceiving the movie as a consistent story rather than a collection of random video-clips.

Hence, authors, particularly authors of fictional stories, deliberately use ambiguity and rely on the audience to find their own interpretation when their imaginations attempt to resolve uncertainties in the story:

> I'd rather let the reader supply the faces, the builds, and the clothing as well. If I tell you that Carrie White is a high school outcast with a bad complexion and a fashion-victim wardrobe, I think you can do the rest, can't you? I don't need to give you a pimple-by-pimple, skirt-by-skirt rundown. We all remember one or more high school losers, after all; if I describe mine, it freezes out yours. (Stephen King, 2002)

Moreover:

> Part of the fun is people speculating about what they are seeing. There's some amazing speculation out there. There are some theories that are so elaborate and beautiful that you wish you thought of them yourself. I think we want to burden the audience as little as possible with expectations of what we think the show is. I'm a big believer in this ever since we went to the Venice Film Festival with Memento. My brother gave an interview about what he thought the

> film meant but stressed it was ambiguous. And afterward we talked about it and I felt from then on that the best thing to do is get out of the way of the audience and let them play with it. And there are some things in Westworld that are intentionally ambiguous. (Jonatahan Nolan in an interview with Hibberd, 2016)

To keep co-creating the story we need to suspend disbelief (Ferri, 2007). Jean Cocteau's 1946 film *Beauty and the Beast* famously opened with a message from the director explicitly asking the adult people in the audience to open their minds for the fairy tale:

> Children believe what we tell them. They have complete faith in us. They believe that a rose plucked from a garden can plunge a family into conflict. They believe that the hands of a human beast will smoke when he slays a victim, and that this will cause the beast shame when a young maiden takes up residence in his home. They believe a thousand other simple things. I ask of you a little of this childlike simplicity, and, to bring us luck, let me speak four truly magic words, childhood's open sesame: 'Once upon a time...'.

Ultimately, we seek *closure* from a story: the resolution of the main conflict, and of the 'range of expectations and uncertainties' that emerged throughout the story (Abbott, 2008, p. 53). Stories generally build up to a closure via a series of surprises and suspense that, ideally, hold our attention until the resolution comes: the greater the suspense, the more satisfying the closure and vice versa. We associate stories that bring closure too quickly with lesser quality (p. 59). Closure does not always come at the end of a story, and in some stories it might not come at all (p. 52). But if a narrative does not bring closure by itself we would often instinctively try to close it on our own, even if that means going against the author's intentions (p. 82).

2.3.3 Digital Stories

With the appearance of new mediums of expression stories evolve, and the popularisation of computers was no exception. While advancements in technology have affected stories in numerous ways, there are two novel types of stories of particular interest to this thesis: digital interactive stories and video games[1].

The history of these two forms of digital storytelling actually begins with the two kinds of non-digital stories that gained popularity in the 1970s: tabletop role-playing games

[1] There is an argument in game studies whether videogames can actually be seen as a form of storytelling, which I omit here, as it is unrelated to the scope of this thesis.

and 'choose your own adventure' books. With role-playing games such as *Dungeons and Dragons,* a 'dungeon master' would orchestrate adventures for players 'using rulebooks, dice, and imagination to calculate the outcomes of players' actions' (Howard, 2008, p. 11). 'Choose your own adventure' books guided the player through a number of different outcomes, depending on the players' choices and dice rolls. *Adventure*[1] (1976) was the first interactive story that brought this kind of experience to the digital form (Howard, 2008, p. 12). *Adventure* was entirely text-based: it would accept a number of textual commands from the player and respond accordingly, also in text (Crawford, 2012). In the 1980s graphic adventures began to replace text-only digital stories (Crawford, 2012). Consequently, the players started to take actions, for instance by controlling an avatar, instead of just giving commands (Howard, 2008, p. 15). With the popularisation of mobile devices in the 2000s interactive stories and video games expanded 'from desks into the pockets'. Now, the current trend is for digital stories and games to 'leave' the screen and enter the physical world (McGonigal, 2011).

The emergence and evolution of novel forms of stories create a fresh set of challenges related to the new forms (Ip, 2008; Vorderer & Bryant, 2012). Moreover, Zimmerman (2004) argues that the lack of challenges might mean for a novel medium that it has not yet fully realised the potential that comes with adapting new format but instead tries to copy the pre-existing one. Klimmt, Roth, Vermeulen, Vorderer, & Roth (2012) argue that to explore the potential of new story forms it is reasonable to look into the existing story mechanics, such as curiosity and suspense, and research how they might be altered for the new format.

2.3.4 Tension Between Stories and Interaction

One of the biggest challenges in interactive stories and video games is the tension between traditional storytelling and interaction. In 1999 the video games theorist Jesper Juul wrote an essay on the tension between games and narratives. In it Juul highlights the fundamental incompatibilities between the two. Juul concludes that games and narratives cannot be occurring at the same time, and therefore videogames and interactive stories can only switch between two modes.

Time

One of the most important differences, emphasised by Juul (1999, 2001) and others (e.g. Calleja, 2011; Crawford, 2012) is the way time is designed. Narratives, points out Juul (1999), are fixed sequences, while games are flexible. Furthermore, narratives

[1] https://en.wikipedia.org/wiki/adventure_(atari_2600)

easily skip ahead in time, whereas videogames generally unfold in real time. Crawford (2012) elaborates:

> [Stories] play havoc with time—breaking it up, jumping backward and forward, and skipping it altogether. Actors are shown embarking on a journey and arriving at their destination; the time the journey itself consumes is skipped over. Years are disposed of with the note, 'Many years later…'. Simultaneity is presented with the simple phrase, 'Meanwhile, back at the ranch…'. Flashbacks jerk you backward in time and then return you to the present. Dramatic time just doesn't behave like physical time; it follows whatever course the story requires.

While it is often possible to speed up, slow down or pause time in games, time jumps are much less common compared to those in stories, and they usually happen between game stages, not during the gameplay itself.

Moreover, narratives are representations of past events that are settled, while video games happen in the present, containing a reaction to the player's actions (Juul, 1999). It is important to note that 'representing past events' does not mean that a story cannot be set in a futuristic world (e.g. the dystopian Los Angeles of *Blade Runner*), but that events in the story have happened, and that they are determined and independent of the audience's actions. The audience watching a movie understands that even though the movie playing is happening *now*, 'the events told are *not*' (Juul, 2001).

In contrast, events in a video game cannot have already happened, even if the game is set in the past (e.g. *Prehistorik*[1]), since the conventional[2] video game has to react in some form to player's input (Calleja, 2011, p. 43).

Thus, in both stories and games there are at least two types of temporalities: 'the time of the thing told and the time of the narrative (the time of the signified and the time of the signifier)' (Metz, quoted from Juul, 1999). As the examples above demonstrate, the relationship between the two temporalities are significantly different in stories and video games due to the nature of interactivity, or the lack thereof. As Juul (2001) put it: 'you cannot have interactivity and narration at the same time'.

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[1] https://en.wikipedia.org/wiki/prehistorik

[2] There are games that explore more complex relationships between game time and player's time, such as an ability to rewind time in *Prince of Persia: The Sands of Time* (https://en.wikipedia.org/wiki/prince_of_persia:_the_sands_of_time) and *Braid* (http://braid-game.com/). Yet the principle still applies here: the events in those games are still not settled but waiting to be co-constructed by the player.

Trajectory

Another major difference between stories and video games is in the approach to the trajectories of experience (Benford et al., 2009).

Partly, the differences stem from the consequences of temporal relationships described above. As it is unlikely for games to incorporate jump cuts into the gameplay, they often thrive on embracing the opposite: exploring what would be a gap in a non-interactive story (Dubbelman, 2011). For instance, a great number of game-world details can be presented for a player to explore or even interact with, whereas detailing a movie scene to the same degree would be unnecessary or even distracting.

Other differences in the approach towards trajectories come from how stories and video games handle repeatability. Conventional stories are experienced once. Sure, one can re-read a novel or watch a movie again, yet that is different to how someone replays a game. It is unlikely that someone would be re-reading the same chapter over and over dozens of times per day the same way that is common for players to be replaying the same level again and again. One of the major reasons for replaying a game is the desire to become better at playing, and there is no analogue for that with non-interactive stories: people rarely re-read a novel just to become better at reading (Juul, 1999).

Noting the difference in how stories and games approach repeatability, Juul (1999) suggests that the more the game is about the story the less replayable the game becomes. Lindley (2002) adds that a complementary point: due to the repetitive nature of games, they are not an appropriate medium for telling complex stories.

Thus, games focus on the visceral enjoyment of playing, while stories focus on the satisfaction of finding out what happens next and developing emotional connections with the characters. Consequently, games are likely to embrace the journey itself, whereas stories tend to cut between the major events of the journey. At the same time, this difference makes game experiences more enjoyable on consecutive repetitions compared to non-interactive stories.

Creative Freedom

As noted before, games can still incorporate stories in one form or another: it might be occasional textual expositions, such as ‘Our princess is in another castle’ in *Super Mario Bros.*[1], or cinematic intercuts, akin to these in *Max Payne*[2], or more complex forms. Yet,

[1] https://en.wikipedia.org/wiki/super_mario_bros.
[2] https://en.wikipedia.org/wiki/max_payne

there are limitations in place that make these in-game stories different from non-interactive stories.

First, games put forward playing experiences, and when creating enjoyable experiences it is not necessary to focus on people (or anthropomorphic animals and creatures). Games can be about people but also can be as abstract as Tetris, which would be hard to imagine as a story[1] (Juul, 1999). This often leads to games being about things rather than people: 'You search for things, acquire things, navigate things, move things, destroy things—it's always things, things, things and never any dramatically significant interactions with people in games' (Crawford, 2012). When games are not about people, it makes any story incorporated into them feel artificial and forced, since stories mostly focus on human experience. Crawford (2012) argues that in this regard, games are different from most artistic and entertainment media. Consequently, missing the humane component makes gaming less interesting in terms of dramatic potential.

Some practitioners from both the storytelling and game industries agree. For instance, George Lucas, the creator of the original *Star Wars*[2] films, argues that one of the main sources of the tension between stories and games is that stories are author-driven. The authors lead the audience through the experience whereas games by their very nature have to share control with the player (Mukherjee, 2015, p. 2). Sometimes that means leaving no place for the story at all, as, for instance, it is impossible to plot out the story in a game such as a football. Similarly, Will Wright, one of the creators of *The Sims*[3], claimed that 'games are not the right medium to tell stories' (Mukherjee, 2015, p. 2).

Second, stories and games having different relationships with the audience lead to the difference in how they address the audience. In conventional stories the reader or the viewer is an invisible observer (Abbott, 2008). Sometimes, the author can 'break the fourth wall' and address the audience directly, yet still, the reader or the viewer is not considered to be part of the story as they do not have any influence over it. It is the opposite for games: here the player either directly controls one of the main characters (e.g. in third-person shooters), or controls many units, often playing the role of some kind of a commander (e.g. in strategies), or is invited to pretend to be the main hero themselves (e.g. in first-person shooters) (Calleja, 2011, p. 60).

Interaction, therefore, imposes certain constrains on storytellers, thus limiting their creative freedom.

[1] There were attempts, such as 2016 *Tetris* movie (https://www.imdb.com/title/tt5452216/), yet, arguably they were rather stories that feature Tetris figures than stories about the Tetris figures
[2] https://www.starwars.com/
[3] https://www.ea.com/games/the-sims

2.4 USER EXPERIENCE

Human-Computer Interaction research originated at a time when computers were situated predominantly in work environments and used mainly for accomplishing work-related tasks. Thus, the research was concerned with the ergonomics, usability and efficiency of task completion (e.g. Norman, 1999; Raskin, 1997).

Computers, however, started to evolve beyond the work context (Monk, Hassenzahl, Blythe, & Reed, 2002). First, computers became more affordable and accessible; now people were buying computers for home use as well. Then, computers became smaller, which allowed the emergence of portable computers that people could carry beyond desks. Recently, in the last couple of decades, it became more and more common for portable computers in urban areas to be connected to the internet.

The context for interaction with computers was changing, and thus the focus of HCI research started to shift as well (Carter, Downs, Nansen, Harrop, & Gibbs, 2014; Hallnäs & Redström, 2002). The research expanded from work-centric contexts to exploring fun and enjoinment (Monk et al., 2002). Still, the expanded focus was considered to be too narrow. McCarthy & Wright (2004) argued that, now, computers not only allow for more contexts for interaction, the very nature of interaction with computers has changed. These days not only do we simply use computers for work or leisure, we *live* with them. Computers have become embedded in more and more aspects of our lives, to the point where it might become hard to distinguish where the interaction begins and ends (Hassenzahl & Tractinsky, 2006). Instead, McCarthy & Wright (2004) suggested that we see human-computer interaction as part of our life experience. Thus, focusing on only enjoyable parts of the experience, such as fun, would mean having a very simplistic view of human nature (Petersen, Iversen, Krogh, & Ludvigsen, 2004).

Consequently, recent work in HCI explores a whole range of user experiences (UX) that could not be unambiguously seen as positive and enjoyable, yet are still rich and meaningful.

Inspired by the use of ambiguity in art, Gaver, Beaver and Benford (2003) suggested that the creation of ambiguous experiences can be a valuable design strategy. They argue that ambiguity in digital systems can create novel ways of engagement and be thought provoking for users, just as it can be in literature and cinematography. Leong, Vetere, & Howard (2006) explored and characterised the serendipity that arises during listening to music in shuffle mode, which turned out to be a surprisingly personal and meaningful experience for participants. Marshall & Benford (2011) investigated the potential of intense experience that set out to overwhelm and even stress people. Moreover, expanding on the previous study, Benford et al. (2012) explored experiences that were designed to be deliberately uncomfortable, similar, for instance, to those that people have during an amusement ride.

Interestingly, the research focus in game studies was shifting in a somewhat opposite direction. Starting with the exploration of fun and enjoyable aspects of video games,

researchers then suggested that games can be beneficial in more serious contexts, such as education or training (Michael & Chen, 2005). Further research revealed that desired outcomes might be achieved not only by full-fledged games but also through *gamification*, i.e. the use of particular game mechanics in order to increase user motivation and engagement (Deterding et al., 2011). Critics of gamification (Juul, 2011) noted that mechanics such as points, achievement badges or leaderboards provide extrinsic rewards unrelated to the actual context, instead of supporting a user's intrinsic motivation. Nicholson (2015), Nacke & Deterding (2017) argued that a better approach might be to use game mechanics to create meaningful experiences rather than simply providing extrinsic rewards.

As the user experience with technology becomes more complex, it becomes harder to study. People's experiences with technology are subjective and connected to other aspects of their life experience. Furthermore, with the mixed reality technology it is becoming even harder to distinguish between the technological and non-technological aspects of our experience.

There is no single approach to studying user experience (Bargas-Avila & Hornbæk, 2011), and considering that UX research builds upon many intersecting disciplines there might never be one.

For studying user experiences with mixed reality systems Benford, Giannachi, Koleva, & Rodden (2009) suggest employing the trajectories of user journeys. In mixed reality systems, these trajectories run through four facets: space, time, roles and interfaces. What makes this set of facets particularly apt for studying experiences with mixed reality is that they allow the exploration of the hybrid nature the experience that connects virtual and physical space, time and roles.

Sub-section 2.2.2, however, revealed that an activity, such as running, could by itself create a deep and meaningful experience for the runner. The four facets suggested by Benford et al. (2009), however, do not allow for the inclusion of the existing experience with the activity, making it unclear how to study a mixed reality system that aims to enhance it.

2.5 MIXED REALITY STORIES

In this thesis I define *mixed reality stories* (MRS) as stories designed to create a mixed reality experience with an existing activity. While the definition is new, MRS themselves existed prior to this project.

The most prominent example of a mixed reality story is *Zombies, Run!*, a running application for mobile phones (Figure 2.4). *Zombies, Run!* provides a fictional story about a zombie apocalypse that is intended to be listened to through headphones while running. Throughout the story different characters talk to the protagonist, thus providing an opportunity for the runner to feel that they *are* the protagonist. Each story chapter is framed as a mission; consequently, finishing a workout with *Zombies, Run!* becomes accomplishing a mission in the story.



2.4 Opening Screens of *Zombies, Run!*

While *Zombies, Run!* is the most commercially successful MRS to date, it is not the only example of MRS. *Runtastic Story Running*[1] (Figure 2.5) is structured in a manner similar to *Zombies, Run!*, but instead of a single serialised story it provides a variety of short yet diverse stories, each with its own setting, set of characters and atmosphere. Moreover, *Runtastic Story Running* offers a number of non-fictional stories mainly revolving around motivating, coaching and travel themes.

[1] https://www.runtastic.com/en/storyrunning



2.5 Runtastic Story Opening Screen

There are also a number of research prototypes that could be considered MRS, such as Marshall & Benford's (2011) *I Seek the Nerves Under Your Skin* that requires runners to accelerate continually in order to listen to the poem throughout. Finally, there are also mixed reality stories for activities other than running, such as *The Walk*[1], which was created by the developers of *Zombies, Run!* in collaboration with the UK's National Health Service and the UK's Department of Health (Comstock, 2013). Similarly to *Zombies, Run!*, *The Walk* provides the walker a story that, as the official description states, turns walking 'into a journey, a challenge, and a rip-roaring adventure'.

Initially, *Zombies, Run!* was announced as a Kickstarter project with a target goal of $12,500. During the campaign, the project managed to raise more than 5 times the target amount. Such interest from potential runners suggests that MRS might provide

[1] https://www.thewalkgame.com

unique opportunities for enhancing the experience of running, as distinct from running with an audiobook or a podcast.

One of the most in-depth studies of *Zombies, Run!* is an autophenomenographic research project conducted by Emma Witkowksi (2013, 2018). During 2013 Witkowski completed 40 runs with the MRS (totalling 180 kilometres and 18 hours of running), and documented reflections on her experiences during cooldowns and post workouts. She complemented her work by studying public discussions of *Zombies, Run!* on social networks, particularly on Instagram. Besides, she carried out interviews with five women who made *Zombies, Run!* tagged posts on Instagram, and two other runners.

Witkowski's (2013, 2018) main focus, however, differs from the focus of this thesis. She investigates the networked and gendered aspects of bodies running in the public space, but in this particular study is less concerned about the broader experience of runners and the design of MRS applications.

Thus, while there has been some research on *Zombies, Run!* (another example is Southerton, 2013) to date there is still no understanding of the ways in which MRS are different from traditional audio-stories, such as audiobooks and podcasts.

2.6 TOWARDS THE UNDERSTANDING OF THE UX OF MRS

Overall, Literature Review identified several gaps in the current work on mixed realities, running and stories in the context of HCI:

Mixed Realities

- Audio-centric mixed realities are under-explored;
- Subjective and emotional aspects of mixed reality experiences are under-studied.

Running

- Current HCI research focuses on the practical benefits of running, particularly on health and social benefits;
- There is also a tendency to replace the existing experience of running with something novel, yet the existing experience can already be meaningful to the runners.

Stories

- It is unclear how a novel story medium might adapt traditional story mechanics;
- There is a tension between traditional storytelling and interaction.

User Experience of Mixed Reality Stories

- There is no indication that MRS format is significantly different from audio-stories or mixed reality performances;
- There is no understanding of how the experience of running with MRS can be supported.

The latter gap in our understanding is central to this thesis, as it directly addresses the aim stated in the introduction. Thus, the research questions guiding this project is

How can the user experience of running with mixed reality stories be supported?

3 RESEARCH DESIGN

Chapter 2 reviewed the literature relevant to the project, and presented the research question that guides the thesis: *How can the user experience of running with mixed reality stories be supported?* This chapter provides an overview of the research perspective, methodology and methods necessary for gaining insight in order to address the proposed question. The chapter is structured in a 'top down' manner, going from more abstract philosophical concepts towards more concrete methods. It starts with the breakdown of the overarching research question into three smaller questions (3.1), so that each of them could guide its own study, which cumulatively act as stepping stones towards the overall answer. The following section situates the project within the Human-Computer Interaction (HCI) research area to help identify epistemological and theoretical perspectives that are best aligned with the thesis (3.2). The next section aligns the thesis with constructivist epistemology and interpretivist theoretical perspective (3.3). Chapter 3 then justifies the choice for grounded theory methodology (3.4), which in turn provides justification for the choice of data collection (3.5) and analysis (3.6) and evaluation (3.7) methods. The chapter then finally arrives at the overview of the design for each study, putting previously discussed concepts and methods in context (3.8).

3.1 RESEARCH QUESTIONS

The main research question for this thesis is: *How can the user experience of running with mixed reality stories be supported?*

This question, however, is too broad to be tackled by any particular study. Thus, I broke down the main research question into three smaller sub-questions. Each sub-question is designed to guide its own study, and also to lead to the next one. Together these sub-questions aim to address the overall research question.

> **RQ1:** What is the current user experience of running with mixed reality stories?
>
> **RQ2:** How do storytellers address the user experience of running when creating mixed reality stories?
>
> **RQ3:** How do runners perceive mixed reality stories while running?

The first sub-question is set to explore existing experience and clarify the focus for the consequent studies. The second sub-question invites us to examine the themes and insights that emerged from addressing the first sub-question from the perspective of storytellers. The third sub-question brings together the insights gained from addressing the previous sub-questions in order to validate and extend them. Together the findings lead towards a better understanding of how can the user experience (UX) of running with mixed reality stories be supported, thus bringing the thesis to closure.

3.2 SITUATING THE THESIS

In the Literature Review chapter I highlighted how the research in this thesis draws upon contributions and insights from a wide range of research areas, including Performance Studies, Game Studies, Sports Studies, and even Urban Studies. It is mainly situated, however, within the field Human-Computer Interaction. Still, HCI itself is a multi-disciplinary research area, founded on the intersection of psychology, ergonomics and human factors (Grudin, 2012).

HCI started with a focus on engineering, ergonomics and efficiency. Lately the focus has shifted towards understanding the personal, social and cultural aspects of the overall experience people have with technology (M. Carter et al., 2014; Harrison, Tatar, & Sengers, 2007). Human-Computer Interaction research also expanded the focus beyond work scenarios and environments (Monk et al., 2002). In other words, HCI shifted from focusing on the *outcomes* of work to focusing on the *experience* of using technology in a variety of contexts. Consequently, this has led to a shift from approaches inspired by psychological studies towards approaches inspired by social science (Harrison et al., 2007).

McCarthy & Wright (2004) argued that a rationalist view of user experience does not capture the context: 'different individuals, or even the same individual at different times, may experience technology in quite different ways, and that is not easy to capture in rationalist models' (p. 26). Thus, they suggested situating the research in the field (as opposed to the lab), as close to the actual context of use as possible, which would allow the capture of 'sensual, emotional, volitional and dialogically imaginative aspects' of the user experience that would be otherwise missed (p. 184).

Back in 2006 Hassenzahl & Tractinsky called for more empirical research in the area of user experience studies. The call is still relevant in regards to studying the user experience of mixed reality environments, particularly running with mixed reality stories (MRS). The existing work on *Zombies, Run!* by Witkowski (2013, 2018) and Southerton (2013) focuses on specific aspects of the experience of running with this particular story, but might be insufficient for drawing a broader holistic understanding of the MRS format. Marshall & Benford's (2011) work features a larger sample of runners, yet is built around one-time events rather than ongoing running experiences. Other work, similar to this thesis, focuses on gamification (e.g. Steinberger et al., 2015), health benefits (e.g. Ma, Jain, & Anderson, 2014) or sociality (e.g. Mueller et al., 2003). Moreover, while Benford and colleagues (2009) studied the process of creating mixed reality environments, their work did not focus on how storytellers can affect the existing experience with activities such as running

This thesis is aligned with McCarthy & Wright's (2004) holistic worldview of experience and continues the corresponding trend in the Human-Computer Interaction field of research. It also aims to cover the gap in existing research by featuring a continuous study with a variety of runners and storytellers, and by focusing on the running experience itself, rather than practical benefits associated with running or exertion in general. Altogether, these factors situate the thesis with a constructivist epistemological stance and guide my research design towards qualitative ethnography-based approaches.

3.3 CONSTRUCTIVISM AND INTERPRETIVISM

Epistemology is the theory of knowledge (Crotty, 1998, p. 3). Epistemology questions the nature of what knowledge is. There are three main epistemological stances.

First, there is *objectivism*, which 'holds that meaning, and therefore meaningful reality, exists as such apart from the operation of any consciousness' (Crotty, 1998, p. 9). Knowledge exists on its own, and researchers are merely discovering it.

Second is *constructivism*: the view 'that all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world, and developed and transmitted

within an essentially social context' (Crotty, 1998, p. 42). Knowledge is not to be discovered but to be constructed 'in and out of our engagement with the realities in our world' (Crotty, 1998, p. 9). From that stance arises the proposition that different people or groups of people might construct different knowledge from the same phenomenon.

Finally, the third epistemological stance is *subjectivism*. It is similar to constructivism in that there is no single objective truth, yet different in its understanding of the source of knowledge: in subjectivism the meaning 'does not come out of an interplay between subject and object but is imposed on the object by the subject' (Crotty, 1998, p. 9).

As discussed above, this thesis focuses on people's experience with technology. It is based on a stance that such experiences are subjective, and meaning is constructed, in particular, in and out of interaction between people and technology; and thus, aligns best with constructivist epistemology.

Each epistemological stance ties to a particular theoretical perspective, which inform methodology, which in turn suggests the appropriate range of methods (Crotty, 1998). Theoretical perspective is 'the philosophical stance lying behind a methodology' (Crotty, 1998, p. 3).

Constructivist epistemology is tied together with the interpretivist perspective, which 'sees people, and their interpretations, perceptions, meanings and understandings, as the primary data source' (Mason, 2017, p. 56) and 'emphasizes meaningful social action, socially constructed meaning, and value relativism' (Neuman, 2014, p. 87).

In the context of UX research there are three prominent levels of interpretations. First, the participants interpret their experience. Second, the researchers interpret participants' interpretations. Finally, the researchers construct a framework or a theory for understanding the interpretations made on the second level (Corbin & Strauss, 2007).

Aligning with the constructivist epistemology and the interpretivist perspective also means acknowledging that there is no single objective interpretation of reality (Miles, Huberman, & Saldaña, 2013; Neuman, 2014, pp. 103–109). Thus, different interpretations are possible, which in turn means that researchers' perspective influence the outcome of the project. Another researcher presented with the same set of data could develop a very different set of frameworks. This is not to say, however, that every perspective is equally valuable. To evaluate the findings one ought to choose particular methodologies, aligned with the research aims, and follow the methods for data collection and analysis, justified by the choice.

3.4 GROUNDED THEORY METHOD

Epistemology and theoretical perspective deal with the questions of what knowledge is. Methodology analyses assumptions and principals in a particular approach to gain the knowledge (Carter & Little, 2007; Neuman, 2014, p. 2). Furthermore, methodology justifies the choice of methods (Crotty, 1998, p. 7).

This thesis is aligned with *Grounded Theory* methodology.

Grounded theory originates in sociological studies (Glaser & Strauss, 1967). Later, Strauss & Corbin (1990; 1992) systematised the process of developing a theory, basing it on three stages of coding: open, axial, selective.

In grounded theory research starts not with preconceived ideas but an area of study or a research question. While the theory is grounded in data, it only emerges during the coding stages, as researchers make meaning of the data. This methodology does not offer a rigid set of rules to follow but instead a set of techniques (Charmaz, 2006; Corbin & Strauss, 2007) for 'selecting cases, measuring and observing, gathering and refining data, analysing the data, and reporting on results' that are called *methods* (Neuman, 2014, p. 2).

Earlier studies of user experience relied mainly on quantitative methods, inspired by psychological studies (Harrison et al., 2007). However, in the last decade a noticeable shift happened towards qualitative methods, in an attempt to harness a better, more contextual, understanding of the rich and meaningful experiences people have with technology (Isbister & Höök, 2007; McCarthy & Wright, 2004). This shift is well aligned with grounded theory.

This thesis starts with an area of study (introduced in the previous chapter) and a set of research questions (introduced in the beginning of this chapter). The thesis employs grounded theory and qualitative methods, since they are best fit for addressing the 'why?' and "how?' questions, such as the ones guiding this project. The user experience, which is central to this research, is hard to quantify, as there are too many variables affecting the experience and the environment surrounding it. Quantitative methods do not allow gaining a rich understanding of lived experiences and subjective meaning. On the other hand, qualitative methods enable researchers to 'explore a wide array of dimensions of the social world, including the texture and weave of everyday life, the understanding, experiences and imaginings of our research participants… and the meanings that they generate' (Mason, 2017, p. 1).

During the data collection and analysis, Corbin and Strauss (2007) also recommend using related literature, as it might help to contextualise emerging findings. Charmaz (2006) warned, however, against forcing preconceived ideas on the data, as that contradicts the purpose of the grounded theory (pp. 155–158). Still, she notes that in practice it is impossible for the researcher to stay fully uninformed of the existing related literature until the theory forms.

The two following subsections will describe in detail how data collection and analysis methods used in the thesis are designed to form a significant contribution to knowledge, according to the grounded theory methodology.

3.5 DATA COLLECTION

Case Studies

Case studies focus on an in-depth examination of a single example of the phenomenon of interest (case). According to Stake (2000) there are three types of case studies: *intrinsic*, *instrumental* and *collective*. Intrinsic case studies are more apt for an exploration of an intrinsically interesting case. In an instrumental study, the case plays a secondary role, as a vehicle for facilitating understanding of something else. A number of cases jointly studied 'to investigate a phenomenon, population or general condition' constitutes a collective study (Stake, 2000, p. 437).

This thesis happens to feature all three types of case study. The first study is set up as an exploratory intrinsic study of the experience with *Zombies, Run!*. It capitalises on the unique opportunity to explore the experience with a commercially successful MRS for running and sets up the foundation for the following studies.

The third study consists of instrumental studies of three different MRS, which collectively form a collective case study. Study 3 helps to test how generalisable the findings from Study 1 and Study 2 are by comparing and contrasting more cases with different mixed reality stories.

Study Environments

As mentioned before, lab research can feel like an artificial environment for the participants, who can lead to the loss of context (McCarthy & Wright, 2004, p. 184); on the other hand, a more natural setting allows for better capturing of real-world behaviours (Tuffin, 2005, pp. 20–22). Field—as opposed to lab—research is also more aligned with the aims of grounded theory, which is to ‘discover rather than test variables’ (Corbin & Strauss, 2007, p. 12).

For that reason, participants in Study 1 were allowed to run wherever and whenever they wanted over the course of three weeks. Such an approach let runners experience *Zombies, Run!* in an environment that was most natural for their runs. Similarly, the writing environments in Study 2 were unconstrained for the participants. They had to follow a particular format and had to finish a story till the end of the study, but they still had freedom in all other aspects, such as choosing where and how to write.

Nevertheless, there are downsides to a more naturalistic approach, namely that it provides less control over external factors. However, the structure of this project allowed me to address this shortcoming by balancing a more natural study with a more controlled one. Since Study 3 focused not on exploration but evaluation of emerged findings, it followed a slightly different approach. It still was not conducted in a lab, but all participants were invited to the same location, the University of Melbourne Parkville campus. This allowed, for instance, the comparison of the route choices different participants made while running. It also allowed me to interview participants right after they finished their runs, while their memories were still fresh.

With mixed and virtual reality research, interaction happens in augmented or fully virtual locations. Some researchers argue that there is benefit in studying such locations in a matching context. For example, Boellstorf (2008) did not interact with participants face-to-face but instead conducted the interviews in the virtual world. This approach is known as 'virtual ethnography' (e.g. Moore, Ducheneaut, & Nickell, 2007). While virtual ethnography can sometimes be expanded for mixed reality, it was not the case with this project: since the mixed reality stories are audio-centric. Asking the questions via the same medium would risk changing the nature of the mixed reality, thus affecting the experience. Instead, participants were interviewed at the location of their choice in Study 1 and on campus in Studies 2 and 3.

Prototypes

As mentioned in the previous chapter, this project benefited from the existence of an established commercially successful MRS for running. The existence of *Zombies, Run!* allowed me to employ it in Study 1 in order to explore the existing experience people already have with MRS. Nevertheless, I decided that the consequent studies would benefit from custom-made prototypes, designed to test the assertions emerging from Study 1. In fact, Study 2 was not only about studying running with MRS from the writers' perspective but also laying a foundation for the development of new MRS. Three MRS prototypes developed in Study 2 then served as vehicles for Study 3, each driving their own instrumental mini-study (Stake, 2000, p. 437).

The process of creating the prototypes itself inspired reflection and illuminated insights that could be missed otherwise (Klemmer et al., 2006). Furthermore, the scripts developed during the course of Study 2 also served as data points, and were analysed together with the interview transcripts.

There were limitations imposed by the nature of prototypes. Most importantly, creative writers were asked to make only one episode: requesting one story was a reasonable request on the author's time, but it also meant that runners would not be able to have a continuous experience with their story. This limitation was mitigated, however, by the three-study nature of this thesis: Study 3 was complimented by Study 1, which had less stories than Study 3 but a longer running period.

Semi-Structured Open-Ended Interviews

Semi-structured open-ended interviews, also known as qualitative interviewing (Mason, 2017, p. 62), is the main method of data collection in all three studies in this thesis. Semi-structured interviews are particularly good for capturing details of a personal experience with technology, since they allow researchers to gain access to information that cannot always be observed externally (Weiss, 1993). Unlike surveys, qualitative interviews are driven by open-ended questions to provoke detailed and personal responses (Fontana & Frey, 2000). Bargas-Avila & Hornbaek (2011, p. 2693) found that a semi-structured open-ended interviews is the most popular method in the qualitative studies of the user experience.

In a semi-structured interview meaning is constructed by the participant and the researcher together, which aligns well with the interpretivist perspective (Rapley, 2001). Since the researcher influences the outcome, it is important not to guide participants towards particular answers: even the way questions are asked can reveal researcher's preconceived notions (Charmaz, 2000; Weiss, 1993). At the same time, it is important to reassure the participants that the researcher is actively listening, for instance by paraphrasing and repeating significant details back to the participant (Weiss, 1993). In the context of grounded theory, it is particularly important for the researcher to ensure that the thematic codes come *from* the participants, and are not imposed *on* them by the researcher. It is only after the codes started to emerge that the researcher might clarify the focus for the subsequent interviews (Charmaz, 2000, p. 514).

While an interview might take many forms, including long distance, such as a Skype call or instant messaging, generally a face-to-face interaction is preferable. Thus the studies mainly featured interviews conducted this way. Still, when using grounded theory method, data analysis is performed in parallel with data collection, which means that data analysis might reveal that something important is missing from the interviews, while data collection is still going on. For such occasions, prior to each study participants could opt-in to additionally answering follow-up questions via email, in case they emerged during analysis.

Creative Workshops

For Study 2, the interviews were integrated in a creative workshop, inspired by actual *Melbourne Screenwriters* workshops. This approach was employed to introduce the participants to the novel story format. In line with other grounded theory research, it was important not to impose any ideas regarding the format (Sengers & Gaver, 2006). Instead, workshops allowed writers to discuss their understanding of the format among their peers. From that perspective it was similar to the 'think aloud' approach, which is commonly used in HCI for evaluating research prototypes (Ramey et al., 2006).

Group Interviews

Most interviews in Studies 1 and 3 were one-on-one. There were, however, opportunities for participants to be interviewed together, if they knew each other and wanted to be interviewed together. Participating together could help participants to feel more relaxed during the interview; to ask their friend for help when they struggle to describe something by themselves; and also to bounce off something that the other person had said, elaborating on the remark (Fontana & Frey, 2000). Moreover, since participants in group interviews knew each other, they were less likely to be afraid of sharing something out of embarrassment, which is more the case for strangers (Weiss, 1993).

All interviews bar one in Study 2 were group interviews, since they were integrated into the workshops in the follow-up discussions. On the contrary, none of the participants in Study 2 knew each other prior to the study (or at least, they decided not to disclose that they did).

Audio Recordings

All interviews were audio recorded, which is common for qualitative interviews in grounded theory (Corbin & Strauss, 2007). Recordings allow the researcher to return to the interview and capture details that could be missed during the session. It is particularly important in grounded theory, since the significance of any particular code might change through the data analysis process, and therefore what seemed insignificant during the interview might become important afterwards.

Video Recordings

Video recording is becoming increasingly popular for interviews (Blomberg, Burrell, & Guest, 2002), in particular due to video-recording tools becoming cheaper and more accessible. Video recordings might provide significantly more visual cues, such as a participant's facial expression or environmental details. This can be helpful when sharing interviews within a research group, and also for invoking more details of the interview during a rewatch (DuFon, 2002; Heath & Hindmarsh, 2002).

Nevertheless, there are downsides to video recordings: most notably, they increase the time required for the analysis. Their usefulness is particularly questionable in the context of studying user experience, since such studies generally focus on internal experiences.

In the course of this project, video recordings were used in Study 2, since that study was following creative writers, and not focusing on the runners' internal experience. Creative workshops were organised in the Interaction Design Group's Lab at the University of Melbourne, which allowed the use of built-in cameras in the ceiling, which are less

distracting to the participants compared to a camera set up on a tripod[1]. The initial stage of data analysis, however, failed to demonstrate any significant benefits of video recordings for this project, and thus, video cameras were not used for the consequent sessions.

Public Interviews

Another benefit of studying a commercially successful mixed reality story is the public availability of the interviews with the developers and story author. Such interviews were used in Study 2 for getting an insight into the creative decisions behind *Zombies, Run!* and then comparing it with the participant interviews.

Use of online data can sometimes raise ethical concerns, as even when people's online presence is public they might not like their behaviours being observed and then reported without protecting their privacy (Kozinets, 2002). All the interviews in Study 2, however, were already meant to be read by a wide audience, which mitigated any possible concerns.

Questionnaires

Study 3 also made use of questionnaires (Appendix III.IV) that proved to be useful in Study 3 due to a significantly increased number of participants compared to Study 1. Questionnaries were used to quickly capture information that generally did not require an elaborate response from the participants, such as their age and occupation, how familiar they are with the campus, whether they usually listen to music while running, and so forth.

Diaries

A downside of a naturalistic approach in regard to running is that it might be difficult for the researcher to observe the participants in situ. While it is oftentimes possible for a researcher to place themselves among the participants and observe from within (Jorgensen, 1989), this was not the case with running studies in this project: the mere presence of the researcher during a workout would significantly affect the experience.

Similar to qualitative interviews, diaries help in capturing inner thoughts and feelings that might otherwise be hard, or even impossible to observe (Toms & Duff, 2002). Diaries also allow the comparison of earlier and later experiences. Moreover, diaries help

[1] Participants were informed about the video-recording and had to give their explicit consent in order to continue with the study.

to better see the participants' perspective, since they make entries on their own, without the presence of the researcher.

In Study 1 diaries served to capture thoughts that participants had right after they had a run with the MRS. Since they already had their phone with them for running and were outdoors, it was more convenient for them to make audio entries with the built-in voice recorder.

The main drawback with diaries is the burden they place on participants: they have to remember to make entries, and also must be motivated enough to do so (Alaszewski, 2006). To address this concern, diaries were only used in one study out of three, and even in that study the diaries were optional for the participants.

Interview Props

During the interviews, additional props were used to inspire participants. The approach was inspired by 'photo elicitation' (Harper, 2002) and 'cultural probes' methods (Gaver, Dunne, & Pacenti, 1999) used in some social studies, including Human-Computer Interaction. Both methods work in a similar manner: additional objects are introduced, such as photographs, to invoke reflection from participants, similar to how people start telling stories when sharing their photo albums with friends and relatives (Chalfen, 1987).

Over the course of this project, four types of props were used during the interviews: running logs, scripts, diary transcriptions and questionnaires.

Running Logs

This thesis does not focus on the practical benefits of running with mixed reality stories. Still, running logs were collected with the permission of the participants but for a different purpose to measuring performance. In this project, running logs mainly served as interview props for participants to recall particular details of their runs. Running logs could remind them, for instance, of a run that happened late in the night, or of a run that made them take an unusual route. Moreover, Study 3 employed running logs in a similar fashion, except that this time there was generally only one running log per interview, which made it easier for participants to focus on a particular run. It was also easier to remember particular details, since the interview took place immediately afterwards.

Scripts

Similarly, scripts written during Study 2 were used in the follow-up interview with the creative writers. Participants could, for instance, elaborate on any particular part of the dialogue or a plot twist. Writers also had each other's scripts, so they could ask their peers about anything that might catch their attention.

Diary transcriptions and questionnaires

Finally, diary transcriptions in Study 1 and questionnaires in Study 3 were used as interview props in the corresponding studies. In Study 1 excerpts from a runner's diary were brought to the interview so that the runner could elaborate on a particular quote or just better recall that particular run. In Study 3, participants' own questionnaires were presented back to them during the interview. While generally questionnaires did not require any additional explanations from the participants, they still could occasionally invoke reflection.

3.6 DATA ANALYSIS

Coding

This thesis adopts qualitative analysis guided by the principles of grounded theory method. Qualitative analysis is based on an inductive approach, which means that thematic codes emerge from the data during the analysis. With each iteration, a researcher clarifies the importance of each code, and also the relationships between them—until saturation is reached (Corbin & Strauss, 2007). The approach starts with more specific observations and moves towards more abstract concepts (Neuman, 2014, p. 60). Since data analysis in grounded theory goes in parallel with data collection, it is recommended to transcribe audio and video recordings as soon as possible, ideally right after the recording has been made (Charmaz, 2000; Hammersley, 2010). Following the recommendation, I began analysing the first interview of the first study shortly after it was recorded. I also did all of the transcriptions myself, to familiarise myself with the data (Patton, 1980).After the data has been transcribed, Corbin & Strauss (2007) recommend a three-stage coding process for identifying recurring themes and examining the relationships between them.

The first stage, **open coding**, reveals the preliminary themes. To identify the emerging codes I was mainly looking for sections of the interview transcripts that seemed relevant to the research questions, repeating parts that occurred frequently, and aspects of the experiences that seemed particularly important to the participants, even if they were not mentioned frequently. I was also looking for differences in participants' experiences.

Then the second stage, **axial coding**, examines the relationships between the themes and develops sub-themes. While open and axial coding are described as two separate stages, in practice they merged for me, as from the beginning I was thinking about possible connections and relationships between the codes. Throughout the process I discussed the emerging codes with supervisors and peers, and on a few occasions presented preliminary findings to a broader audience. These discussions helped me to clarify the codes and the overall hierarchy.

Finally, the third stage, **selective coding**, gathers all the relevant data in accordance with the established themes. As data collection and analysis happen simultaneously, it becomes possible to end data collection when new insights cease to emerge from the analysis, in other words, when data reaches saturation (Corbin & Strauss, 2007).

Computer Assisted Data Analysis

The use of software can facilitate data analysis (Bringer, Johnston, & Brackenridge, 2006) by allowing researchers to attach several codes to a single piece of data; nest codes within one another; easily rename or merge codes; set up search criteria, which would highlight only specific pieces of data; manage large sets of data; synchronise the results between different devices, as well as share with other researchers. There are limitations and downsides to the use of software as well: for instance, the amount of data presented at any given time is limited by a device's screen size. Most importantly, however, the software might influence researchers' interpretation of data (Corbin & Strauss, 2007).

Over the course of the thesis, I used *DEVONthink*[1], and *MindNode*[2], in addition to paper-based analysis. In the consequent chapters I will describe in detail ways in which I employed each application during the data analysis stage. This is important to ensure the transparency of the process, as advised by Bringer, Johnston, & Brackenridge (2006).

Presentation

While it might seem that presentation is done after the analysis is concluded, in the grounded theory approach, the presentation by itself can inform the analysis (Charmaz, 2000, p. 536). In the course of the project, I presented the preliminary results from the studies in various forms and to different audiences. The feedback following early presentations informed the consequent iterations of data collection and analysis.

A researcher rarely presents collected data in full, and therefore has to make decisions on what to present, when and how. Charmaz argues that the presentation should focus on the main arguments, and that themes that are irrelevant to the argument should be removed for clarity (2000, pp. 156–167). Data analysis can proceed further into later stages of a project, including the writing up. In my case, I did not need to omit any themes, but I did end up rethinking ways in which they are organised and relate to each other very late into the writing up process. This is most noticeable with changes to the way Study 1 findings were presented in an early conference publication (see Appendix I.VI) compared to the final version presented in this thesis.

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[1] https://www.devontechnologies.com/apps/devonthink
[2] https://mindnode.com

3.7 EVALUATION

3.7.1 Quality Criteria

Due to the subjective nature of the interpretivist approaches, different researchers might come up with different ways of interpreting data. This, however, does not mean that every interpretation of the same data set is equally valuable. Thus, it is important to ensure the *quality* of qualitative research.

The quality criteria of quantitative research do not translate well for qualitative research (Whittemore, Chase, & Mandle, 2001). Qualitative research tends to be more flexible (Charmaz, 2000, p. 9), thus, the criteria have to account for not only scientific rigor but also subjectivity and creativity (Johnson, 1999). Two main criteria Whittemore, Chase & Mandle (2001) suggest for ensuring the quality of the results are credibility and criticality.

Credibility refers to the accuracy of data interpretation, which includes the portrayal of the participants and the phenomenon in question. To reach credibility a researcher has to assure that results reveal the truth outside of their own experience. That requires being attentive to the uniqueness of the voices of the participants, particularly those whose experience is different to the researcher's, along with receiving confirmation from participants that the findings reflect their actual experience (Lincoln, 1995; Lincoln & Guba, 1985).

Criticality refers to the repeating checks that data interpretations are grounded within the data. To reach criticality a researcher must be self-critical and reflective at each stage of the research process. This requires acknowledging how their background and prior knowledge might influence their interpretations. It also requires an awareness of contradictions and ambiguities within the data. The researcher must actively seek rival explanations and make each stage of the research process transparent for the audience, as well as check the preliminary results with other researchers.

3.7.2 Techniques

To ensure that the quality criteria are met, I employed a number of techniques for each stage of the research process:

Research Stage	Technique
Design and planning	Reflexivity
	Triangulation
Data collection	Memoing
	Member checking
Data analysis	Expert checking
	Exploring rival explanations
Presentation	Applicability
	Transparency

3.1 Research Techniques

Reflexivity

Kozinets (2002) suggests that reflecting on their own experience could help researchers gain additional insight. To address criticality criteria throughout this project I was questioning how my own background, prior knowledge, and assumptions might influence the way I collect, analyse, and present the data. While it is impossible to remove one's personal subjective perspective entirely, there are ways to reduce its influence and to ensure that it does not significantly distort the emerging theory.

For instance, I started running on my own prior to conducting Study 1, and later joined two running groups in Melbourne (not simultaneously). This, hopefully, helped me to better relate to other beginner runners in both Study 1 and 3, and maybe notice similarities and differences from my own experience that I would miss otherwise (boyd, 2007). Moreover, my lack of experience could also affect the way experienced runners see me: experts talk differently to amateurs compared to how they talk among themselves (Fine, 1983). To address that, I suggested group interviews for participants who knew each other. This way they could be more comfortable talking about some aspects of the experience they would not bring up during a one-on-one interview.

In another instance, the results from Study 1 suggested ways in which ways MRS might differ from traditional audio-stories. Still, I did not want the participants of the following study to be guided by that knowledge in a particular direction; instead, I wanted to see what are the differences from their perspective. Thus, I chose not to reveal to the writers from Study 2 the what preliminary findings of Study 1.

Triangulation

Semi-structured open-ended interviews come with their own shortcomings: there might be misunderstanding between participant and researcher: participants might intentionally deceive the researcher; participants might want to avoid certain topics, and so on (Bainbridge & Douglas, 1977, pp. 57–81). To mitigate the issues, I used triangulation (Neuman, 2014, p. 166). Instead of relying on a single method for data collection, I combined data from several methods, described in the previous section, and then compared them in order to gain a more holistic understanding of the user experience. With triangulation, findings do not have to rely on a single method and can be cross-checked across different data sources (Neuman, 2014, p. 166). In this project I recruited two different sets of participants, runners and creative writers, who allowed me to tackle the research question from different perspectives. Moreover, the three-study nature of this project allowed for comparisons and contrasts to be drawn between the findings of each study. The absence of contradiction between different sources increased the credibility of the overall findings (Hammersley, 2003).

Memoing

Analytic memos serve as a step between data collection and a completed iteration of data analysis (Charmaz, 2000, p. 517). Memos document how codes emerge from the data, ensuring the grounded nature of the results (Charmaz, 2000, pp. 517, 518). Thus, memos allow tracking researchers' decision process (Corbin & Strauss, 2007; Miles et al., 2013), which in turn makes the research process more credible. Moreover, memos can spark new thinking by reminding the researcher of details they might have forgotten otherwise. Finally, memos on their own can serve as means to discuss the research with peers and supervisors (Birks, Chapman, & Francis, 2008).

Throughout the project I took memos, capturing my observations at the time, developing initial concepts, and exploring potential connections between thematic codes. Personally, I tend to capture memos in the form of outlines and mindmaps, toying with different ways of organising emerging thoughts. Thus, it was common for me to base early publication drafts and presentation slides off the analytic memos I already had (see Section 4.1.4).

Member Checking

As noted above, it is crucial to ensure that the way findings are described reflect the actual experience of the participants (Whittemore et al., 2001). To that end, I sought feedback from the participants to ensure that I understood their experience correctly and did not misinterpret their words (Neuman, 2014, p. 440). During the interviews, I would paraphrase points that seemed important back to the participants for validation. During data analysis, I sent follow-up questions via email. Furthermore, I sent publications arising from Studies 1 and 2 to the participants, who had agreed to receive additional

materials emerging from the studies. No participants reported feeling mischaracterised in response.

Expert Checking

In a similar vein, it is essential to seek feedback from other researchers (Corbin & Strauss, 2007). I presented the preliminary findings from this thesis at both academic and industry conferences, participated in a doctoral colloquium at OzCHI in 2013, prepared seminars for the Interaction Design research group at the University of Melbourne, and consulted with my supervisors throughout the course of the project. The responses I gathered allowed me to clarify the results, strengthen the claims, and provide more transparency to the parts of the process that seemed opaque to the audience.

Exploring Rival Explanations

An essential part of being critical of one's research is exploring rival explanations to make sure that the researcher does not merely observe in the data the results they want to see (Whittemore et al., 2001). I followed this technique in each study, as well as with the overall results, which is why I inquired, for instance, if novelty effect could be the main driver behind the findings of Study 1 and 3 (Sections 4.4 and 6.4 respectively) or whether the limited number of writers is the reason why the findings of Study 2 turned out to be the way they are (Section 5.4).

Applicability

While it is important to ensure that the results are grounded in data coming from the project, it is also important to argue that the implications from these results go beyond just a single project (Glaser & Strauss, 1967). The multi-study nature of this thesis allowed me to establish that the same themes were emerging throughout different contexts, thus suggesting the applicability of the results beyond this thesis. Moreover, to support the applicability of the findings outside this project, I extracted practical suggestions for researchers and designers of future MRS, and provided specific suggestions for the future work in the area (Section 7.4).

Transparency

Finally, the research must be described in a transparent way (Miles et al., 2013). This increases credibility by allowing other researchers to validate each step in the research process, and to then search for potential inconsistencies. To that end, I describe each stage of the project in detail, and provide additional material for each study in the Appendices.

3.8 STUDY DESIGN

So far, this chapter serves to situate this thesis amongst existing research work: it justifies the chosen epistemology, theoretical perspective, methodology, and a set of methods for data collection and analysis:

Epistemology: *Constructionism*

Theoretical perspective: *Interpretivism*

Methodology: *Grounded Theory*

As discussed above, different methods come with different trade-offs. Thus, all three studies were designed differently, so that each could negate some of the downsides of the approaches used in other studies.

Title	RQ	Participants	Data	Summary
Study 1: Exploring the Experience of Running with Mixed Reality Stories	What is the current user experience of running with mixed reality stories?	Runners	Semi-structured interviews, diaries, running logs	Three week trial of *Zombies, Run!*+ interviews before and after the trial
Study 2: Creating Mixed Reality Stories for Running	How do storytellers address the user experience of running when creating mixed reality stories?	Creative writers	Creative workshops, semi-structured interviews, scripts, public interviews with the creators of *Zombies, Run!*	Creative workshop + developing a story + follow-up discussion
Study 3: Understanding the Perception of Mixed Reality Stories	How do runners perceive mixed reality stories while running?	Runners	Semi-structured interviews, running logs, questionnaires	A run on campus with one of the prototypes + interview afterwards

3.2 Study Design Overview

Study 1 is an exploratory study of the experience that runners have with *Zombies, Run!*. It addresses the lack of empirical research in the area and lays out the foundation for the consequent studies. In the tradition of grounded theory research, its findings are mainly based on the semi-structured open-ended interviews. Some participants keep audio diaries throughout the trial period to capture their experience right after they finish running. Additionally, running logs serve as props to evoke memories and reflection during the interviews.

Study 2 capitalises on Study 1 findings but from the creative writers' perspective. Consequentially, its design starts with creative workshops that aim to introduce mixed reality stories to the writers and encourage discussion among peers. The insights from the workshops and the follow-up interviews are complemented by the analysis of the scripts developed during the course of the study, as well as by the analysis of the public interviews with the *Zombies, Run!* creators.

Study 3 is a collective case study with three MRS prototypes: each prototype serves as a mini-case. It introduces interviews with more structure compared to Study 1, as the thematic codes are more formed at this stage. It also features questionnaires, designed to accommodate for the increased number of runners compared to the first study. Study 3 validates and extends findings from Studies 1 and 2.

4 STUDY 1: EXPLORING THE EXPERIENCE OF RUNNING WITH MIXED REALITY STORIES

The previous chapter broke down the overall research question into three sub-questions, so that each of them would guide one of three studies. The first study was intended to be an exploratory study of the existing experience of running with mixed reality stories (MRS). Thus, the initial question behind the study is

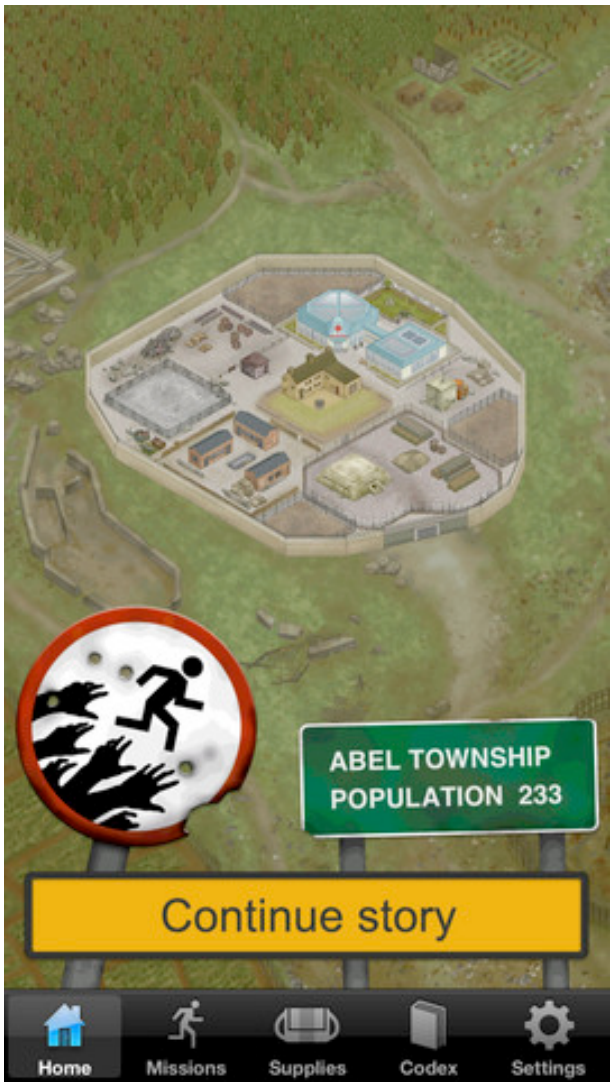
What is the current user experience of running with mixed reality stories?

To address the question, *Zombies, Run!* was chosen over the other existing MRS and deployed to 11 participants to run with for three weeks. Two interviews were conducted with each participant, one prior to the study period, and one after it ended. Moreover, runners were asked to keep a brief audio-diary throughout their use of *Zombies, Run!* and to provide access to their running logs.

The findings from the study revealed the hybrid nature of the experience of running with MRS and suggested how runners balance different aspects of the experience with voluntary engagement. Moreover, they reveal how significant to the experience people's attitudes towards running are. On top of that, the findings suggest that mixed reality stories are significantly different from audiobooks and mixed reality performances in the experience that they create.

4.1 DESIGN

4.1.1 Preparations



4.1 The Main Screen of *Zombies, Run!*

Zombies, Run!

Zombies, Run! seemed like a natural fit for the first study, due to the quality of writing, a wide variety of available missions, and its commercial success. Nevertheless, I did consider some other options, namely *Runtastic Story Running*, *Ingress*, and creating a custom-made prototype. None of them, however, could best *Zombies, Run!*. *Runtastic Story Running* was nowhere near as successful with runners, and the stories lacked the depth that the *Zombies, Run!* plot had. *Ingress* was not as story-centric as the other options. And starting with a custom-made prototype instead of an established MRS seemed like missing an opportunity. Thus, the decision to employ *Zombies, Run!* for Study 1 was made final.

The app featured a simple interface[1] with a single large button 'Start story'. After the first run, that button would be replaced with a button that says 'Continue story', which would continue the story from the point where it was left off (Figure 4.1). The simplicity of the main screen made it easy for runners to begin using the application.

Completing each mission advanced the story. The 11 missions used in this study were all in chronological order. There were no flashback missions or missions happening on a parallel time track. All *Zombies, Run!* missions were designed in a way so that mission time matched real-time in a run; in other words, 30 minutes of mission time would equal 30 minutes of running.

The app logged data about each run including time, distance, pace, playlist and location. All data was collected and stored on the device and in the cloud. None of the data, however, was used to affect the story in any way. The runner could evade zombies by sitting on a couch at home, if they so wished.

Ethics

All of the potential study participants were informed about the purposes of the study, and the risks of running with headphones on (Appendix I.I). They were also informed that each participant would receive the *Zombies, Run!* app for free[2], and that I will have access to the running logs recorded during the course of the study.

Each runner had to explicitly agree to participate (Appendix I.II). Moreover, participants could opt in for receiving the summary of the findings via email. Runners could withdraw from participation at any point with no explanations needed.

The Human Research Ethics Committee approved the project under the project number 1238894.1.

[1] *Zombies, Run!* interface has changed over the years. Here I describe the version that was used in the study back in late 2012.
[2] At the time *Zombies, Run!* cost AU$8.49 to download. In May 2015, the app switched to a free-to-play model with some optional paid features and a paid membership that unlocks unlimited access to game content (https://zombiesrungame.com/presskit/presskit.html#history).

4.1.2 Recruitment

Prior to starting the recruitment process, I joined two Melbourne running groups that I found via the Meetup website[1].



4.2 Melbourne Running Meetup

In both groups I introduced myself as a Human-Computer Interaction (HCI) researcher with an interest in running. My main purpose behind joining the groups was to better understand the running experience, since I myself did not run regularly prior to this study. This could provide me with some insights for the interviews later on.

With permission from the organisers, I also tried to recruit study participants in both groups via Meetup posts and personal conversations. To my knowledge, however, no participant came from the running groups. In hindsight, I suspect that *Zombies, Run!* was not a good match for these runners. Runners within running groups are more likely to be enjoying the social side of running, and MRS such as *Zombies, Run!* require the runner to put headphones on, focus on the story, and thus, in their current form are incompatible with social runs.

On the other hand, recruitment via the University of Melbourne Student Portal, advertisements on campus and a project website (Appendix I.III) was successful, with

[1] https://www.meetup.com/

more than 75 people responding. This number was a lot higher than required for the study, as similar qualitative studies in HCI (e.g. Barkhuus & Rode, 2007) and Game Studies (e.g. Väätänen & Leikas, 2009) suggested that recruiting 15 participants should be enough to lead to data saturation (Corbin & Strauss, 2007) in my qualitative analysis. Thus, I recruited participants on a 'first come, first served' basis. I responded to the rest via email, explained that unfortunately no more participants were needed for Study 1, and offered to contact them later in case there would be future studies involving runners. I added everyone who agreed to a waiting list, which I used later in recruitment for Study 3.

In addition, the very first participant was recruited through personal contact outside the milieu of the University and the running groups.

As the literature review demonstrated (e.g. Murakami, 2009; Oates, 1999), age, gender and cultural background play a significant role in shaping the experience of running. Thus, I was looking for a diverse set of participants. I started by keeping the requirements simple: participants had to be over 18 years old (inviting runners under 18 would require a justification for the Ethics Committee), had no health issues, and had an iOS or Android smartphone for installing *Zombies, Run!*. If the study were to receive interest only from runners of a particular background, I would introduce additional limitations to ensure the diversity of the participants. But that was not required in the end: 14 initial participants turned out to be evenly split among male and female, ranged from 19 to 60 years old, and contained several immigrants from other countries. The participants also varied in their prior experience with running, ranging from people who just wanted to start running regularly, to individuals who were already running a few times a week, including a marathon runner.

Of the 14 initial participants, 11 completed the study (Table 4.1). All 11 participants completed at least one run with the app. Two participants, who went furthest through the story, completed 11 missions. While it was possible to pick a mission out of order, all participants went through the missions in chronological order.

Note that participants №3 and №8 could only start running towards the end of a three-week period due to personal circumstances. Both mentioned that they would accomplish more missions during the period if they were able to. Of the 11 participants who completed the trial, 5 stated that they did not wish to continue using the application, 5 intended to keep using it, and 1 was undecided.

№	Gender	Age	Missions accomplished	Diary entries
1	F	30	1	
2	M	24	4	
3	M	39	1	
4	M	42	10	10
5	M	34	9	9
6	F	21	*Dropped out*	
7	M	60	*Dropped out*	
8	F	40	1	
9	F	19	11	
10	F	19	6	3
11	M	33	2	
12	F	26	5	
13	F	36	11	9
14	M	?	*Dropped out*	

4.1 Study 1 Participants

4.1.3 Data Collection

Interviews

I interviewed each participant twice: once prior to the trial period and once afterwards. There were also initial interviews with the three participants who dropped out later on. Those interviews were not used in the findings, as I lost contact with the runners and was not sure if they would still wish to be quoted in any publication arising from the study.

Each interview lasted for less than an hour, averaging about 45 minutes. All of the interviews were conducted in person. For both interviews participants could choose any location available to them in Melbourne or visit the Melbourne University campus. Participants could also opt to do a joint interview with other runners. As I did not disclose who the other participants were, a runner could only do a group interview with a runner they were acquainted with prior to the study. In Study 1 Runners №9 and №10, and Runners №12 and №13 decided to pair up for both the initial and the follow-up interview.

The interviews were loosely structured and thus adjustable for every consequent participant depending on the preliminary findings (Appendix I.IV). The initial structure

for the first interview was based around the participant's previous experiences with fictional stories, games and running. The initial structure for the follow-up interview was based on the participant's experience with *Zombies, Run!* and any changes in the overall experience the app might have introduced to the runners.

Diaries

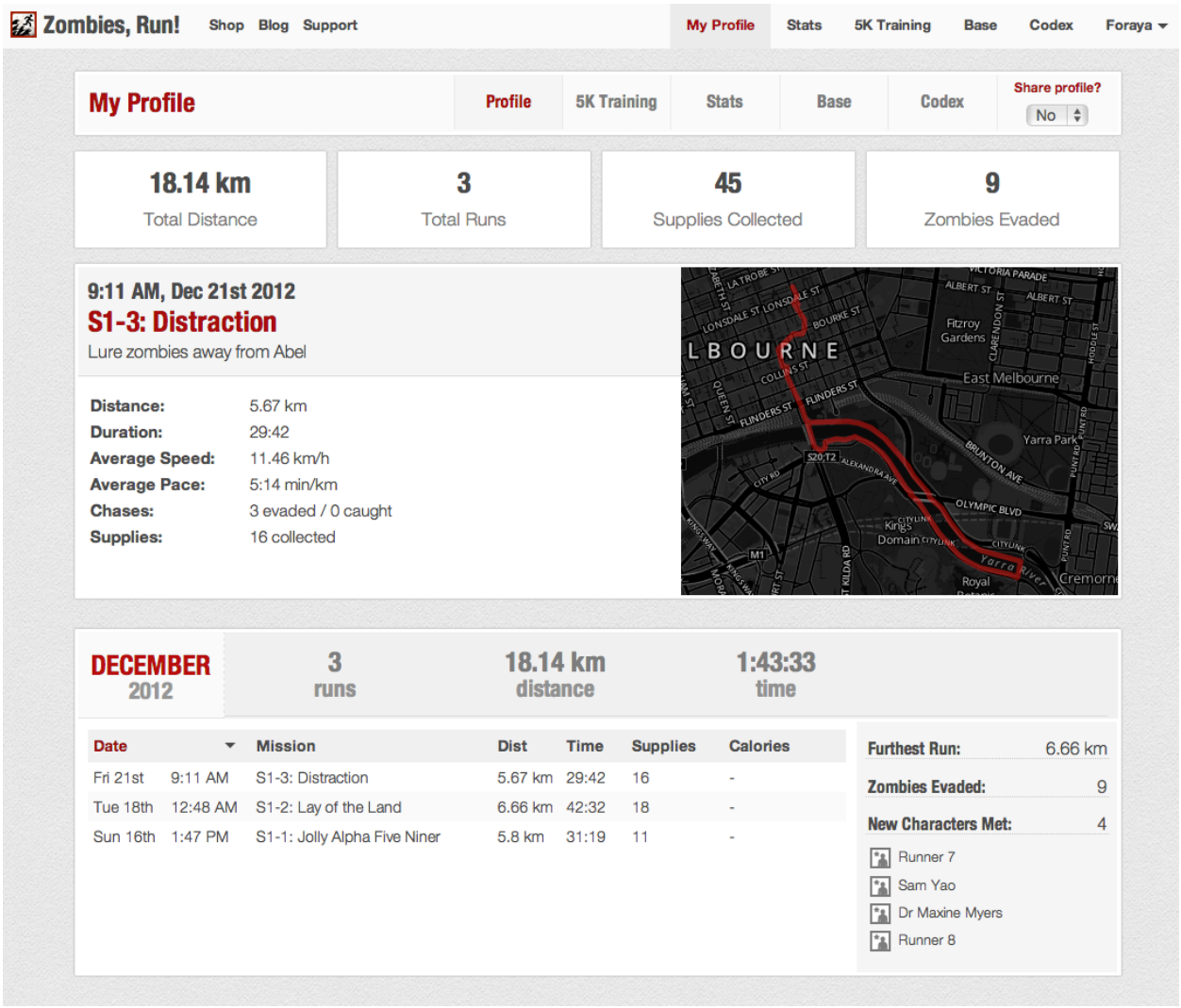
I wanted to make running feel as natural to the participants as possible (as advised by McCarthy & Wright, 2004), so I did not interfere during the trial period (participants, on the other hand, were welcome to contact me at any time, in case they had any additional questions regarding the study or the app). This meant, however, that I would not be able to ask questions during or right after a workout, while the memories of the experience were still fresh. And since running is a physically demanding activity, remembering precise details of a run weeks after the workout could be particularly challenging (Woźniak et al., 2015).

To address the issue, I asked the participants to keep a brief audio-diary. Keeping a diary can be a burden on participants (Alaszewski, 2006), so I tried to simplify the process as much as possible. Participants would already have their smartphones with them when running with *Zombies, Run!*, so asking them to record a voice memo with the built-in app seemed more apt than asking them to type a text entry. I provided a simple structure for an entry, splitting it into three parts: the fictional aspect of *Zombies, Run!*, the physical aspect, followed by any influence on the overall experience they might have noticed (Appendix I.V). I also clarified that even a brief (less than three minutes) entry would be valuable to the project.

Out of 11 runners, 4 provided diary entries by the end of the trial period. Runners №4, №5, and №13 recorded an audio entry for most of their runs. Runner №10 recorded an audio entry for three runs out of six. Diary entries were later analysed together with the interviews. I also re-listened to participants' entries prior to interviewing them for the second time, so that I could ask additional questions based on something they reported.

Running Logs

I asked participants to let the app log their workouts, and give me access to the data. *Zombies, Run!* kept track of the location for each run, its duration and length (Figure 4.3). As mentioned earlier, exploring any practical benefits of *Zombies, Run!* such as an increased frequency of running or changes in average pace were outside the scope of this project. Instead, I looked through each log to make notes and ask runners additional questions during a follow-up interview (for instance, I could ask about a particular run that happened late at night, in stark contrast to all other runs that happened during the daytime). Moreover, I used the logs as props during the follow-up interview: looking back at the routes they took allowed runners to remember some details that could be missed otherwise.



4.3 *Zombies, Run!* Log

I explicitly asked participants to use a temporary password during the trial period, one which they did not use anywhere else. This way after the trial concluded, they could simply change the password and continue using the app without losing their progress and without worrying that anyone would be able to see the logs from after the study.

Follow-Up Emails

Finally, there were two follow-up emails coming from two of the participants. Runner №1 explained in an email why she thought *Zombies, Run!* was not a good fit for her workouts. Runner №5 contacted me in response to the publication, that emerged from Study 1 (Appendix I.VI). He was pleasantly surprised to see many of his quotes presented in the findings: the app did not work particularly well for him, so he expected that his experience would not be of interest to the project. Runner №5 confirmed that I managed to accurately capture his main frustrations with *Zombies, Run!*.

4.1.4 Data Analysis

As described previously, four types of data were collected during the study: audio recordings of the interviews, audio-diaries, running logs, and follow-up emails. Running logs, however, were mostly used as props for the interviews: I would look through the logs prior to the second conversation with a runner, and then, during the interview, bring up anything that caught my attention. The follow-up emails from the runners provided a valuable confirmation that I did not misinterpret their experience, even though these follow-up emails did not bring any significant new information relevant to the scope of the project. Thus, my main sources of data for this study were interviews and diaries.

In alignment with the recommendations for the grounded theory approach (Corbin & Strauss, 2007), I started data analysis early: I transcribed the first interview on the same day it was conducted. Aside from transcribing each interview and diary entry, I listened to all of them several times to familiarise myself with the data (Patton, 1980).

My data analysis was guided by the three-stage coding process (Corbin & Strauss, 2007; Neuman, 2014). In practice, however, I started organising codes very early in the process, which made *open* and *axial* stages virtually indistinguishable for me. Thus, I do not make a distinction between open and axial codes, and refer to them simply as 'codes'.

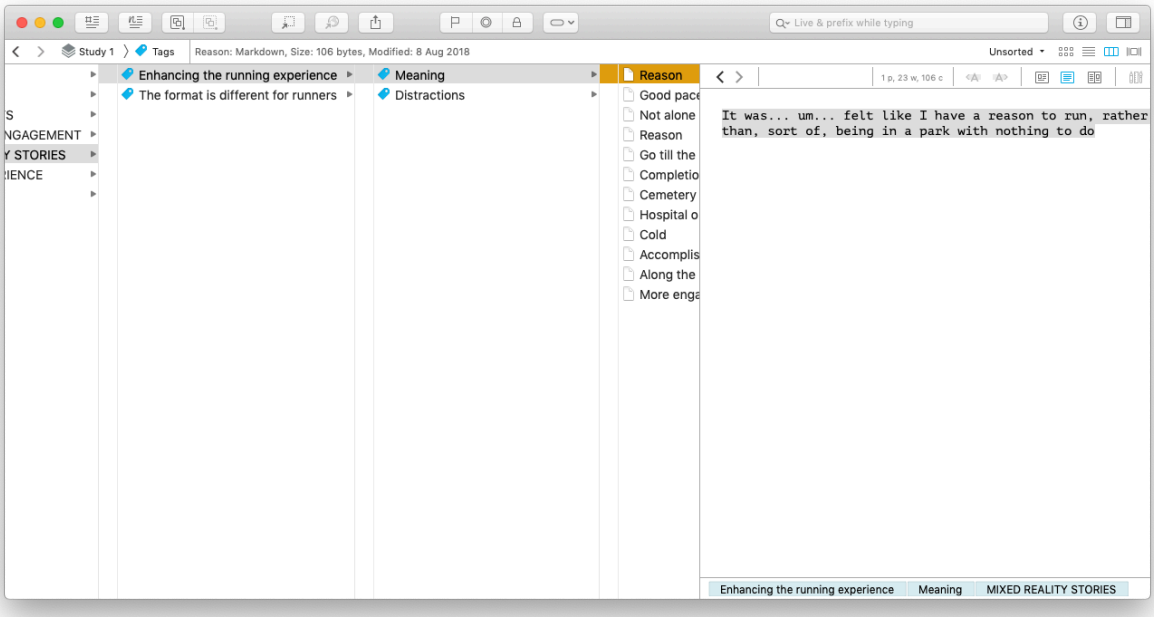
The research question guiding the study was '*What is the current user experience of running with mixed reality stories?*'. Therefore, during the first iterations, I was specifically looking for anything that could be relevant to addressing this question. In particular, I was looking for excerpts that describe participants' existing experiences with running (coded by *personal experiences with running*) and excerpts that describe how participants experience a story during a run (*experiencing story while running*). Three other codes (*hybrid experience*, *MRS format*, *enhancing the running experience*) also emerged due to their relevance to the research question.

Moreover, during the analysis I was also trying to note anything that would seem particularly important to the participants, even if that was not directly related to the research question. For instance, *attitudes towards running* was not something I was specifically looking for at first

On top of that, I was comparing parts of transcripts from different participants with each other, looking for differences and contradictions. While in the positivist research having conflicting data points might be an issue, from an interpretivist perspective no single objective reality exists (Miles et al., 2013; Neuman, 2014, pp. 103–109). Thus, instead of trying to establish which participant's experience is the 'true' one, I instead made sure to highlight the distinctions when presenting the results. For instance, participants having completely different *attitudes towards running* became one of the main insights of Study 1.

Finally, with each iteration I was searching for any other data instances matching the codes from the previous iterations. In many instances this allowed me to realise the complexity behind a particular code, and in some cases break it down into several smaller codes. For instance, *voluntary changes* first appeared as a single code, but after I started looking for it specifically, I realised that the *benefits* and the *downsides* of voluntary changes are significant enough to become their own codes.

I used DEVONthink[1] in my data analysis process (Figure 4.4). The app allows assigning multiple codes (tags) to any fragment of data (simple text files in my case); it allows nesting codes within each other; it allows highlighting any data fragment with one of six different colours, which in my case proved to be helpful for distinguishing some of the more important transcript excerpts from the less important ones; finally, it allows syncing data between devices, including mobile phones and tablets.



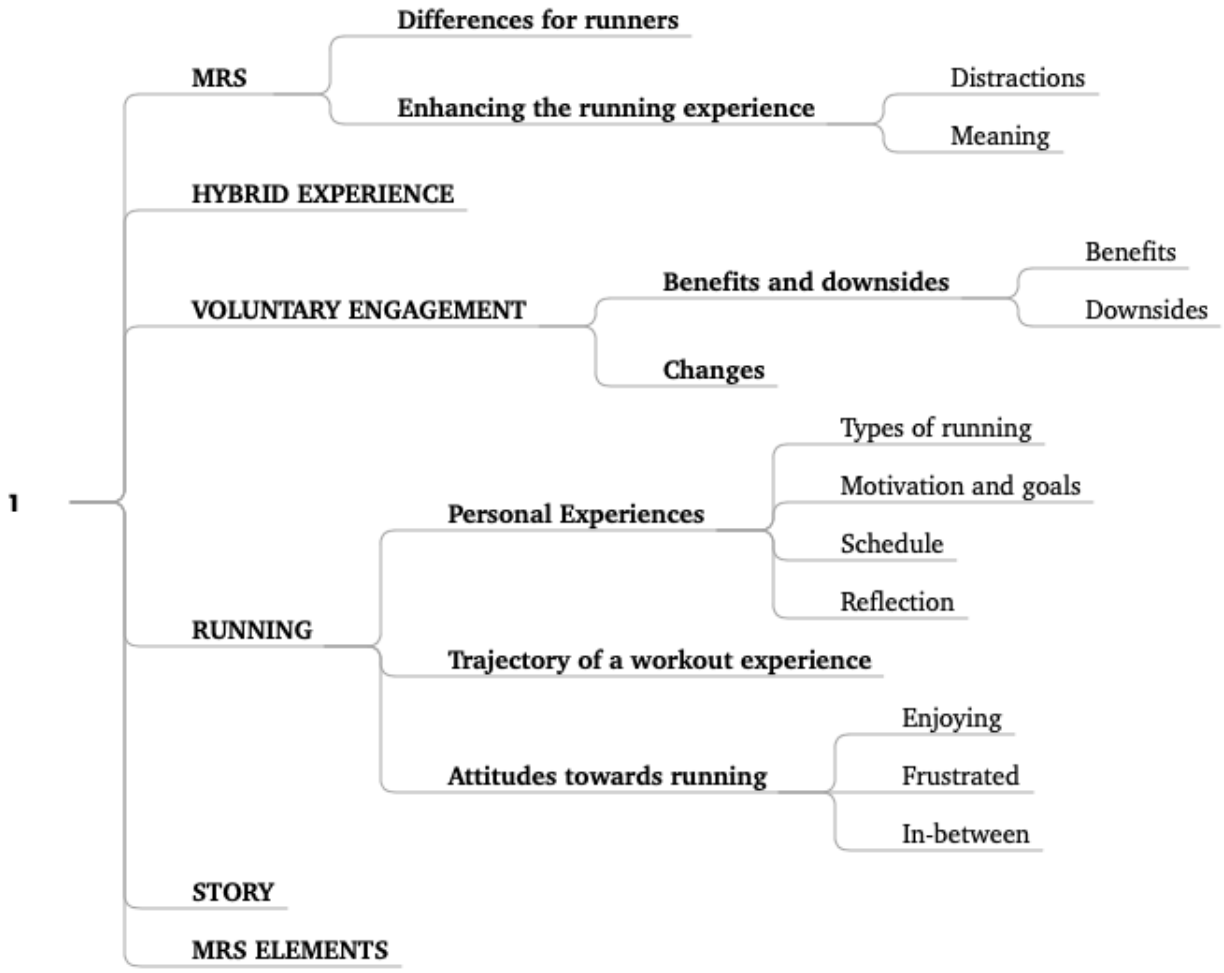
4.4 Coding with DEVONThink

Unlike some specialised software, such as NVivo, DEVONthink is not specifically designed for qualitative data analysis. Nevertheless, after some adjustment period, I found it to be faster and more suited to my personal workflow.

[1] https://www.devontechnologies.com/apps/devonthink

To overcome some of the limitations of DEVONthink I used additional tools. For instance, DEVONthink is not designed to provide an 'overview' of a large number of data fragments. For that purpose I still used a paper version of transcript excerpts, which were easy to group and quick to rearrange if needed. Similarly, DEVONthink does not provide an overview of the codes. To overcome this I kept copying the latest set of codes to a MindNode[1] file. MindNode allowed me to see all of the codes on one screen and freely move them around or nest within each other.

Figure 4.5 shows the final instalment of the code hierarchy made in MindNode:



4.5 Study 1 Themes, Categories, and Codes

With most iterations, relationships between codes were changing. Since the early stages it became clear that some codes naturally merge into larger themes. I ended up with three levels of hierarchy: **THEMES** (capitalised), **categories** (emboldened), and codes.

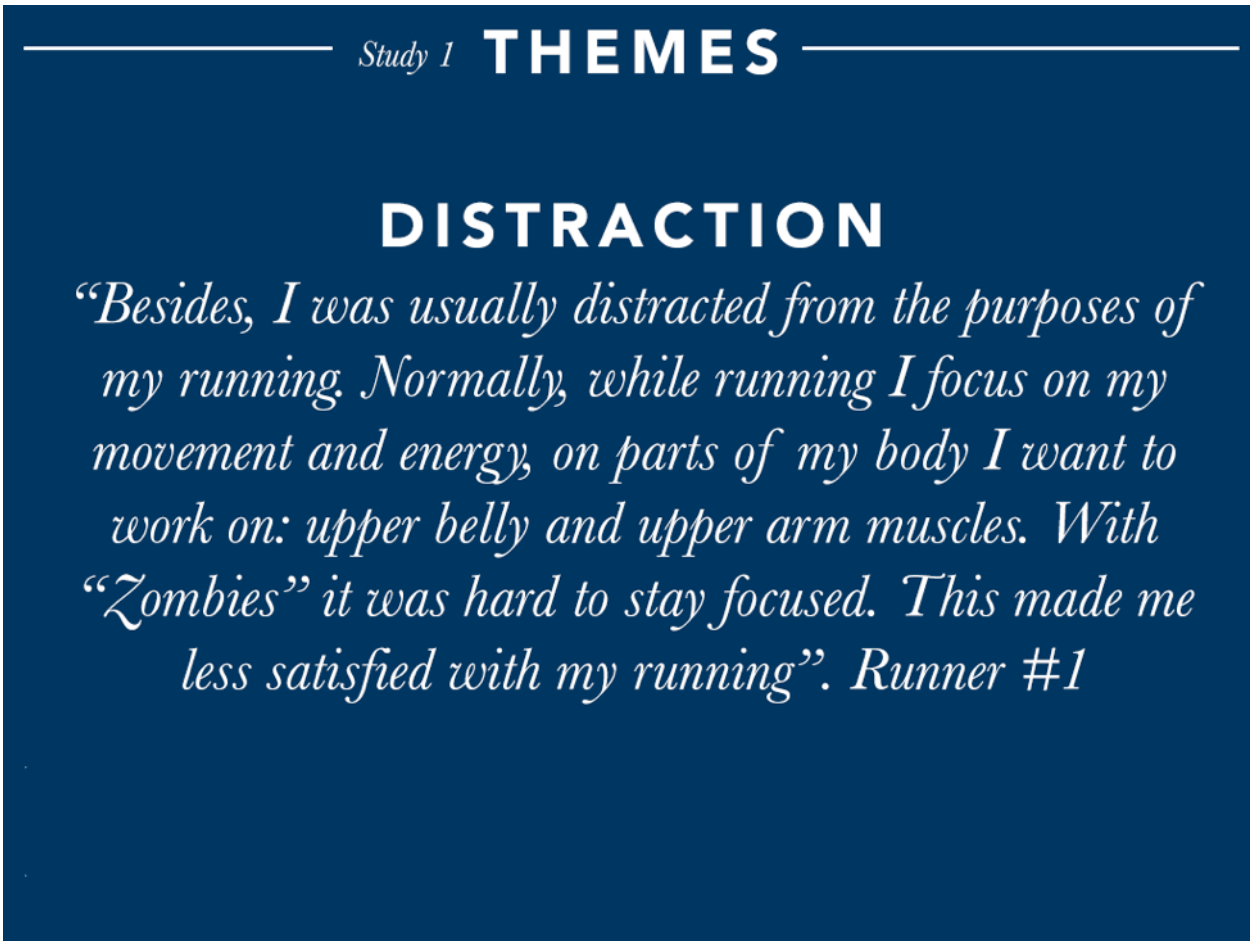
Generally, codes belong to a category, and categories form a theme. Each level, however, also represents a relative 'weight' in the overall structure, and thus sometimes a single

[1] https://mindnode.com

code can become a theme. This was the case with *Hybrid experience*, which became a theme despite not having sub-categories due to how central it was to the overall research question of the thesis.

Throughout the data analysis stage I kept writing analytic memos, reflecting on particular interview excerpts, codes, relationships between them, and possible theoretical concepts, which could encapsulate all the major findings emerging from the research (Miles et al., 2013).

While memos helped me to capture how my understanding of the project was evolving with time, I also found them particularly useful for presenting data (Birks et al., 2008). I used analytic memos to discuss the preliminary findings with my supervisors, my peers at the research group, and also for presenting to wider audiences at academic conferences. For instance, some of my notes easily turned into presentation slides, which would communicate my current understanding of the emerging themes and the relationship between them:



4.6 Study 1 Presentation Slide

While the thesis is written in a linear manner, with each study building on top of the previous one, in practice my analysis of Study 1 data did not finish until the very late stages of writing up. For instance, while during the early stages of conducting Study 1 I

noticed that some elements of MRS seem to influence the experience even when the story does not work, it was only after I started to analyse interviews from Study 3 that I realised the significance of this particular finding. The long-term nature of the project allowed me to then return to previous studies and take another pass at data analysis.

Similarly, the way I presented the results from the study was changing with time, and with each iteration I would perform another round of selective coding, trying to find the excerpts which would describe the underlying code in detail, yet succinctly at the same time.

For clarity and consistency between chapters, at this point I decided to present the codes and the overall structure in a way that reflects my thinking at the late stages of conducting this thesis. An example of a less developed iteration could be found in a publication that emerged from Study 1 at a much earlier stage (Appendix I.VI).

4.2 FINDINGS

During the data analysis stage 10 categories were formed:

THEMES	Categories	Codes
RUNNING	**Personal experiences with running**	– types of running – motivation and goals – schedule – reflection
	Attitudes towards running	– enjoying – frustrated – in-between
	Trajectory of a workout experience	
STORY		
MRS ELEMENTS		
VOLUNTARY ENGAGEMENT	**Changes**	
	Benefits and downsides	– benefits – downsides
MIXED REALITY STORIES	**Enhancing the running experience**	– distractions – meaning
	The format is different for runners	
HYBRID EXPERIENCE		

4.2 Study 1 Findings

Findings in this section are structured around six of these categories. The first two, *personal experiences with running* and *attitude towards running*, cover people's subjective experiences with running, both with and without MRS (for participants with previous running experience). The next finding, *experiencing story while running* focuses on the aspects of the experience related to the story. Then the *MRS Elements* category suggests the ways in which runners can be influenced by some aspects of MRS outside the main story. The fifth category, *voluntary changes* illustrates how runners voluntarily adjust their experiences during the workout. The last one, *enhancing the running*

experiences focuses on the ways MRS can enhance the experience for runners who find it beneficial.

Moreover, the excepts in the following subsections cumulatively cover four more categories: they suggest that the *MRS format is different* to a regular audiobook; they highlight the *hybrid* nature of the experience; they reveal the *benefits* and *downsides* of voluntary engagement; and finally, they illustrate that the experience of a workout is not monolithic, but instead consists of distinct stages that form a *trajectory*.

4.2.1 Personal Experiences with Running

Participants in the study came from various backgrounds, and had different relationships with running.

First, out of 11 runners who completed the study, 1 did not run regularly prior to participating; 3 did not run but were doing other types of physical exercises regularly, such as boxing; 7 did run regularly, and out of them 2 had previously completed marathons.

Second, participants had different reasons to run. While most runners stated health and overall wellbeing among the main goals, there were also more specific ones. 3 participants were preparing for long running sessions, such as 5K runs, 'fun runs' and marathons. Weight loss was a motivation for 2 runners. Runner №9 already had to walk her dog regularly, so she decided she might as well start running while doing that, and thus make more use of that time. Runner №5 was combining running with parkour.

Participants also had different approaches to scheduling their workouts. For most people, of course, running had to be compatible with the existing schedules of work and study. Two runners had social commitments: one runner periodically exercised with a local running group, and another ran regularly with a friend, thus communicating about the schedule was necessary. Runner №8 scheduled her run in the morning but not out of necessity: she did that so she would run early in the day, '*otherwise you won't do it*'.

Along with establishing a convenient exercise schedule, runners must pick a location for their run. Participants in the study mentioned five factors that they considered when picking a location. First, most participants were looking for a location close to where they live. Second, most participants were looking for a location with less traffic and fewer traffic lights. Third, a couple of participants mentioned that they were specifically looking for scenic locations: '*I run to the ocean… and I was like looking at the scenery along there*' (Runner №12). Fourth, one runner said that it was important for her potential location to have plenty of shade and ideally no uphills: she was new to running and she did not want the location to make the activity more physically demanding than it already was for her. Finally, participants who were running socially had to take into account the preferences of people running with them, whether it be a running group or just one running partner.

4.2.2 Attitudes Towards Running

Participants also had different attitudes towards the activity itself.

For over the half of the participants (6 out of 11) running was boring, unpleasant or otherwise frustrating. These participants ran because they wanted to achieve their goals but did not enjoy the activity itself and wanted it to end as soon as possible. Runner №8 also found herself feeling particularly self-conscious while running.

Only two participants found running engaging and the activity itself pleasant. For three remaining participants running was somewhere in-between: they would enjoy some parts of it, while other parts were tedious. These participants had something occupying their minds during running, thus they were not bored with it. Runner №11 was thinking about his body and the physical aspects of the activity: '*I'm thinking about my posture. How I move my feet. How I'm holding my head up. The speed at which my feet are moving. My stride. Where I'm placing my feet on the ground*'. Runner №1, who wanted to lose weight, was similarly focusing on her body: '*I will focus my movement and energy on parts of my body the size of which I want to reduce*'. Runner №13 found that running gets her in a somewhat 'meditative' state of mind that she uses to think about what is happening in her life: '*Often, I will mentally go to a place where I think about my, like, relationship with my partner. So I use that time maybe sometimes to go over things. And then think about my family and I have little conversations with myself about things*'. Two runners mentioned enjoying the scenery along the way: *'I run to the ocean… and I was like looking at the scenery along there*' (Runner №12). Finally, Runner №5 was doing parkour along the way.

4.2.3 Experiencing a Story while Running

Zombies, run! was designed to make it easier for runners to imagine themselves being the main hero. In the study, that aspect of the story worked particularly well for Runner №13: '*I really feel like I'm running from something and to something, and I was, like, imagining myself as a bit of a hero…*'.

Yet even when runners did not fully feel like characters in the story, they still could find the story interesting. This, in turn, would spark curiosity, which kept them wanting to hear more of the story. That curiosity worked between the scenes within a single workout: '*And when the song came in, I was like, I want the song to finish so I can listen to the next bit*' (Runner №10). Moreover, curiosity kept some participants waiting for the next run: '*And I was actually wondering sort of what happens further on […] It's really cool that it's episodic, I'm actually wanting to get to the other ones*' (Runner №8). Ultimately, the story could encourage to run more often, just to find out the ending sooner: '*I wonder how it all ends*' (Runner №8).

Eight runners said that they enjoyed the story or at least some parts of it. Runner №11 was particularly impressed with how it was made, mentioning 'depth', 'good jokes' and 'TV program quality' in the interview.

Yet for three other participants the same story did not work at all.

Runner №2 was excited at first but later found the story predictable and therefore boring. His assumptions about the story were incorrect, but he would not discover that, as he already decided not to continue with the story.

For Runner №1 the story fell apart because it did not match the physical environment around her: '*My surroundings didn't match the story. I didn't have water, [or a] first aid package to collect on the way. Therefore, just after [the] first few unrealistic requests, I preferred to look around me—grass, people, and birds—instead of listening to what people were talking [about] in the story. I just let myself relax and walk instead of running because the zombies haven't appeared*'.

Finally, Runner №5 kept questioning the logic behind the characters' actions ('*Why would I stop to collect a bra?!*') and was becoming increasingly frustrated with not finding satisfying answers: '*I though the zombie chasing was pretty stupid, really. […] The way that […] you outran the zombies, even if zombies [were] like couple of meters behind you. […] You just suddenly evaded zombies and then you could stop running and zombies wouldn't catch up with you*'. Moreover, Runner №5 mentioned that he found the production quality to be low with the voices constantly 'overacting': '*I thought it [the story] wasn't very interesting, wasn't very well written, wasn't very believable. Just kind of another cliché zombie story, which is probably worse than average, I think*'.

4.2.4 MRS Elements

Study 1 also provided some hints that parts of MRS can work as if independent of the story.

For instance, as was mentioned above, Runner №1 did not get into the story, yet she still noted that running by the cemetery became scarier for her, not because of any particular episode in the story but because of the overall theme. In a different example, Runner №3 reported that listening to familiar songs between the story segments helped him with pacing: '*All songs that I knew pretty well, so I didn't have to think too hard when the next segment will be arriving […] So I knew, I could easily pace myself to the song*'.

One of the main advantages of *Zombies, Run!* over other running apps and games was its simplicity. It did not have many features or settings, nor did it require some unusual or bulky equipment. Participants would only need a phone and a pair of headphones to listen to the story during the run. Still, even that incurred too much of an inconvenience for some of the participants, particularly the ones who had already become used to running without headphones:

> *Having headphones on and holding the phone was a bit different. So, the headphones I wear, they feel tightly in [my] ears, so I can hear my heartbeat the whole time holding the phone […] It had a big impact on being able to mix up my run with doing things like parkour and stuff, and stopping my run half-way through during the length of my run. I felt really limited in my run.* (Runner №5)

Runner №11—the one who said that *Zombies, Run!* felt like a 'TV program'—disliked fiddling with the extra equipment so much that he ended up postponing subsequent missions. He ultimately reverted to running the way he used to prior to the study: '*I don't really want to put headphones on and a wristband, so I won't bother this time but might do next time. And then… oh I don't want to do it this time, I'll do it next time… and then it's like oh, it's January…*'.

The simplicity of *Zombies, Run!* also led to a couple of participants not being able to understand whether some parts of the story were interactive or not; that, in turn, led to some confusion during the run. For example, when a character in the story said 'Head East!', Runner №8 was not sure if she literally had to head east or whether the direction would not matter (with *Zombies, Run!* it would not).

Also, a glitch occurred during the study: the app did not clearly mark the end of a mission. Despite it only happening once (that I know of), it led to some serious consequences: Runner №5 ran for about 30 minutes after the mission finished, before realising there was something wrong with the app and finally stopping.

Finally, 3 out of the 5 participants who decided to continue using *Zombies, Run!* after the study clarified that they would not listen to the same story outside running. Thus, it was not just the story that interested them, it was the combination of running *and* listening to the story:

> *I think I would find it boring [listening to a story without running].* (Runner №3)

> *I might now, I wouldn't [have] chosen before to just to listen to it, I don't think. I think it was the element of interacting with it that was good for me.* (Runner №13)

> *Both!* (Runner №12)

4.2.5 Voluntary Changes

The story in *Zombies, Run!* unfolded in a fictional place, Abel Township and its surroundings. It was in no way connected to any actual places where participants ran. Nevertheless, runners noticed that on many occasions they felt that the story was

connected to either their immediate surroundings or to something that was happening in their lives.

In some cases, these connections occurred serendipitously, sometimes surprising even the runners: '*I had a cold for the last week. [...]. Then I started the mission… during the mission… they sent runner 8, who has a cough and a cold [...] and that got me laughing: I though about the irony [...] that was quite funny*' (Runner №4).

Such serendipitous occurrences did not have to be specific in order to create the connection, sometimes just matching with the story emotionally was enough: '*…so I ran along this river […] I felt it synced with the part of the story I was [in], where we were kind of running through a forest and it started raining. And I started feeling like I'm really getting into the story*' (Runner №13).

Generally, runners enjoyed serendipitous connections between virtual and physical environments and thought that they improved the overall experience: '*It was a run through a hospital [Runner №4 here means he was actually running through a hospital], the app [mission] was… to pick up more… medical equipment. And that was good, because that was related to the story… that was a really good aspect*'.

Still, on a rare occasion such connections could be detrimental to the experience. For examples, in the case of Runner №1: she could not get into the story due to it being too detached from what was actually happening around her, and then she reached a park by a cemetery. Interestingly, even though Runner №1 was not following the story at this point, she reported that she felt apprehensive about running near a cemetery (compared to her previous runs there without the app), and she did not like to be frightened by the atmosphere there.

In other cases, runners intentionally put in an effort to make the story match the physical environment in some aspect or another. They knew that it would not affect the story in any way, yet decided to do that regardless. I call an intentional effort like this *a voluntary engagement*.

For instance, in *Zombies, run!* a mission would usually end with the protagonist getting back to the base, so two runners tried to connect a physical location (home) to a location in the story (base): *I quite enjoyed the fact that the first mission ended with you running into a base and then I sort of timed my run so I arrived back home* (Runner №13). Runner №9 mentioned how she was looking for potential connections between physical and virtual places throughout her workout: '*I have a pretty vivid imagination, so I was thinking about the story [during the run], I was "Oh, the church is right ahead!" [both an actual church and a church from the story]*'.

A couple of runners also moved their runs to nighttime. Runner №5 did that for just one mission: '*There was one mission which was specifically for night, so I make sure I ran that at night*'. And Runner №3 chose to run at night every time during the study, because this way it would match the mood of the story better: '*I intentionally chose to run in the evening because I thought it would be more interesting than running during the morning*'.

Moreover, among the participants who became engaged by the story, there was a general consensus that physically walking, while the hero in the story is being chased, would feel wrong: '*I don't think it's interesting if you just have to walk. Walking away from zombies seems a bit boring. Doesn't match the story really, you want to run*' (Runner №3).

Frustrations with Voluntary Changes

This desire to intentionally match the physical and virtual, however, led to frustration at times when the connection would break. While, each *Zombies, run!* mission lasted for about 30 minutes, the actual length would depend on runners' playlists. This made it hard to time the ending precisely: '*I wanted to plan my run so that I'd finish off at home. Instead, because it finished short, I end up still five minutes from home, and so I keep running after the mission had finished, which seem kind of out of place with kind of getting back to the base*' (Runner №5). It was also hard to pace oneself during the run. Runner №4 wanted to speed up when zombies were approaching in the story (again, even though he knew that speeding up or not speeding up would have no effect on the story) but found it hard to do so without knowing exactly how many chases there would be in any particular mission: '*You wanted to be prepared and have some energy to be able to run, to get chased by the zombies. So, I was holding back a lot. And there were some runs that had three zombie chases and some that had two zombie chases, so I couldn't moderate my running […] When I was running, it was like you never knew when it was going to stop,... or how you have to pace yourself to do a longer run, or a shorter run. And it got really annoying.*'

Another kind of frustration arose from trying to create a mental map of fictional locations in the story: '*And very quickly, we've got back to Abel Township, so seem like the two towns were incredibly close - just few hundred meters apart? Still getting a bit of sense of the scale…*' (Runner №5). Two participants independently suggested that a virtual map of the fictional setting could help runners get a better sense of the scale, and get more involved as a result: '*…it'd be really cool, if you had a little map of how much of that you had done, just so you get an idea of the environment*' (Runner №8); '*It could just show you the way you were running [in a fictional world] across the map, you would've been, like, involved in it, I think*' (Runner №10).

Yet another source of frustration arose when the physical surroundings did not match the importance of the runner's mission. For instance, traffic lights—which can be quite annoying to runners, even without the app—felt particularly out of place: '*The first time I used it, there were too many traffic lights. And there'd be zombies and I had to stop and stand*' (Runner №12). Moreover, for a bystander, a *Zombies, run!* hero would be indistinguishable from someone who simply runs listening to music. That, in turn, could also at times break the connection with the story: '*Someone asked me for directions and I wanted to tell: "Can't you see I'm running away from the zombies?!"*' (Runner №12).

While voluntary engagement helped runners feel more connected to the story, three participants noted a lack of interactivity and said that they would enjoy making choices

that would actually lead to different outcomes in the story: '*I'd like to interact, I'd like to make some choices, I'd like to be a little bit more involved*' (Runner №12). Runner №11 even specified what kind of choices he would want to make: '*The idea of being able to run to a particular place, based on you GPS navigation and Google Maps, would make a real difference […] It is saying you can run to location A to pick up a medical kit—it's closer, but there are more zombies. Or you can run further to get the same thing from location B. It might be fewer zombies…*'.

4.2.6 Enhancing the Running Experience

Distraction

The study revealed that *Zombies, run!* worked best for participants who found running boring, exhausting or otherwise frustrating. For them, the main benefit of running with 'zombies' was having a distraction, which in turn made the workout seem less unpleasant, and also end faster:

> *I did find it quite distracting. It was good in that respect […] I didn't feel lack of enthusiasm towards the end of the missions, cause it was distracting.* (Runner №4)

> *With the application I sort of forgot I was doing exercises, sort of you kind of get into the story.* (Runner №10)

In the case of Runner №8 the MRS was a useful distraction not just from boredom or physical exertion but also from feeling self-conscious: '*I didn't feel quite so self-conscious, because I wasn't worried about things, I was busy listening. Because you can feel a bit self-conscious when you need to lose a bit of weight, you're not very fit. And it just kind of took my mind off it. It'll make it easier to go again, I think*'.

Interestingly, for the effect to take place, attitudes towards running mattered more than prior experience; i.e. it was likely that if participant found running unpleasant, they would enjoy running with *Zombies, run!*; yet there was no clear correlation between how long participant was running prior to the study and their enjoyment of *Zombies, run!*. For instance, Runner №12 was an experienced runner, who ran a marathon before, and she still found that running with MRS can enhance the experience: '*It breaks up what can sometimes be a very repetitive activity, so variety or a bit of spice to the running […] cause you do get tired of doing the same thing*'.

On the contrary, both participants who found running already engaging decided not to continue using *Zombies, run!* after the study. Runner №11 at first said that he did not like fiddling with wristband and headphones, but then revealed that the main reason he decided non to continue with the MRS is more likely that he did not want to be distracted during the run: '*This is probably […] why I only used it couple of times. Because I value every time I go out running… I felt it could be a bit distracting for me*'.

Meaning

Another way *Zombies, run!* enhanced the running experience was when it provided additional meaning. Participants felt like they had more reason to go for a run:

> *It […] felt like I have a reason to run, rather than, sort of, being in a park with nothing to do*. (Runner №3)

> *It's like a good excuse to do exercise, rather than just doing it for the exercise, because that feels like a chore to me, and I don't like doing that.* (Runner №9)

They were not only curious about what would happen next—which would be the case with a good audiobook as well—but also felt as they themselves had a heroic mission to complete, or, as Runner №13 put it: '*Look at me going to rescue some people!*'.

Moreover, even though *Zombies, run!* is a single player app, it was still able to provide a sense of social support for at least one runner in the study. Runner №8 felt self-conscious, and thus was unlikely to run with a partner or with a running group. Still, she could enjoy some sociability with *Zombies, run!*: '*It's hard to just go by yourself, and I didn't feel like going by myself, because I had the application*'. Interestingly, she felt social support even when she felt that MRS was inaccurate: '*One bit, where the guy, that's on the radio: "You pace is really good". And I'm like "No, it's not", but it was really funny to hear, it's still a nice thing to hear. "Not at all, but it's very nice of you to say*".

Finally, *Zombies, run!* also provided a greater sense of accomplishment after each run:

> *I'm up to the next level now, as well as 'I just gone for a run', 'pushed myself' or whatever. You can tick something off and you're up to the next stage.* (Runner №12)

> *I think, I sort of weirdly felt more engaged with a run, like I felt maybe the greater sense of accomplishment, because it was tied to something else, it wasn't just a run for the sake of it.* (Runner №13)

In one case, this greater sense of achievement was enough to keep a runner going when she would otherwise stop:

> *Couple of days ago I went for an hour long run, instead of a half an hour… I felt kind of energetic, so I decided to try that. But, um, towards the end, it got like really hot and I was really tired, I was like 'I just kind of would've gone home'. But because I didn't finish the mission yet, I felt like I needed to keep going. […] If I try to run normally, then when I'm tired, I go home.* (Runner №9)

By providing a continuous story, MRS also provided a long-term goal for the runners, which is to discover how the story (eventually) ends. This by itself became additional motivation for some runners: '*I like completing things, so probably I'll finish. 99% per cent chance I'll finish*' (Runner №9).

4.3 DISCUSSION

This section is structured around six major themes that emerged from Study 1. It introduces the themes and connects the findings of the study to the existing literature. The first subsection covers two themes: *hybrid experience* and *voluntary engagement*. It reveals the hybrid nature of the experience of running with mixed reality stories, and the way runners balance different aspects of such hybrid experience by voluntarily engaging or not-engaging. The following subsection reveals three themes, each dedicated to a major component of the overall experience: *running*, *story*, and *MRS elements*. Finally, the last subsection focuses the format of *MRS* itself, and the way it is different from traditional audiobooks and podcasts.

4.3.1 Hybrid Experience and Voluntary Engagement

The findings revealed that the experience of running with MRS is hybrid, combining the experiences both from running and from the story.

Throughout the workout, most runners would mentally switch between the running aspect of the experience and the story aspect. Thus, at different points during the workout the running and the story get different priorities. Sometimes running and story complement each other. For instance, the very premise of a zombie story aligns well with the desire to start running. Sometimes running and story are in conflict and the runner has to choose one over another. For instance, one runner prefers to run first thing in the morning, but the story makes it clear that the next mission will happen at night.

Moreover the findings indicate ways in which runners balance the running and the story by deciding when to engage during their runs.

The story of *Zombies, Run!* unfolds in the same way regardless of how people run. In fact, participants can listen to the whole story while standing still. And yet, the study revealed how runners increased their speed depending on the narrative; timed their workouts to get back home at the same time the protagonist would arrive at the base; and even moved the exercise to a later time so it would better match the dark atmosphere of the story. Different segments of a story serve as props, for example, the mention of a nighttime mission that might lead a runner to decide to run at night next time.

This approach is different from other mixed reality systems and exertion games which involve running. Participants were changing parts of their runs not because they would be rewarded or punished, which was the case with, for instance, the poem that would stop playing, if the acceleration was not sufficient (Marshall & Benford, 2011). This approach also allowed participants *not* to engage, when they did not want to or when it was inconvenient, for instance, when they were approaching traffic.

Witkowski (2018) warns that having to fiddle with running equipment or manage convoluted user interface can break an established running rhythm. By relying on voluntary engagement, designers can use the technology primarily to deliver the story to the runner during a workout, without a reliance on precise trackers, expensive equipment or human orchestration. This also simplifies the user interface. In turn, this allows the participants to run anytime they like, and as often as they want to.

Still, there are downsides to adopting such an approach.

First, relying on voluntary engagement shifts the burden of orchestration and control to the runners, which can be frustrating at times. The experience was particularly irritating for the runner who wanted to time his run so that he would arrive back home at the same time as the hero finishes the run back at the base. Yet, the exact length of a *Zombies, Run!* mission would change depending on the chosen music playlist, preventing him from timing the run precisely. Another runner became frustrated when someone asked her for directions while she was running away from zombies.

Second, it requests a stronger suspension of disbelief (Abbott, 2008) from the runners, as with MRS participants were encouraged to experience themselves inside the story. For one runner this became hard to believe after he calculated that the distance he covered during his run did not make sense as a distance between cities in the story. Another runner simply felt silly pretending there were zombies present during her run.

Finally, some participants wanted to have more interactivity. Suggestions to add some form of interactiveness for the story appeared in a number of interviews without any prompts. The findings suggest that there is an expectation that a mixed reality system should be interactive, to allow the runner to make an impact on the story in some form.

4.3.2 Running, Story, and MRS Elements

Running turned out to be an essential aspect of the hybrid experience of mixed reality stories. While, in the current HCI literature, running is often seen as a single continuous experience (Section 2.2), the findings revealed the more complex nature of this activity. Interviews with the participants identified a number of different types of running, including solo and social runs, and running as part of sports training combining running and parkour. Different types of running appeal to different runners, depending on their current motivation, goals, and schedule. This was true even for those participants who had just begun to consider running as an activity. In their case they would have to consider why they wanted to run, when, where, and how often. And with these deliberations, begin their personal relationship with running.

Consequently, MRS might either fit better or worse with existing and habitual experiences of running. For instance, having to run with headphones on was an annoyance for the runner who would generally combine running with parkour along the way. Similarly, listening to a story was too distracting for the participant who thought of running as a meditative activity that helps her to free up her mind.

Interestingly, the findings revealed that one of the most essential aspects of people's personal relationship with running was their attitude towards it. There were 5 participants who found running engaging on its own (including the 3 drop outs); 6 participants who thought of running as a frustrating or boring activity; and 3 participants who were more ambivalent.

The study suggested that in the context of MRS, understanding runners' attitudes towards their activity can be more important than understanding how long or how often they were running. It could seem at first that novel runners would benefit most from using a mixed reality story but the findings did not support the claim. The findings suggest that runners who are frustrated with the activity would be more likely to enjoy MRS even if they are experienced runners. And vice versa: novice runners who find the activity enjoyable on its own would more likely decide to drop MRS from their workouts.

Finally, Study 1 indicated that some elements of MRS outside of running and story might still influence the overall experience. For instance, a runner can still become increasingly frightened, even when she thought that the main story did not capture her attention.

4.3.3 Mixed Reality Stories

Material in Literature Review served to define what mixed reality stories are but remained uncertain whether MRS are significantly different from audio-stories, such as audiobooks or podcasts. After all, to an observer a runner listening to MRS and a runner listening to an audiobook would look the same. Similarly, it was unclear whether MRS are different from mixed reality performances (such as described by Benford & Giannachi, 2011).

The findings from Study 1 indicate that mixed reality stories are indeed different from both conventional audio-stories and mixed reality performances, as they create a distinctly different experience. MRS provide enhanced opportunities to connect running to the story, which leads to a more prominent sense of 'being in the story'. At the same time, MRS is less restrictive than participation in a mixed reality performance: in Study 1 runners could run when they wanted to and as often as they wanted to. Moreover they could vary the level of their engagement with the MRS throughout the story. This was particularly noticeable around traffic lights, where runners were 'falling out' of the story in order to shift their attention to safely crossing the road before resuming the story on the other side. Witkowski notes that traffic lights are 'an oft quoted woe' among *Zombies, run!* Instagram posters (2013, 2018).

Some runners explicitly said that while they enjoyed running with *Zombies, Run!*, they would not listen to it without running. For them it would not work as a simple audio-series. One of the runners further clarified that while he would not enjoy *Zombies, Run!* without running, he would also not enjoy running without *Zombies, Run!*. This suggests that MRS can create a unique experience, which requires that both running and the story work together.

Finally, the findings suggested how mixed reality stories can enhance running. First, MRS provided a welcome distraction for participants who find running unpleasant. Second, MRS created additional meaning for the physical act of running, now making it more than just an exercise. For instance, when participants experienced themselves being a hero on mission they reported a stronger sense of accomplishment at the end of each run, and it also made them anticipate the next run, as their help would be needed in the story. Witkowski (2013, 2018) notices that this also affects the way runners experience familiar locations: local spaces are given new life and can be seen anew with each different mission; mundane encounters, such as seeing a tunnel, can become 'creepy' when coloured with the context of a post-apocalyptic zombie story. Interestingly, a mixed reality story also helped create an experience that felt social for the participant who was avoiding running socially before. With *Zombies, Run!* she could run without feeling self-conscious and also without feeling alone.

4.4 LIMITATIONS

Novelty Effect

While I did not look specifically for people who had not previously used *Zombies, Run!*, the MRS ended up being a novel experience for every participant. It was possible that this sense of novelty might colour the responses from participants and affect the findings of the study. To address this issue I informally interviewed a couple of avid *Zombies, Run!* users to see if their experiences would be significantly different from those outlined in the initial findings. The interviews, however, covered most of the existing codes, and did not provide any new insights. This suggests that the novelty effect did not significantly affect the findings of Study 1.

4.5 SUMMARY

The objective of this study was to explore the current experience of running with a mixed reality story. First, the study claimed that the experience of running with MRS is hybrid, blending together two major threads: the running and the story.

Second, the findings revealed that runners use voluntary engagement to balance different aspects of the experience. The study further suggests ways in which runners extract props from the story and adjust their running accordingly. The study showed that runners' experience with the story depends significantly on their subjective perceptions of it. It also suggested that sometimes MRS has an effect on the overall experience even if the story itself fails to captivate the listener.

Third, Study 1 revealed that running activity by itself already provides a rich and meaningful experience which integrates with the overall experience of running with MRS. It also highlighted a somewhat surprising significance of the personal attitudes participants have towards running.

Finally, this study indicates that mixed reality stories are different from traditional audio-stories, as well as from other mixed reality systems, such as described by Benford & Giannachi (2011). Moreover, it provided insight into how mixed reality stories enhance running.

5 STUDY 2: CREATING MIXED REALITY STORIES FOR RUNNING

Study 1 suggested that runners' relationship with the story is core to understanding the user experience of running with mixed reality stories. To better understand how stories can influence the experience of running, Study 2 turns focus to the storytellers and explores their mixed reality stories (MRS) from their point of view. Hence, the guiding research question for the study is

How do storytellers address the user experience of running when writing mixed reality stories?

Study 2 features 7 storytellers, 3 of whom have completed 3 scripts for the future MRS prototypes. 3 creative workshops were conducted to introduce the writers to the format and to Melbourne University campus, which played an important role in the upcoming prototypes. After the scripts were completed, 2 additional discussions were organised with the writers who created the stories.

The findings from the study revealed how writers can address the running experience within their stories, three different ways to connect the story to the physical environment, and how writers repurpose the familiar story mechanics for the new goal. Furthermore, Study 2 indicates that from the writers' perspective mixed reality stories were also different from other story formats that they previously worked with.

5.1 DESIGN

5.1.1 Preparations

Prototype Format

I started the preparations for Study 2 with defining the format for the upcoming MRS prototype. While MRS can take different forms, I wanted to stay close to *Zombies, Run!* format, so that I could explore the difference in stories themselves, rather than the differences in formats. Thus, the format for the MRS I settled on closely following the structure of a *Zombies, Run!* mission: a few short story segments, interrupted by music, in a timed run.

There was, however, one adjustment to the format. With *Zombies, Run!* people could run anywhere they wanted to, but for the consequent study I decided to have all the participants run in the same area. As Study 1 highlighted, runners were willing to make their own connections between the fictional places of *Zombies, Run!* and their physical location, and thus, I wanted to explore how different stories could affect this. By letting the writers know the running location upfront, I would give them an opportunity to shape their stories with such connections in mind. Nevertheless, the writers still would not know the exact route, just the general area. Seeing how runners change their route on the go was also important in Study 1. Hence, I did not want to restrict the runners to a particular route in the following study.

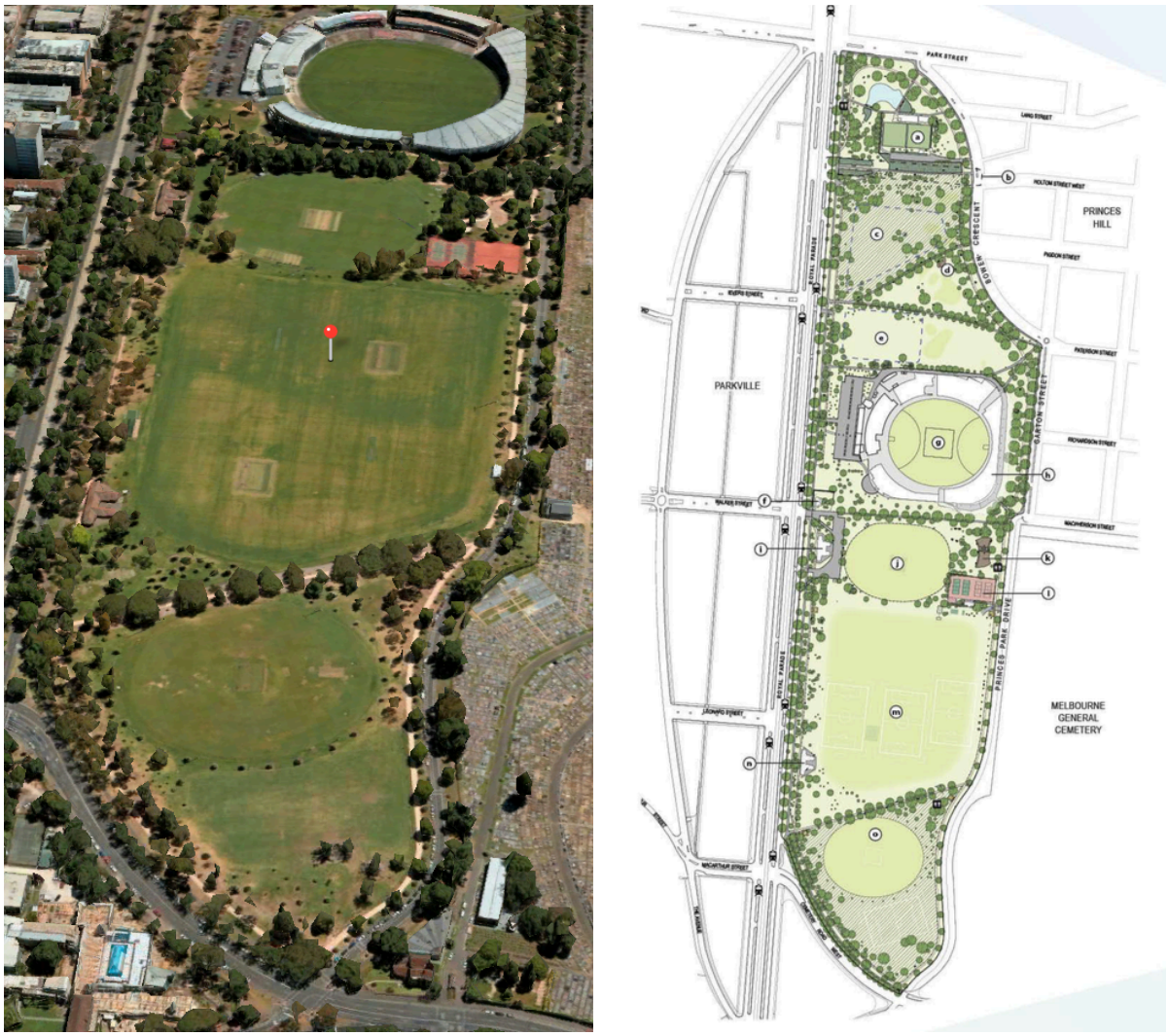
While Study 1 findings influenced my decisions on the MRS format for Study 2, I did not want any of my preconceived notions to lead Study 2 participants towards specific creative decisions. Thus, I decided to only describe MRS format to participants in general terms, without revealing any of the Study 1 findings. It was important for me to see how writers would adjust their process to work with a new format, and thus, I did not want them to think that they had to fulfil any of my expectations of what their own process was supposed to be like.

There was also a limitation to only one story mission, which I placed, because I wanted to reduce the required amount of work for the writers in hope of attracting more potential participants. Moreover, according to my plan, Study 3 would aim to compare different stories, and adding a variety of missions to each story would increasingly complicate the setup. Nevertheless, since *Zombies, Run!* had a number of related missions, I still planned to ask writers to think about their missions as only the beginning of a bigger story, not a complete story in and of itself. Thus, writers would be asked to pretend not to notice this particular limitation existed when writing their stories.

Location for Study 3

As I wanted the writers of Study 2 to know where Study 3 will take place, I had to confirm the running location for Study 3 with the Ethics Committee before the first workshop commences.

The original area for Study 3 runners was supposed to be the Princes Park (Figure 5.1), one of the most popular running location in Melbourne[1] and the closest to the Melbourne University. I picked the one that was the closest, as Study 1 suggested that most runners will find out about the study through the university-related channels, hence, proximity of the running location could be important for potential participants in Study 3.



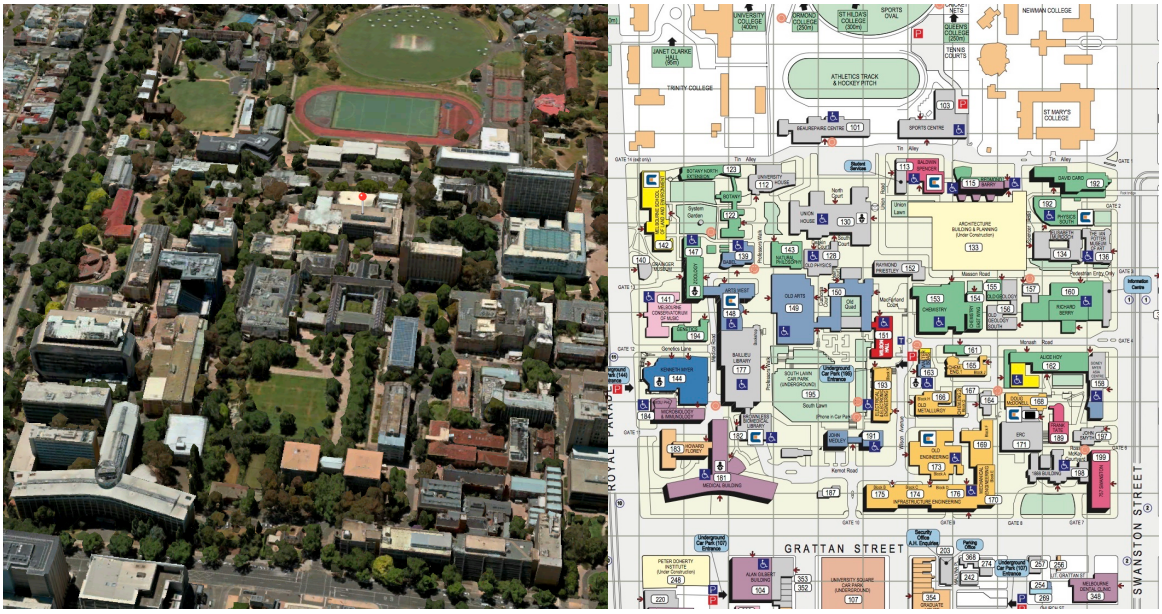
5.1 Princes Park[2]

[1] https://www.melbourne.vic.gov.au/community/sports-recreation/sport-hobbies-activities/pages/walking-and-running.aspx

[2] The map on the right is reprinted from City of Melbourne's Princes Park Master Plan (https://www.melbourne.vic.gov.au/SiteCollectionDocuments/princes-park-master-plan.pdf)

As the risks for Study 2 were low, the application got through without any issues. The ethics committee, however, rejected the application for Study 3, as they did not feel that participants would be safe enough to run with a mixed reality story in Princess Park. The reasoning behind the rejection was that due to its popularity, the Princess Park can be very crowded, and the participants might collide with other runners, since their attention will be focused on listening to a story. Thus, I had to choose another area for Study 3 participants to run at. For the choice of another location I excluded all other popular running tracks, as they would unlikely seem safer for the Ethics Committee than Princess Park.

Instead, I turned my attention to the University of Melbourne Parkville Campus itself:



5.2 The University of Melbourne Parkville Campus

Under the further examination, the Parkville campus turned out to be an even better choice than Princes Park, as it would provide writers with more potential objects to connect to the story. The campus is the second oldest university campus in Australia, and features interesting history both in regards to buildings and to people who have been involved with it. The rich history of the campus could be inspirational for the writers. This location would also provide runners with more choices to make during the run.

The Ethics Committee approved the change under condition that all runs will happen during after-hours on workdays, and anytime on weekends and University holidays. To avoid traffic, the runners would also not be allowed to cross any major roads, such as Royal Parade, Grattan Street, and Swanston Street (all three pictured on Figure 5.2).

Melbourne Screenwriters Workshop

As Study 2 was set to explore the storytellers' perspective, during the preparations for Study 2 I started to look closer at creative writers' communities and practices, both to better understand their current process of writing and for potential recruitment. From

the format perspective, a radio play is the closest format to the script of *Zombies, run!* (see Appendix II.VI for an excerpt from the script). There were no communities of radio play writers, most likely due to the relative unpopularity of that particular format. There were, however, communities of screenwriters.

Melbourne Screenwriters[1] was one of the largest communities, with regular free meetups in Melbourne. During the course of Study 2, I attended several of their meetings. The regular meetings that I attended followed the same structure. First, one of the participants would give a brief speech on a particular topic, and then the group discussed the topic. In the second part, a writer would offer an excerpt of a screenplay for a table read, which would be followed by a Q&A with the author and a discussion on potential ways to improve the story.

These meetings inspired me to organise similar workshops for Study 2 writers, instead of interviewing them individually, as it was the case with most runners in Study 1. I also included a university tour prior to workshops to introduce writers to the campus. During the walk around, I intended to introduce some of the most interesting features of the campus, most of which were drawn from the official University of Melbourne campus tour[2]. Then, in the first part of the workshop, I would give a brief introduction to the format, which was followed by a group discussion. In the second part, I would propose an exercise for writers to put the theory into practice (see Appendix II.IV for the outline).

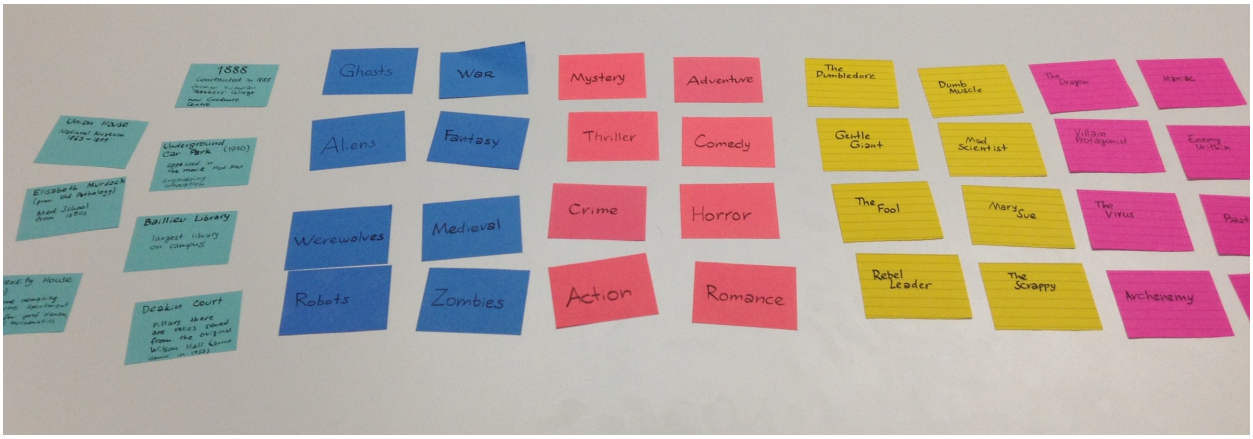
Writing Exercise

The aim of the writing exercise was to help writers start thinking about their story and how they can adapt it to the specific format of MRS. Inspired by some of the cards-based workshops in Human-Computer Interaction (HCI) and video game design (e.g. Hornecker, 2010; Schell, 2008), I also made a set of cards that writers could use for inspiration. Each card featured a trope (a recurring element in stories). Eight tropes from four different categories I picked randomly from TV Tropes[3]. I also added seven cards with some of the prominent features of the Melbourne University campus (see Table 5.1 and Figure 5.3).

[1] https://www.meetup.com/melbourne-screenwriters/
[2] https://www.unimelb.edu.au/campustour/home
[3] https://tvtropes.org/

Genre	Theme	Archetype	Villain	Campus Feature
Comedy	Zombies	Dumbledore	Archenemy	University House (1884): *the only one remaining professors apartment building (currently repurposed).*
Horror	Ghosts	Rebel Leader	Dragon	Baillieu Library: *the largest library on campus*
Mystery	Robots	Scrappy	Villain Protagonist	Deakin Court: *pillars there are relics saved from the original Wilson Hall (burnt down in 1952)*
Thriller	Medieval	Fool	Enemy Within	Union House: *National museum from 1863 till 1899*
Romance	War	Dumb Muscle	Maniac	Underground Car Park (1970): *appeared in one of the Mad Max movies*
Adventure	Fantasy	Gentle Giant	Virus	1888: *former Victorian teachers' college, now Graduate Centre*
Criminal	Werewolves	Mad Scientist	The Chessmaster	Elizabeth Murdoch (prev. Old Pathology): *medical school, built in 1880s*
Action	Aliens	Mary Sue	Bastard	

5.1 Cards for the Writing Exercise

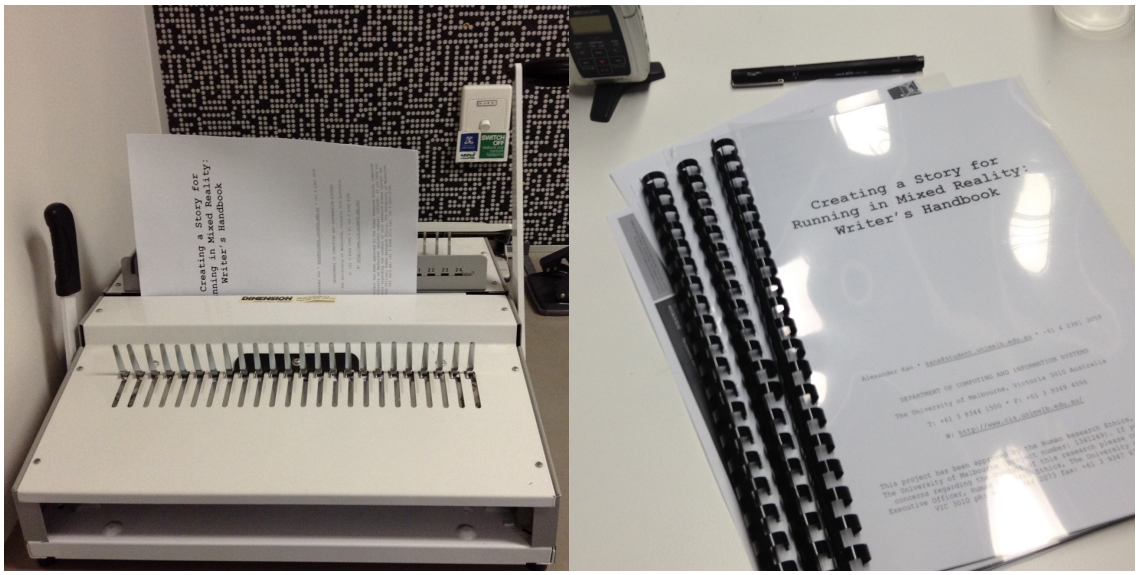


5.3 Cards for the Writing Exercise

At the beginning of the exercise, each writer would get a random card from each category. Then they had 15 minutes to develop a synopsis for a mixed reality story that would feature all of the cards they were given. During the process, the writers could swap up to three cards for another random card of the same category. The writers did not have to use any of the developed material in their actual stories (and none of the writers did); the exercise was there solely to get them started and to inspire a discussion among the writers on the format of MRS.

Writer's Handbook

I also wanted writers to have a summary of the most essential information from the workshop. Thus, I put together a 'Writer's handbook' for each participant to take home (see Figure 5.4). The handbook included the explanation of the *Zombies, Run!* format, the University of Melbourne campus map, and an excerpt from *Zombies, Run!* script (Appendix II.VI). I also included 'The Periodic Table of Storytelling' from TV Tropes (Appendix II.V) with a brief description of how writers might use it when they need to generate some ideas for their stories.



5.4 Writer's Handbook

Ethics

As per usual, each participant was informed about the purposes of the study (Appendix II.I) and had to give an explicit consent in order to participate (Appendix II.II). The writers could also withdraw from the study at any point, without providing any explanations.

In the ethics application (and at the workshops) I emphasised that writers will keep all the rights to the material they produce during the study. I only asked for their permission to use the stories as part of this project. If I ever were to use the stories in any other context, I would be required to ask for another permission.

I did not plan to recruit more than ten writers, and I knew that I wanted to put their names in the acknowledgements section of any publication that would arise from the study, including this thesis. This meant, however, that it would become possible to connect the quotes from the study with the full names of the participants. Thus, I suggested an option to use a pen name for any participants who felt uncomfortable with a chance of having their identity being revealed, as well as for participants who prefer to use a pen name for any other reasons.

As motivation for the participants, I suggested an opportunity to learn from other writers and share knowledge while helping researchers to understand the process of creating MRS for better running. I also offered a AU$20 Readings[1] gift card to each writer who would complete a story, as a compensation for their time.

The Human Research Ethics Committee approved the study under the project number 1341249.

5.1.2 Recruitment

I advertised the study at one of the *Melbourne Screenwriters* meetings, as well as online, on writers' and screenwriters' public discussion boards. I published the same advertisement via the university newsletters and on the student portal. A couple of the writers were also recruited through personal connections. All writers who expressed an interest in the study were welcome to participate.

During the study I recruited seven writers (see Table 5.2). I split writers into small groups to give them some flexibility in regards to scheduling, to make it easier to coordinate, and also to be able to start the study before I finish the recruiting. Overall, three workshops were conducted (Figures). The first one had three writers, and the following workshops had two writers each.

[1] https://www.readings.com.au/

Three writers out of seven completed a script and participated in a follow-up discussion. Four writers dropped out during the writing stage due to time constraints or without further explanations. I offered everyone to extend the period for writing, or to participate in a follow-up discussion without a script. The writers, however, declined or did not reach back.

I organised two follow-up discussions for the writers who completed their scripts. Writers №4 and №5 participated together, just like they did in the first workshop; Writer №7 participated on his own in the second session.

Group	№	Gender	Prior Experience with Storytelling	Story
1	1	M	Screenwriter, has short films produced, and written scrips for feature films.	
	2	M	Screenwriter with 2,5 years of experience. Has short films, promo and music videos produced.	
	3	M	Primary school teacher, his teaching includes creative writing.	
2	4	M	Amateur writer.	*Coffee Break*
	5	M	Screen and game writer.	*Horror Runner*
3	6	M	Amateur writer.	
	7	M	A former radio producer.	*Adam*

5.2 Study 2 Participants



5.5 Study 2 Workshop

5.1.3 Data Collection

Group Discussions

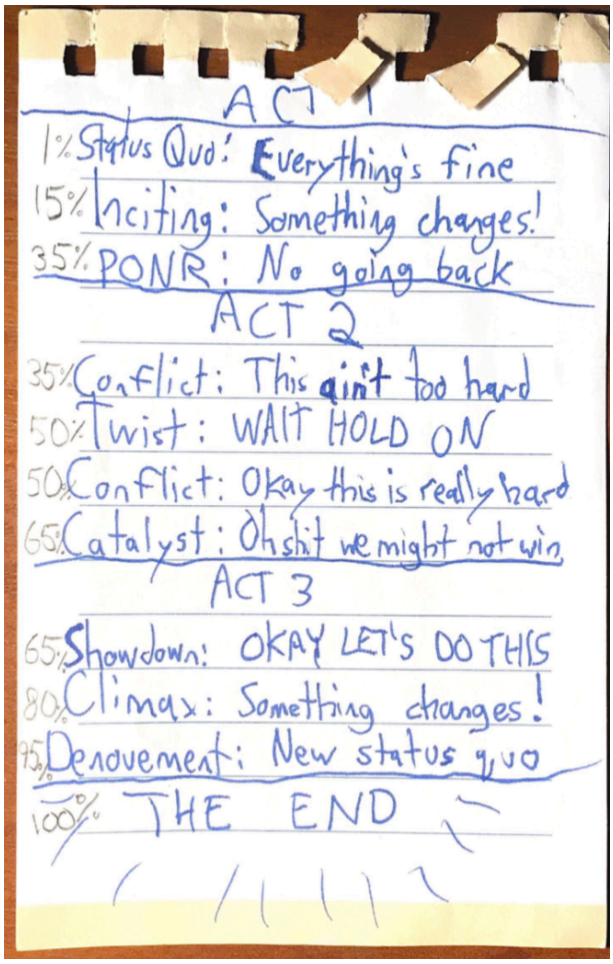
There were two discussions during each workshop. The first one was right after I introduced the writers to the format and the second one followed the writing exercise. Consequently, the former part was more focused on the format, while the latter part was more focused on the writing process.

I also had a chance to clarify the authors' intentions during the follow-up discussions. Those were organised only for participants, who completed their stories, and structured around the scripts, and the differences between their usual routine and participating in this study.

I had a loose structure for the discussions (Appendix II.III), yet the main goal was to have writers guiding the conversation themselves. I also tried to provide only essential information regarding the format and leave as much interpretation as possible to the writers. My approach was inspired by Sengers & Gaver (2006), who argue that by leaving interpretation up to users (writers, in my case) researchers can gain better insight into users' understanding of a system. As the study suggested, this allowed writers to have more creative freedom. For instance, I explained that the stories would be later tested with actual runners on the University of Melbourne campus. While I initially expected each writer to feature the campus in their story somehow, in the end, only one of the three writers did. Exploring the reasons why two other writers decided to take a different approach led me to the findings that I might have missed otherwise.

A conversation in the presence of a clear amateur would be different to a discussion among peers (Fine, 1983). Thus, I presented myself as an HCI researcher with an interested in the use of stories, which, however, does not knows much about storytelling himself. During the discussions I noticed that without any prompts, writers would be more willing to provide a commentary behind their thinking. For instance, discussions at the *Melbourne Screenwriters* workshops would often feature 'story acts', yet it was implied that everyone around the table was familiar with what that means. At the follow-up discussion of Study 2, story acts came up as well, but this time Writer №5 explained to me what those acts were and how he used them while writing the script (Figure 5.6).

All of the discussions were audio-recorded. On top of that—with participants' permission—I also audio-recorded casual conversations that occurred during the initial walking tour around the campus. Overall, workshop discussions were about 2 hour long, and the follow discussions were closer to 1 hour. For the first workshop I also used video-recording, but during the analysis it became clear that in this case video would not provide any significant benefits, while making the analysis much more time consuming.



5.6 Writer's Note

Scripts

Interestingly, the scripts created during the study served an important data source themselves. I asked writers to send me early drafts as soon as possible. This way I would have more time to analyse the scripts before the follow-up interview. Overall, three scripts were developed over the course of Study 2: *Coffee Break, Horror Runner, Adam*.

Coffee Break by Writer №4 (Appendix II.VII)

In this story Baron is at risk of dying without his coffee and the protagonist (the runner's character) is on a mission to find some for him. Another character—Ramone—is trying to help the runner with the task. The story ends with the runner finding the coffee for Baron.

According to the writer's intention, in *Coffee Break* the runner's character is located on the Melbourne University campus. He supported this intention by having characters directly mentioning the campus and names of nearby streets, areas and cafes. Ramone and Baron are talking to the runner from an unknown place. They are also talking to each other, so they are probably both in the same place, although the author has never stated that in the story explicitly.

Horror Runner by Writer №5 (Appendix II.VIII)

Horror Runner begins with four characters (including the runner's character) in a car, on their way to a cabin by the lake. The car hits a mysterious monster and the characters are forced to leave the car, split up and run to the cabin separately, while the monster is roaring in the background. The story ends with the main characters reaching the cabin, only to find out that one of their friends is missing, and that two other friends decided to go back and find her.

From the very beginning the writer made it clear that the story is not happening on the University of Melbourne campus, and that this choice was deliberate. The writer was aiming to create the atmosphere of a horror movie, and he decided to use certain tropes and clichés to achieve this end, even if it contradicted the runner's physical surroundings (e.g. there is neither a cabin nor a lake on the campus).

Adam by Writer №7 (Appendix II.IX)

Adam starts with a spirit named Anna talking to another character, Adam, and quickly realising that the person she is talking too is not Adam but a mysterious runner. It surprises Anna, as the runner is human, and humans rarely have the ability to hear spirits. Still, Anna is glad to have someone to talk to, so she asks the listener to keep running, as running would summon the winds that allow her to speak for longer. Meanwhile, Adam is trying to warn Anna that something went wrong, and she should not talk to anyone, otherwise she puts herself in danger. It seems, however, that Anna cannot hear Adam (while runner can). The story ends with the winds calming down and Anna asking the runner to talk with her again.

The characters in *Adam* are spirits, so it is hard to say whether they belong to a particular location, live in the parallel world, or exist in multiple places simultaneously. The story does not mention any specifics in regards to place. This ambiguity was intententional, so that runners could connect the story to whatever route they chose.

Public Interviews

After I had identified an initial set of findings, I analysed some of the publicly available interviews with the creators of *Zombies, run!* to see, if they could help to validate, extend or contradict my findings. The interviewees were the founder of a company that made *Zombies, run!* (Six to Start[1]) Adrian Hon and the main story writer Naomi Alderman. While conducting Study 1, I followed Alderman and Hon on Twitter[2], and I also subscribed to *Zombies, run!* blog[3]. This way I was informed of any new significant interviews that were available online. I did not, however, use every interviews and blogposts in this thesis, focusing only on those that could strengthen the findings. During the course of the thesis, I did not encounter any claims that would contradict the findings. Table 5.3 presents the final list of the interviews that I used.

№	Interviewer	Interviewees	Date	Source
1	Sarah Dobbs, *Dan of Geek*	Naomi Alderman	26.06.2013	http://www.denofgeek.com/games/naomi-alderman/26054/naomi-alderman-interview-zombies-run-crying-and-music
2	Andy Orin, *LifeHacker*	Naomi Alderman & Adrian Hon	09.10.2014	http://lifehacker.com/behind-the-app-the-story-of-zombies-run-1632445358
3	Scott Henderson, *The List*	Adrian Hon	10.02.2015	https://www.list.co.uk/article/68303-interview-zombies-run-creator-adrian-hon/
4	Niall De'Ath, *Power Up Gaming*	Adrian Hon	08.04.2015	http://powerupgaming.co.uk/2015/04/08/zombies-run-interview-with-adrian-hon/

5.3 Interviews with the Creators of *Zombies, Run!*

5.1.4 Data Analysis

Overall, three types of data were collected for Study 2: audio recordings of the group discussions, completed scripts, and public interviews.

I transcribed group discussions in the same way I transcribed the interviews and diary entries for the previous study. The interviews with the creators of *Zombies, Run!* did not

[1] https://www.sixtostart.com
[2] @AdrianHon and @NaomiAllthenews respectively
[3] http://blog.zombiesrungame.com

need to be transcribed, as each of them had already had a publicly available transcription. The completed scripts also did not require transcription, since I had them in plain text, yet they required a different process for data analysis, as this type of data was significantly different from the group discussions and the interviews with the creators of *Zombies, Run!*

I did not code the scripts in a traditional manner, instead I started the analysis by simply going through scripts page by page and making notes next to any fragment that seemed relevant to the research question guiding the study (Table 5.4). Of course, at the time the relevance of such fragments were purely my assumptions. I later brought them up during the follow-up discussions with the writers for confirmation.

On top of that, as soon as the first codes began to emerge from the analysis of the group discussions and the public interviews, I went back to the scripts and tried to find a fragment relevant to each code. I kept transcript excerpts and corresponding script fragments together in a spreadsheet (Table 5.5).

Similarly to Study 1 I began my analysis by restating the research question '*How do storytellers address the user experience of running when writing mixed reality stories?*' and then looking for any fragments of data that seemed relevant to it. In other words, I started by looking for any differences between the writers' usual process and the process of creating a MRS. From this approach three codes emerged: *MRS format differences for creators*, *writing for running* and *repurposing story mechanics*.

The code *environment* emerged because of the frequency with which it kept coming up throughout the discussions.

Finally, I was also looking to use the codes I already had from Study 1. This allowed me to see which codes are still significant, and which become less relevant. For instance, an existing code *trajectory of a running experience* proved to be relevant even from the writers' perspective, as they kept discussing different parts of their stories. On the other hand, codes under *personal experiences with running*, such as *motivation* and *reflection* proved to be less significant, as the project kept focusing more on the workout itself, putting less weight on what happens before and after.

JOHN (CONT'D)
Just keep going by the lake and you'll see the cabin very soon.
And yeah, definitely keep off the main road, I think we can see some movements there.

Lake and cabin are key places in the story, yet they don't have any resemblance to the actual places on the campus.
'The main road' is ambiguous though, could be any big road on the campus.

SCENE 5

MARY
Get it! Quick!

JOHN
Where is Sally? I thought that Sally is with you! Oh Jesus Mary, why didn't you call her?!

Unexpected turn: we thought that everyone is safe now, but it turned out that one of the friends is missing.

MARY
Her phone is dead.

JOHN
So where the hell is she now?!

MARY
John! Be quiet!
Sally will be fine. It was just a weird animal. Just an animal. It'll go away.

JOHN
Just an animal?! I can't deal with this. I need to sit down.
(Beat)
We need to go back there and find her. Well, I'm going back there to find her, you can stay in, if you like.

MARY
We're going with you.

MISSION ACCOMPLISHED

Runner's character is an observer that doesn't get to 'vote'.

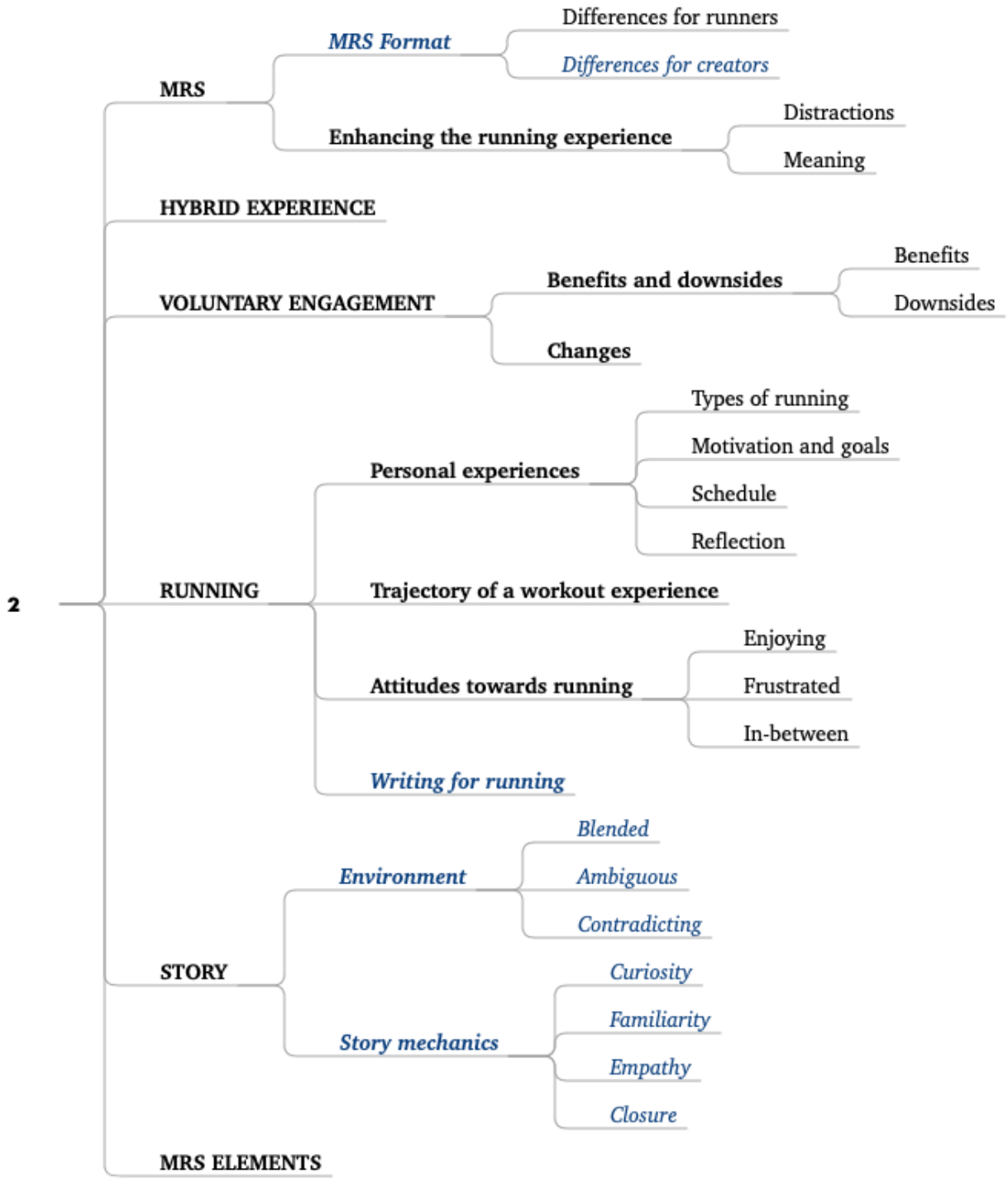
Cliffhanger: what happened to Sally? Will they find her? Might motivate runners to come for the next run.

5.4 Script Notes Example
Excerpt from *Horror Runner*

Codes	Verbatim Transcript	Trimmed Excerpt for the Findings Section	Corresponding Excerpt from the Script
Curiosity Empathy	Erm, well, I think the basic feeling that I want runners to have is the sense of curiosity. *Okay, yeah. About what happens in the story next* About what happens in the story next. But! I also want all these different experiences, you know, like the… I think that's why I chose that, you know, Anna, because… you know, it's almost like living the experience, you know, if you're just walking and then a little girl comes up to you and say 'Oh, please help me, I'm lost'… *Yeah.* …you know. I want that feeling, I want that, sort of, um, okay, you know, that's, um, you know, the whole 'poor girl', you now want to help this girl. *Yes.* Ah, but of course, I also want to have all these feeling of, you know, like, the runner probably feeling 'Oh , what have I got myself into?!', you know… *Yeah.* …you take this little girl around and try to find the parents… *Yup.* …and you have to fill up all these forms inside… *Yeah, yeah.* … 'what am I?'. Then you know that at the end of it you feel some sort of "I've helped a little girl!".	…I think the basic feeling that I want runners to have is the sense of curiosity. […] I also want all these different experiences […] you know, if you're just walking and then a little girl comes up to you and say 'Oh, please help me, I'm lost', you know. I want that feeling […] now want to help this girl. […] I also want to have all these feeling of, you know, like, the runner probably feeling 'Oh, what have I got myself into?!', you know, you take this little girl around and try to find the parents and you have to fill up all these forms inside […] Then you know that at the end of it you feel some sort of 'I've helped a little girl!'.	ANNA You have no idea how much this all means to me. I've been here for so long without anyone to talk to. I'm so glad to have met you, I'm so excited.

5.5 Matching Transcripts with the Scripts Excerpt from *Adam*

I used MindNode to keep track of the evolving connections between the codes and their relations to the existing codes. Figure 5.7 demonstrates the overall hierarchy of **THEMES** (capitalised), **categories** (emboldened), and codes (*new categories and codes* are italicised):



5.7 Study 2 Themes, Categories, and Codes

5.2 FINDINGS

As the previous section revealed, Study 2 contributed three new categories. In addition, it extended a previously existing category on MRS Format with the writers' perspective:

THEMES	Categories	Codes
RUNNING	**Writing for running**	
STORY	**Environment**	– blended – ambiguous – contradicting
	Story mechanics	– curiosity – familiarity – empathy – closure
MRS	**MRS Format**	– differences for creators

5.6 Study 2 Findings

This section is structured around three new categories. First, *writing for running* covers the changes the writers needed to make to accommodate the story for a specific activity. Second, *environment* suggests three different ways in which writers were connecting their story to the surroundings. Third, *repurposing story mechanics* focuses on particular storytelling techniques that writers also accommodated for running.

On top of that, each subsection cumulatively reveal how working with the *MRS format is different* from story formats the participants used to work with.

5.2.1 Writing for Running

Differences in the Creative Process

All[1] writers reported that MRS was a novel format for them and that it felt different from the formats they have previously worked with:

> *It's very different. I really tried to use the medium to create a story that can be used to maximise the medium. I was really interested in the story. And then I tried to see if I can do it in another medium: like in a*

[1] Here and further by 'all' I refer to the three writers, which completed the scripts.

> *short story or very different format. It was very hard. Because from the start I was thinking: 'Ok, this is going to be recorded, the characters are going to talk to the runner'. It was quite an interesting experience*. (Writer №7)

All of them also admitted that knowing that the audience would experience their stories during running was the major difference they had to consider in the process:

> *The whole 'running game*[1]*' aspect of it is a major restriction basically. […] All things have to be related in some way to running and you have to give it a lifespan that allows them to run past it, that makes any sense*. (Writer №5)

Consequently, all the writers felt that they need to have running present in the story, even though it was not a formal requirement. This part became a starting point for creating a story: the writers wanted to figure out why someone has to run. For Writer №5 running dictated the choice of a genre for the story:

Interview Excerpt	Corresponding Excerpt from the Script	Codes
It's meant to be: your blood's pumping, because you're running. You might as well give them a story that emphasises that. Very visceral fear reaction: you've got something chasing after you, you don't know what it is.	There are roars through the mission at random times. MARY Jesus Christ!!! The car spins out of control. JOHN What did you hit! What was that?! Groans JOHN Do you see that? What the hell is that?	Blending (running as an activity and running in the story) Empathy Curiosity

Similarly, Writer №4 started with exploring what kind of stories would align well with running:

> *I was thinking about different gameplay mechanics, in terms of why would you be running. So, it's either running to collect something, tag kind of game, or you're running away from something. Or it can be timed. So I thought I'll do object-orientated: you're searching for something, so you've got this excuse to kind of be looking around.*

[1] I avoid using the word 'game' in description of *Zombies, Run!* and other MRS, as it raises a question of whether they are games or not, which is irrelevant to the thesis. The participants, however, sometimes referred to MRS as games, and I kept the word in the direct quotations.

Writer №7 wanted to explore a particular idea, inspired by the mythology of Indigenous Australians:

> *The Mimi spirits are the spirits from the Northern Territory, and they're like these thin, human-like creatures, who lived in the Northern Territory before the first people came. And they're so thin that they would be blown away by the wind. So, I thought 'That's pretty cool!'. Because I wanted to play with the wind.*

Yet like two other writers, he realised that the story would benefit, if he builds around running. Thus, Writer №7 set to explore what connection he could make between running and the wind spirits:

…you know that saying, that the wind carries the news; and there are those sorts of sayings around the world as well. I know in Indonesia, for example, there is a saying that if you tell your news to the wind, then the wind will bring it around. And I was thinking "Ok, let's play with that". And create this idea that the wind spirits [that] were [here] before the first people came to Australia, they'd bring news. The spirits, the mimi spirits, and all these mythical creatures in Australia would use the wind to leave a message and the wind would take it to other people or the other places.

And I was saying to the runner, you know "You have to keep on running, you have to keep on running, to awake the wind spirits". The wind spirits know the secrets, and if you run around, then you will awake the wind spirits, then you will be able to hear the messages from the past.

The idea is this: if you run, you can awake the wind spirits and the wind spirits will tell you more secrets

ANNA
I can certainly feel you there. I feel you with the wind. Just keep running please, just keep running.

Blending

Empathy

While Writer №7 was able to clearly state an idea of how he could tie together running and the winds, he admitted that he is not entirely satisfied with it: '*I think I'm still struggling with justification of why the runner needs to run, that's the biggest challenge*'.

Naomi Alderman stated in an interview that finding ways of blending the story one wants to tell and running does not end after the writer figured out the initial set up but is indeed an ongoing process:

> *I guess that writing the story tends to be both […] I'm always thinking about new ideas for episode setups and new things to do with the characters. But I try to remember that the core feature is 'having fun with a bunch of cool people running away from zombies'.* (Alderman, interview №2)

Writer №4 revealed that had he been writing for another format, he would not build the story around running: '*I've written the other stuff, just playing with the idea of coffee being magic or something like that. […] That wouldn't be a short story that I'd write from a runner's perspective*'.

Ambiguity of the Protagonist

The final aspect of the running experience that writers have to address was the runner's character. Interestingly, all writers (including the creators of Zombies, run!) felt that the best choice for a running MRS is to have a gender-neutral character any runner could associate with. The inability to use any gender-specific pronouns has certainly influenced the way characters communicate:

Interviewer: *How did you decide to go with four [characters]?*

Writer №5: *Honestly, it was gonna be two, but then I figured, how do you get across what gender the main character is? So, I just said 'them' and made it two people in the back.*

Ambiguity

MARY
Hey, in the back. You two doing alright?

JOHN
They can't hear us.

Writer №5 also noted that leaving the character gender-neutral felt natural to the format:

> Interviewer: You decided to make the runner gender-neutral…
>
> Writer №5: *Why wouldn't you? […] In this types of games you're playing yourself. So you're playing literally as yourself.*

Interestingly, Writer №7 left the character gender-neutral even though he was writing with a specific gender in mind:

> *I was imagining… have you seen that film 'Her'? Scarlett Johansson was my… you know, if I could pay her, I would get her to read it. […] I guess, my first sort of model in my head was a male runner. But, of course, I wanted it to be played by anyone. […] I wanted to play with an idea of the runner […] wanting to help this ghost spirit. I think it'd work better if the runner was a male… and if Scarlett Johansson was reading the script. But I think it'd also work, if it's a female runner. And that's why I tried not to say anything along the line of male or female.*

In conventional storytelling, the main character is usually also the most interesting and developed. Nevertheless, as findings show, writers' argue that in MRS revealing any character's traits will potentially make an identification with that character harder for the runner. While the gender was the most remarkable demonstration of this notion, it was also true for any personality traits:

> Writer №4: *It's hard to supply identity to the reader [runner]. Because you've got to say what they're supposed to say. Sure, you can take on masculine actions or feminine actions you might want to take, but…*
>
> Writer №5: *It's a little curtsy.*
>
> Writer №4: *Yeah, that kind of stuff. But you're getting to act along a lot more than they should have to, because that kind of affects the emotion. […] You could provide dialogue for your protagonist. But you've got to create this complete, I don't know, this completely formed character for them to […] follow along. […] By giving it too much personality, you kind of risk alienating whoever's playing. So, I kept it minimal. […] You can like add the voice. Just I don't know, I feel as if that break you out of it, cause you'd be a girl, he'd be a dude. He'd be 15, you'd be 20.*

Writer №4 also used Gordon Freeman, a mysterious silent protagonist of Half-Life game series, as an example:

> *He doesn't say anything. He can be anyone. […] [In Coffee Break] you are this blank slate that just walks through. […] The events kind of shape you, it's not you saying: 'Oh, I feel this way'. […] So, in that regard you're not so much a character, you're pushing switches*.

It has certainly resonated with how Writer №5 thought of the main character: '*The runner character has literally no personality whatsoever. […] A pair of legs*'.

During both follow-up interviews, I noted that in many video games players are forced to play as a character of the opposite gender and asked the writers why this approach would not work well for running with MRS. Interestingly, one of the answers was that runners have limited abilities to take on a character, as it takes more effort to identify with someone who is different.

> *I wanted to have that role-play feel, where the runner just becomes a character in the story. So, I didn't think of the runner as a player. I really thought about how to make runner feel like he's a part of the story. So, when you run you feel 'Oh, I'm really part of this story'. […] That was a position that I made. I didn't want put any sort of background for the character of the runner. I think it's just to make sure that anyone who listens to the story can just enjoy the game without having to do that heavy work. […] You need to have a certain type of person to be able to really enjoy that sort of 'Ok, I'm going to think that I am a warrior in 18th century Germany'. But I think for this story I wanted the story to be just open to anyone, who just wants a bit of an extra experience in their everyday lives, without having to do the extra effort of imagining as yourself as someone that you're not*. (Writer №7)

Writer №5, however, noted that giving no personality to the runner's character might just be the first natural choice for MRS writers, but it does not mean that a mixed reality story with a developed character is necessary worse:

> Writer №5: *It [providing no personality to the character] is however very safe thing to choose, very instinctual. It's very safe, not very difficult to follow. […] I think, it might be more affective to actually have a runner as a [developed] character than you might immediately think*
>
> Writer №4: *But then you still gonna prescribe them certain things that they react to.*
>
> Writer №5: *But that might be not as big of a deal. […] There is something to be said about taking on a role assigned to you rather than deciding on one for yourself.*

Finally, writers suggested that technology can be used to resolve the conflict between wanting the specificity, yet at the same time not conflicting with the actual runner's traits: '*You could do two different versions of the script. The pronouns change. You just have like an option at the start, you select one or the other*' (Writer №5).

5.2.2 Environment

Another restricting aspect of using running in the story was that, as a consequence, all writers used real-time in their stories, i.e. there were no scene cuts except for the planned musical interruptions, and there were no scenes in slow motion or time-lapse scenes. In fact, one of the first questions from Writer №1 during the workshop was regarding the pauses between the story segments, so that he would know approximately how much the distance would be covered during a mission.

Writers reported felling less constraint regarding space, however. While all of them decided to keep the story time in sync with the running time, they felt that the audio channel provides them a possibility to create a rich space that is not necessary in sync with the actual running route:

> *I was really playing with the idea of having different sounds and giving almost like an alternative reality to the runner. […] I suppose, this is coming from my radio background where I feel like you can create this whole theatrical experience using only sound, if you do it well.* (Writer №7)
>
> *I formatted it like a radio play. So basically, a bunch of stuff happens and despite what's going on around you, you've got sound effects in your mind that basically create a little world in there.* (Writer №5)

I use sound descriptions to kinda set the tone. As opposed to using visual descriptions, if that makes sense. […] This intonation or whispers this, or talk away from microphone. So like in that kind of sense all that creation of space […] through the radio play. Writer №4

```
                RAMONE
They're still very active in the
area and wouldn't appreciate
anyone grabbing coffee for someone
up in Brunswick…
              (Quietly)
Especially THE BARON
            (Normal voice)
There are quite a few coffee
places nearby.
```

Contradiction (the space in the scene is not trying to mimic the running space)

Writers also intuitively acknowledged that the running experience is rich and consists of different stages, while also depending, to a great extent, on the particular circumstances and environmental conditions. For instance, here Writer №7 notes how he imagined that, while running, different kind of stories would work differently depending on the time of the day:

> *What I did was I walked around Melbourne Uni at different times, I walked around Melbourne Uni during the day, nighttime and early morning. And I thought well, most runners probably will be running sort of early morning. Although you see runners running daily time as well. And, so I was just trying to sort of imagine, the feel that the runner would feel when he or she is running and just what kind of story would add to that experience? […] I was walking around at nighttime and early morning with this story in mind and I thought 'Oh, this is perfect'.*

Interviewer: *You didn't mention any specific time periods in the story. […]*

Writer №7: *No […] I mean, you know, I don't want to limit the time when the runner can run. But I wanted to maximise the story. I sort of knew that well, you know, runners will probably want to run in the morning, or later in the evening, so I was writing for those times, but I tried to write it so that people can enjoy it at any time.*

```
                ANNA
Look around stranger, isn't that
beautiful? I used to love this
place when I was a human. I used to
come here often.
```

Ambiguity

In addition to the scheduling for a particular session, the experience also changes within a single session:

The idea is that it's slow going until the monster attacks you. You have to sprint forward as fast as you can. It's almost an interval training. Writer №5

```
                MARY
Get out of the car! Get out! Go!
You two at the back, get out now!
Run! RUN!!!
```

Blending

5.2.3 Repurposing Story Mechanics

Empathy

Writers also considered how traditional story mechanics could be adapted for running. For instance, along with a rationale for running, writers also attempted to complement it with an emotional reason. As Writer №5 stated above, it was essential for him to use fear to support the running. Writer №4 also wanted to establish an emotional connection. He explained that he needed Ramone's character to demonstrate how deeply Ramone cares about Baron, which in turn would hopefully transfer to the runners, making them actually care, whether they find the coffee for Baron or not:

Interviewer: *And you didn't want to have just Baron sending you for the coffee…*

Writer №4: *It's kind of like this chain of command, it kind of works with the feudalism. So like Baron is there, but Baron can't even cope. There's this element of care and I guess the player is supposed to pick up on that and care about what happens to Baron.*

RAMONE
BARON please sit back over here. There'll be something, don't you worry. Can I get you some tea?

BARON
I want no tea! Coffee! Bring me coffee!

Empathy

Writer №7 used the similar approach, trying to make runners care about Anna, and therefore, be more motivated to run for her:

…I think the basic feeling that I want runners to have is the sense of curiosity. […] I also want all these different experiences […] you know, if you're just walking and then a little girl comes up to you and say 'Oh, please help me, I'm lost', you know. I want that feeling […] now want to help this girl. […] I also want to have all these feeling of, you know, like, the runner probably feeling 'Oh, what have I got myself into?!', you know, you take this little girl around and try to find the parents and you have to fill up all these forms inside […] Then you know that at the end of it you feel some sort of 'I've helped a little girl!'

ANNA
You have no idea how much this all means to me. I've been here for so long without anyone to talk to. I'm so glad to have met you, I'm so excited.

Empathy

Familiarity

Listeners being on the go, while experiencing the story, meant that the amount of attention they could dedicate to the story would be constrained. This urged writers to make stories as simple as possible. In fact, Writer №5 started with a whole different story at first, yet had to start over when he realised that the first story was too complex for running: *'[The first script] was too complicated. There was too much going on, too much*

to be explained. This one [the second one] is pretty clear [about] what's going on. […] Biggest issue is basically trying to be concise about it'.

Writer №5 also revealed that to make it easier for runners to understand quickly what would be happening, he utilised familiar tropes and references to other stories:

I do like starting in the car, because it directly references a scene from Jurassic Park. The thing climbing on top of the car. You don't know where it is, one has to draw it off, save the others.

[…]

In fact, I took a shortcut, a major one. It's basically a B-movie and a horror movie. I chose that because it's got all the tropes that you're familiar with. Bunch of teenagers going off and doing something really stupid. Monster attacking. And the main goal there is 'run for your life'.

The characters are just archetypes really. You've got the nagging girlfriend you've got the idiot jock.

SCENE 1

Obnoxious music.

MARY
Turn that off.

The volume lowers.

MARY
Dammit John, all the way. I can't see anything.

JOHN
How does turning off the radio make you see better?

MARY
Just turn it off. You know what, fine, here, I'll do it for you. Why do you have to be like this?

Familiarity

Simplicity

The other writes also confirmed the importance of keeping the story simple:

> *I don't want to overwhelm people, I think people like when it's simple. For example, if this was an app, once you open all of these stories, you can look at different images or sketches […] but it would be between runnings, it's not the same time as you run.* (Writer №7)

> *I'll just keep it as short and simple as possible, and see how that goes. […] I thought it [having many characters] would be too confusing […] unless you have a really strong character with a different point of view, I didn't really need to add that.* (Writer №4)

Simplicity helps to introduce the runner to the story world, yet it does not mean that writers cannot develop some complexity to the story as MRS progress.

Interviewer: *Why did you pick the horror genre?*

Writer №5: *Honestly, because it's the quickest way to get across goals and ideas very quickly. As soon as the monster appears, you realise 'Ok, my goal here is not get caught by the monster'. Doesn't have to be complicated, doesn't have to be anything else. You can add stuff later on, obviously I did when one of them gets lost and obviously, if there's further mission, you'd have to go and find them. […] It's very quick to start. […] They have got their heart pounding, their blood pumping, so I figured story based around fear would be the best*

```
JOHN (CONT'D)
Just keep going by the lake and
you'll see the cabin very soon.
And yeah, definitely keep off the
main road, I think we can see some
movements there.
```

Contradiction

Familiarity

Simplicity

This study focuses on the techniques that writers use to address the running experience. While having listeners running as they experience MRS was an important reason to keep the stories simple, it is important to note that there were also—smaller—reasons, such as keeping the production costs low ('*Obviously, you don't want 100 characters, because that means hiring a lot of different actors to cover that*' Writer №1), being very constrained with writing space (*'If I'd had another character, I'd have to even it out with lot more dialogue*' Writer №4), writing for a particular format of MRS that combines story segments with the music ('*Because they'll probably listening to […] music in between, I don't want to be too intrusive*' Writer №7), and so forth.

Curiosity

To keep affecting runners even during the music breaks between story segments, writers used curiosity:

You sort of want to end it [a scene] before the next scene, when it's coming up, you have to leave up climaxes. You want to start the story with a bit of an action and then you want to keep the action going and then keep going until you hit a mini climax and that's where the scene ends. And I think it's also good for this, because then the runner will want to know what's happens next.
Writer №7

```
ADAM
Stay quiet and hopefully they will
never know that you are here.
Do not talk to anyone Anna.
(To himself)
Oh Lord, what have I done?!
```

Curiosity

Naomi Alderman revealed in an interview that she used a similar approach:

> *I wanted to do it in a way that'd feel like a US TV show, structured around 'ad breaks' (music) and with good cliff-hangers at the end of every section to keep you coming back after the ads (in our case, keep you running). Fortunately for me, there's a lot of literature out there about how to do that—I read a lot of Buffy scripts, I read what Sorkin says about how to do it.* (Alderman, interview №1)

Closure

Of course, an important part of every running session is the ending. Moreover, an ending is also an important part of every story. Here Writer №4 tells how he managed to tie the two together:

> *I thought, what would I want to do if I was running in this situation? What would be the best way to finish it? […] In the end I kind of encouraged that a bit with a chase. For me, when I run, it ties the way I do it. I have a jog and last 20% or 10% I kind of sprint to get rid of the excess energy. So, in that regard I kind of encouraged that in the writing. […] So, I thought, the kind of chasing would be interesting in terms of the story but also interesting for the player in terms of the physical exertion. It ties in together well.*

Writer №4 also strived to provide a reward for the runner through his story:

You've gone this far—enjoy, so there's gunfire, chasing, these kinds of things.

GALLOPING, with the odd pistol shot. Sound changes to less distorted radio, as though you're face to face with RAMONE. — Closure

RAMONE
(To horse)
Come on Macchiato! Away!
(To RUNNER)
You did good. Now quickly back to Brunswick.

MISSION ACCOMPLISHED

Writer №5, however, warns that MRS writers should not provide a fully satisfying ending, as they want the listener come back for the next run:

There's the success: you evaded the monster. But then there's also 'We're not done yet, the night's not over. Someone's missing—go find them'.

MARY — Closure
Her phone is dead.

JOHN — Curiosity
So where the hell is she now?!

[...] — Empathy
We need to go back there and find her. Well, I'm going back there to find her, you can stay in, if you like.

MARY
We're going with you.

MISSION ACCOMPLISHED

Two writers used a similar approach that kept runners interested during the music breaks also to keep them interested in between the running sessions:

Like with any sort of episodic stories, I just want the runner to want to know what happens next. Writer №7

ANNA
Can you hear me? Please come again soon and I will tell you more about me, and about Adam, and the spirits, and the winds. I want to talk to you, I missed that so much.
Just promise you'll keep coming here and you'll keep running. Could you do that for me please?

MISSION ACCOMPLISHED

Curiosity

Empathy

As revealed above, writers assumed that in this case curiosity could work well together with empathy: runners would not only be interested in what is going happen next, but they also would want to come back to 'help' the characters they care about. This combination looks like a natural choice for MRS writers to keep runners interested in the long term:

> *I said three seasons seemed like a good run, maybe three seasons with 20 missions each. What we've already done is three seasons with 60 missions each. […] It's grown much bigger in terms of content and that is really in response to what the players want. They enjoy running to it and they want more stories*. (Hon, interview №3)

5.3 DISCUSSION

Study 2 allowed further development of three themes that emerged from the previous study; this time from the perspective of the writers. Each theme is covered in the following subsections. The first one is dedicated to *running*, and the ways writing for running was different for the participants. The second subsection further develops the *story* theme. It suggests how writers connect their story to the surrounding environment and how they repurpose traditional story mechanics when writing a MRS. The third subsection returns to the themes of *MRS* format, extending it with the creators' perspective.

Notably, Study 2 did not significantly advance the themes of *hybrid experience*, *voluntary engagement*, and *MRS elements*. As mentioned previously, the study was designed to explore how the process of creating a mixed reality story is different from the writers' usual process. Thus, I described the format but did not provide any directions as to how to create stories for it, as this could steer the writers' creative process in specific directions. The study revealed that writers did not deliberately consider the *hybrid nature of the experience*, the opportunities for *voluntary engagement*, and *MRS elements* that could work beyond the main story. This might indicate that the three themes are unique to the MRS format compared to the story formats the writers previously worked with.

5.3.1 Running

While the format of MRS provided more creative freedom to the writers than interactive stories (Crawford, 2012) or video games (Howard, 2008) generally do, participants of Study 2 still felt limited in a number of ways.

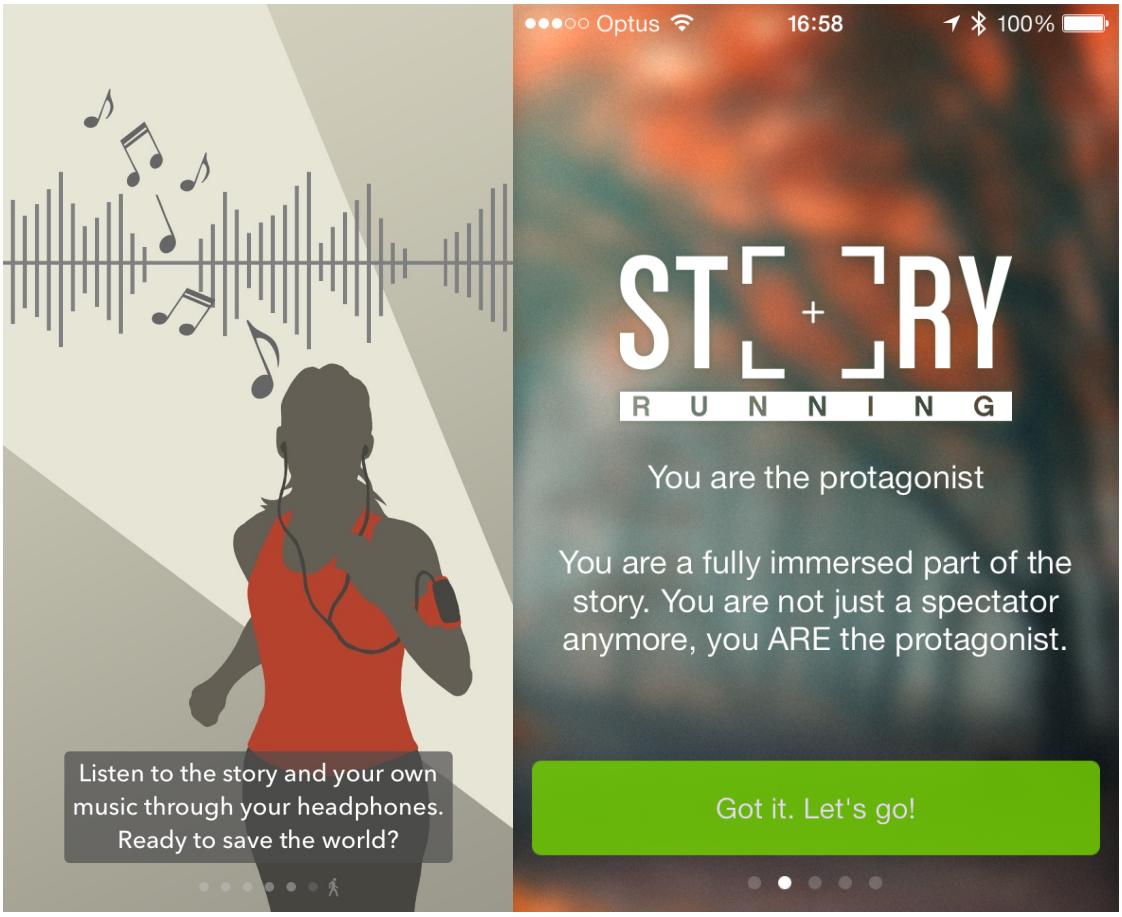
The biggest limitation according to all three writers was that they had to build the story around running. Most importantly, they needed to provide a believable motivation for the protagonist to keep running, something what one of the writers admitted to have struggling with.

Consequently, the writers assumed that the story time and the running time should match, since it would make it easier for the listener to imagine being in the story. In a book, a writer can simply jump years ahead between the scenes (Abbott, 2008); in a MRS such cut could break the connection for the runner. Thus, it was also important for the writers to know, how long the pauses between the story segments would be, so that they could match the overall story time with the overall run time. While there were potential ways to mitigate this (such as creating a time-travel story, in which runner literally runs through time), it nevertheless creates a necessity for MRS creators to carefully consider such issues.

Writers also felt strongly that the protagonist should have as little personality as possible, so that any runner could easily identify with being the hero. In all three stories, they decided not to explicitly specify the protagonist's gender, age or occupation. This limitation was in line with the commercial MRS that openly invite the runner to feel being the protagonist (Figure 5.8).

Finally, writers had to rely on the audio channel to deliver the story, and they mentioned being concerned about how adding certain sound effects or bringing more characters could affect the costs of the consequent production of the MRS prototypes.

While not every limitation was implied by the format itself, writers agreed during the follow-up discussions that each of them is essential. One of the writers suggested that it is possible to imagine a mixed reality story that breaks those limitations, while still enriching the running experience, it just felt most natural to apply those limitations, at least in the beginning of exploration of MRS format.



5.8 *Zombies, Run!* and *Runtastic Story Running* inviting to become a hero

5.3.2 Story

Connecting a Story to the Environment

Study 2 revealed how writers use three approaches for juxtaposing fictional world of the story and runners' physical world.

The most straightforward approach is the use of **blending**. With it, writers aim to blend together virtual and physical. The most typical example of blending, used in all MRS used in this thesis is the running itself. Writers specifically build a story around a running character to facilitate connection between the story and the physical act of running. The use of blending was particularly prominent in *Coffee Break*, which deliberately featured several places that located on either the Melbourne University campus of in the nearby area.

Another approach, also common for storytellers, is the use of **ambiguity**. Writers decide to deliberately be ambiguous when they want some part of the story to be applicable to different situation. The most prominent example of ambiguity, also used throughout the different mixed reality stories in this thesis is the unspecified protagonist's gender. All stories were built in such a way so that different runners could easily identify with being a hero, regardless of their gender. Thus, this aspect was deliberately left ambiguous, so

that runners later could adopt it depending on their specific situation. The use of ambiguity was particularly prominent in *Adam* with Writer №2 explicitly noting that he intentionally did not specify where the story is taking place, so that runners could try to connect the story to the place they were currently running at.

The most counterintuitive approach in the context of MRS was the use of **contradiction**. As it turned out, sometimes writers want to deliberately break the potential connections between virtual and physical worlds to create a specific effect. The use of contradiction was particularly prominent in *Horror Runner*. Writer №5 deliberately decided to set his story in the dark forest, even thought he knew that runners will be listening to the story on the University campus, and also most likely to be running during the day. Still, the dark forest setting was more fitting for the horror-genre, and for Writer №5 that was worth sacrificing the connection between the story location and the physical running location.

Repurposing Traditional Story Mechanics for Running

To address the specifics of MRS format, writers also repurposed traditional storytelling mechanics. This section by no means provides a comprehensive list of all traditional mechanics that MRS may repurpose but rather presents the most prominent ones that emerged during the study.

Curiosity

Storytellers need to keep the audience curious about what is going to happen next, otherwise they are not likely to stick to a story (Abbott, 2008, p. 242). The use of this mechanic is particularly prominent in crime mysteries: people would often want to finish the story as soon as possible to find out who the murderer is[1]. In writing for TV series storytellers would often end an episode with a *cliffhanger*, an unexpected plot-turn that would potentially bring the audience back for the next episode (e.g. Laurel, 1991, p. 75). Moreover, if the show has commercial breaks, it is particularly important for the screenwriters to ensure that the audience would not switch channels (Barbour & Stirling, 1979). Therefore, storytellers frequently put smaller cliffhangers right before a commercial break, so that the audience would be interested to find out what is going to happen next and, therefore, keep watching the show. Similarly, they would put a larger cliffhanger at the end of a season to keep the audience waiting for the next one.

Thus, in serialised stories curiosity works on different levels: to keep the audience interested between the story segments within an episode, then between the episodes within a season, and finally between the seasons until the very end. Klimmt et al. (2012)

[1] Sometimes it is the gardener.

argue that the same principle apply to digital stories and videogames and should be taken into account by designers of such systems.

In one of the interviews, the main storyteller of *Zombies, Run!* mentioned that she relied on cliffhangers while writing the MRS. Just like in a TV series, in MRS cliffhangers work on different levels: to maintain curiosity between the story segments within a mission, between the missions, and ultimately between the seasons. *Zombies, Run!* does not have commercial breaks, cliffhangers here are used with a different purpose: to keep the running interesting and appealing even to those who do not enjoy running in general.

Findings revealed a similar use of curiosity in all the stories but particularly in *Horror Runner*. For instance, at the end of the first mission the runner would safely arrive at the cabin, only to find out that one of the friends is missing, and they have to go back into the woods to find her.

Familiarity

Storytellers rely on familiar tropes to facilitate the audience's understanding of the story and set up the expectations (Abbott, 2008, p. 49). Following the genre conventions is one of the prominent examples of such approach: if a story starts with a murder, the audience starts anticipating the investigation, false allegations and then, finally, the reveal in the end.

In interface design, familiarity is used to facilitate the user understanding of the technology. Thus, interface designers rely on familiar metaphors, so that users had an understanding of how the interface works, even if they see it for the first time (Raskin, 1994).

Writers use familiarity in mixed reality stories somewhat similarly. For instance, Writer №5 had to make a choice between familiarity and blending: he wanted to add a cabin by the lake, placed inside a forest. These are familiar locations for the horror movie watchers, but none of them could be found on the University of Melbourne campus. Nevertheless, the writer argued that familiarity is particularly beneficial when it comes to MRS designed for running. Running requires attention, which can make it hard for the runner to concentrate on the details of a story (Marshall & Benford, 2011). Thus, he needed to quickly explain to the runner what is happening and how running is part of the story. This left very little room for the introduction, and the use familiarity helped to set up the right expectations quickly: with the help of familiar elements, the runners would feel like they already know what the story is about and what is required: their car broke down in the middle of nowhere, there is a mysterious monster and they need to run for their lives. Thus, Writer №5 added a cabin by the lake and placed the story in a forest, even though neither was connected to the University campus.

This does not, however, mean that that the use of familiarity is always beneficial. The use of familiar tropes simplifies the story. McKee (1997) warns that while simple characters are demanded in action and adventure stories, the same characters would be

unacceptable in a story of an interpersonal or inner conflict (p. 107). In the study, Writer №5 argued that for a running MRS it might be beneficial to combine approaches. Thus, to use simplicity in the beginning to ease runners into the story, and then gradually add complexity to avoid boredom. As the creator of *Zombies, Run!*, Hon, points out in one of the interviews, if runners enjoy MRS, they will be asking for more story. Story writers need to be inventive to keep an ongoing story interesting.

Empathy

Storytellers aim to create an emotional connection between the audience and the story. McKee (1997) argues that in life meaning and emotion are generally separated (p. 110). The two influence each other, yet come sequentially. In art, however, the two can be united. Emotional connection strengthens the influence of a story. For instance, Klimmt et al. (2012) notes that empathy turns curiosity into suspense: the audience not only is interested to find out what happens, but they also want a particular outcome for the characters they are empathising with.

The findings suggest that MRS writers can potentially increase users' interest in running by creating emotional connections between the runners and the story. In the study, all three writers used empathy in their stories. In two instances, runners were meant to empathise with characters who needed their help and in the horror story; it was the protagonist who needed to run for their life.

In HCI the discussion around empathy revolves around designers empathising with the user to create a better user experience (McCarthy & Wright, 2004). The findings from the study suggest that the approach can be extended to the users themselves, in that if a system would provide them elements to empathise with, that in turn could create additional motivation for the users. Thus, for instance, when the runner knows that a character in the story waits for their help, they might be more willing to go for another run.

Closure

Finally, storytellers generally aim to create a sense of closure at the end of a story (McKee, 1997, p. 303). In conventional storytelling, the ending ties together different story threads to resolve the central conflict driving the story (Arndt, 2017).

Unlike with the other mechanics, the participants explicitly advised against using closure in MRS. Running is meant to be a repeating activity, and story closure does not align with the repeatability. Thus, Study 2 findings suggest avoiding closures or making sure that while some threads end and conflicts get resolved, other continue to stay open and maintain runners' interest

5.3.3 Mixed Reality Stories

Study 1 claimed that mixed reality stories are different from traditional audio-stories. Study 2 supported the claim from the writers' perspective. All three participants, who finished their stories, mentioned during the follow-up discussions that writing a script for MRS was significantly different from any writing they had done before. Throughout the whole process they had to keep in mind the specific differences of writing for running, for instance, the need to provide a continuous motivation for the protagonist to run, they also wrote all three stories from a 2nd person point of view, which is more common for 'choose your own adventure' books than classic novels. Furthermore, the mechanics they used in creation of other type of stories oftentimes needed to be adapted for the new medium.

Despite the number of limitations that MRS place on storytellers, the format overall still allows for more creative freedom than interactive stories and story-centric video games allow in general (Juul, 1999). Since the stories unfold regardless of what runners do or do not do, there is no need for creating alternative storylines. It also means that the story does not need to change depending on the number of objects collected, or quests completed (Howard, 2008), which in turn allows the writers to focus their stories on people and the relationships between them, as it is the case with traditional storytelling; not objects, as it is often the case with digital games (Crawford, 2012).

5.4 LIMITATIONS

Small number of writers

The main aim of the study was to gain an understanding of how writers address the running experience through writing mixed reality stories.

Out of seven recruited writers, only three completed their stories, which is less than half. On the other hand, the three stories that I received by the end of the study were significantly different. They were written in different genres, took place in different settings, with different types of connections to the University of Melbourne campus.

Thus, the study provided insights into significantly different techniques for affecting the running experience through story-telling. Nevertheless, it was not initially clear if the findings were sufficient.

To check if the study has reached the point of data saturation, I went back to the transcripts of the workshops and separated all the excerpts that came from the four writers who dropped out. I coded their initial thoughts and intentions separately and compared to the themes that emerged from the excerpts that came from the three other writers. In this way I was able to see whether recruiting more writers would be likely to

result in any additional themes. Moreover, I repeated the process for publicly available interviews with a creator and story writer of *Zombies, Run!*. While that helped to extend the existing findings, I did not find any new themes or contradictions, which made me confident that the study has reached a point of data saturation.

In addition, this study aimed to provide a number of new MRS for a further evaluation in the next study with actual runners. From that perspective, a limitation on the amount of writers was actually welcome. Since I promised the writers that their stories will be used in the next study, I had to be careful not to produce too many scripts, as it would unnecessarily complicate the set up for Study 3. The findings from Study 2 indicate that the stories are both different from each other, as well as from *Zombies, Run!*.

5.5 SUMMARY

The objective of this study was to explore how writers can address the experience of running within the stories themselves.

First, Study 2 provides an overview of how the requirement to write for running affected the process of creating stories, as storytellers had to think differently about story time, the protagonist, and so forth.

Second, it suggested that writers can adopt blending, ambiguity and contradiction to relate the story to the physical environment of the workouts. The approach to use contradictions is unexpected in the context of mixed realities, yet is suggested to be beneficial in some cases.

Third, the findings revealed how writers repurpose traditional story mechanics, such as curiosity, familiarity, empathy, and closure, to align them with running.

Finally, the study supported the claim that MRS are different from other story formats by revealing the significant differences in the process of creation of MRS compared to more traditional stories.

6 STUDY 3: UNDERSTANDING THE PERCEPTION OF MIXED REALITY STORIES

Study 1 highlighted the importance of subjective story perceptions and the way they affect how runners make connections between the story world and their surrounding environments. Study 2 provided insight into the process of creating stories with the goal of enhancing running. Study 3 delivers those stories to actual runners and bridges together two previous studies by investigating the following question:

How do runners perceive mixed reality stories while running?

In this study 36 runners had 45 runs on the University of Melbourne Parkville campus (15 runs with each of three story). An interview was conducted with the runners right after they arrived back from the workout.

Study 3 findings identified four stages of story perception, elaborated on how exactly runners adjust their workout on the go, recognised three distinct types of MRS elements that can use independently from the main story, and further complicated the understanding of the relationships people have with running.

6.1 DESIGN

6.1.1 Preparations

Assembling MRS Prototypes

I offered the original writers of Study 2 to participate in building the MRS prototypes with their stories, but they politely declined due to other commitments. Thus, the conversion of the scripts to the Study 3 prototypes happened without the supervision from the authors (I will return to this issue later, in 6.4).

During the early stages of preparations for Study 3, I decided on two requirements for the prototypes. First, I planned to use them from my own devices, rather than from participants' smartphones. Second, I wanted the participants to be able to run with the prototypes on their own, without me having to orchestrate the experiences as a 'a wizard of Oz' (Dahlbäck, Jönsson, & Ahrenberg, 1993).

The first requirement allowed me to streamline the participant's experience with the study. They would need to come in, get the device with the prototype and start running: no installation on their smartphone required. I also had a back-up device, in case something goes wrong with the main one, or if participants would like to book the same session and be interviewed together.

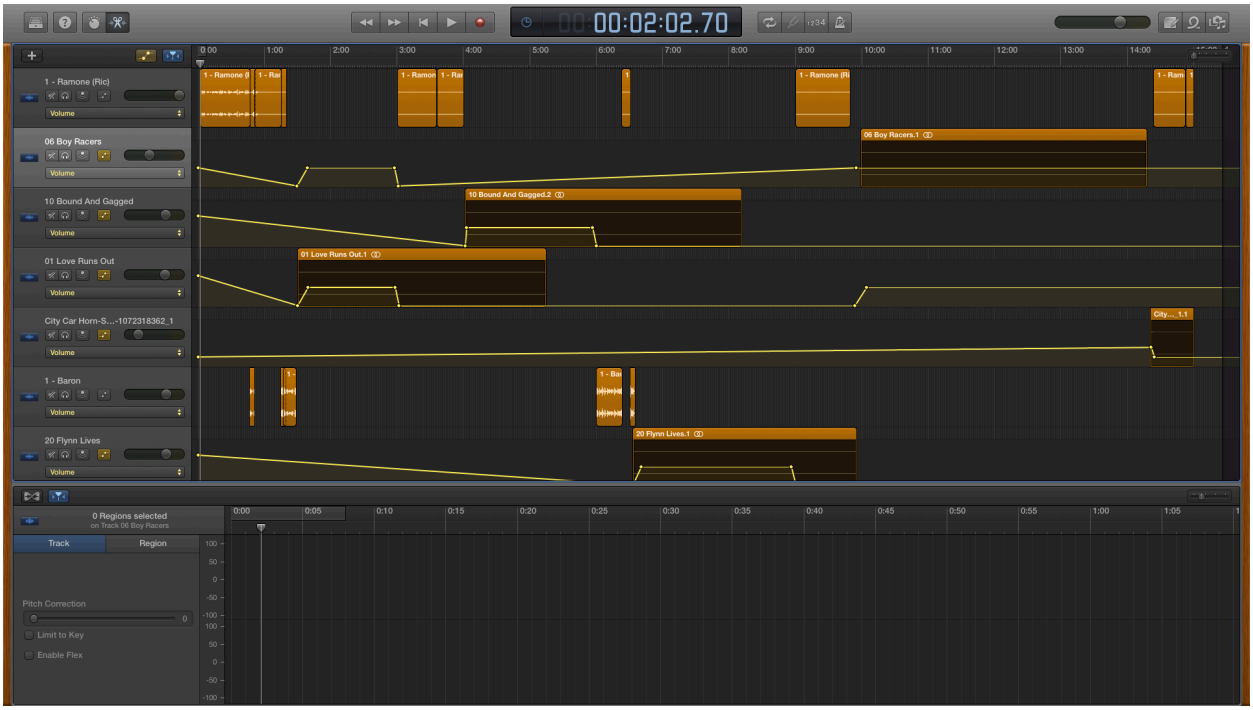
The second requirement emerged from the earlier findings. Study 1 suggested that one of the main benefits of designing for voluntary engagement was that it does not require external orchestration of the experience. Thus, I aimed for a prototype that participants could run with on their own, without the researcher controlling it behind the scenes.

The most difficult part during the preparations was the voice recording for story dialogs. At first, I tried to recruit professional or even amateur voice actors for some help with that part. I was, however, unable to offer a compelling compensation for the job, and gain interest from any experienced voice actors (this issue will also be addressed later in 6.4). Eventually, I managed to get help from two fellow researchers from Interaction Design Lab, as well as two personal acquaintances. All of them volunteered to help, for which I am grateful.

I also needed to add sound effects, which were specified in the scripts: a sound of breaking glass, city traffic, monster roaring, and many others. All of these I found on online sound collections, such as FreeSound[1].

Finally, I needed to add music for the breaks between the story segments. Unlike with *Zombies, Run!* the prototypes would come with pre-chosen set of songs instead of letting the runners use music from the device. This limitation was necessary, since I did not want to require participants installing anything to their phones. There was also a benefit from knowing which songs participants were running too, since this way I was more familiar with the rhythm of the songs and could use that later for data analysis. For the prototypes I tried to pick songs that were related to running in some sense. For instance, *Love Runs Out* by One Republic has 'runs' in the title, *Feral Love* by Chelsea Wolfe has 'run from the light' in the lyrics, and *Bound and Gagged* by Teenager was previously used in Nike's advertisement that featured running[2].

The dialogs, the sound effects, and the music were put together in GarageBand (Figure 6.1). Each story consisted of five small scenes. I distributed the scenes evenly throughout the length of a run and filled in the gaps with music.



6.1 Assembling *Coffee Break* in Garage Band

[1] https://freesound.org
[2] https://youtu.be/FRLZ7EuJJxA

Ethics

As described in the previous chapter, the ethics application for Study 3 was submitted and reviewed in parallel with Study 2.

I had to change the location from Princes Park to the University of Melbourne campus (Figure 6.2) to ensure the safety of the participants. Moreover, I limited the running sessions for after hours and weekends to make sure that the campus will not be too crowded for runners.



6.2 The University of Melbourne campus map
(The starting point for each run is marked with the red arrow)

All of the participants were informed in plain language about the objectives and the risks of participating in the study (Appendix III.I). Each runner had to give an explicit consent in order to enter the study (Appendix III.II). Participants did not have to finish the run, and could also halt the interview at any point, in case they change their mind.

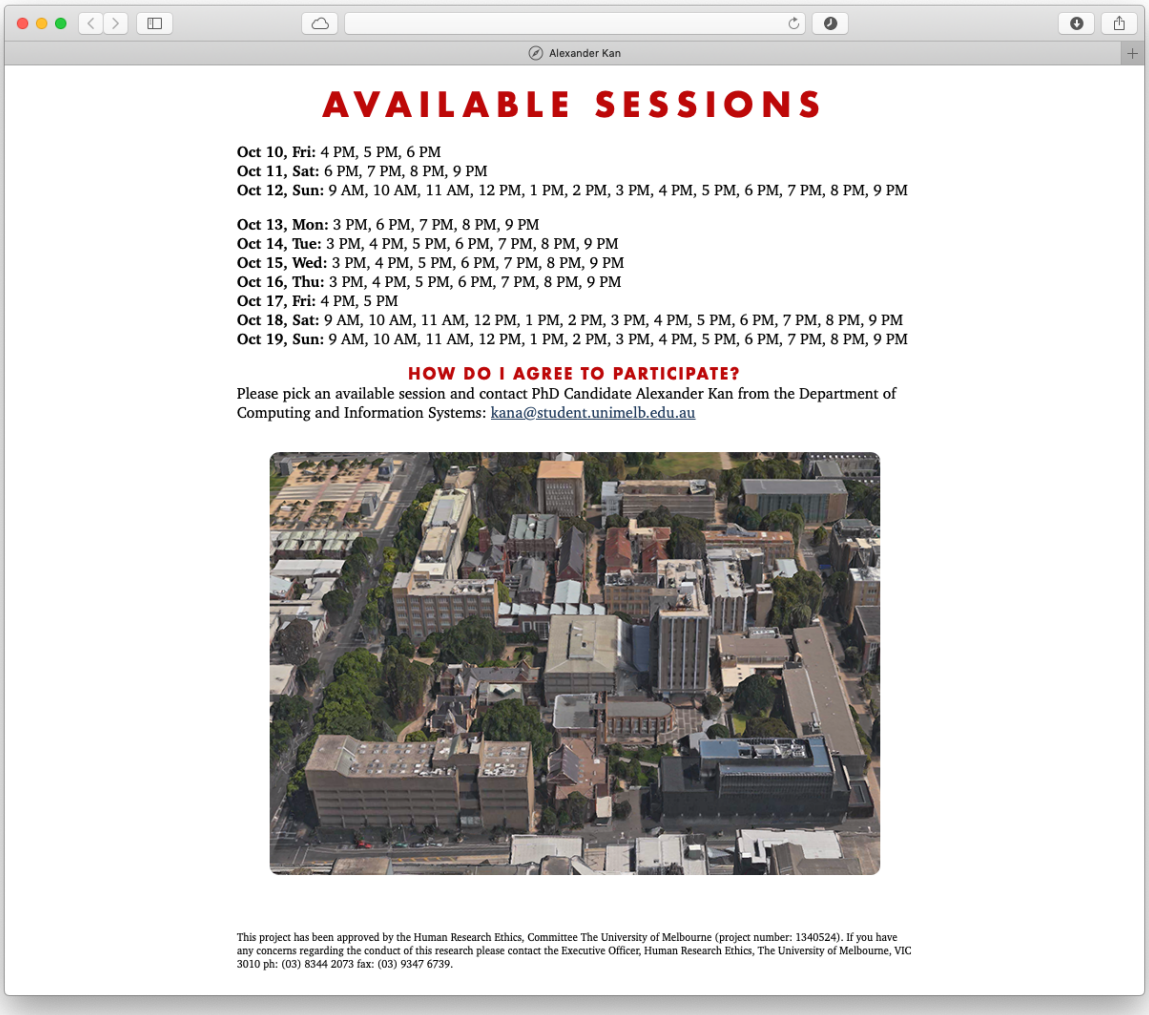
Due to the increased number of the runners, there was no monetary compensation for participating this time. Instead, participants were invited to voluntarily help to advance the current understanding of the experience of running with mixed reality stories.

After all of the suggested changes were made, the Human Research Ethics Committee approved the study under the project number 1340524.

6.1.2 Recruitment

I started the recruitment for Study 3 by sending an email to everyone on the wait list from the first study (4.1.2). Some were still interested, and joined the study, but I did not manage to recruit enough runners for the study via the wait list alone. There were three times more stories in this study compared to the first one, and thus I was aiming for three times the number of participants.

After reaching out to everyone on the wait list, I also released advertisements for the University of Melbourne Student Portal and around the campus (Appendix III.V). In addition, I updated project website with the available session times for potential participants to book (Figure 6.3). I was also asking the existing participants to invite anyone they think might be interested in trying a mixed reality story, using an approach that is known as 'snowballing' (Babbie, 1983; Crabtree & Miller, 1992). The requirements for the potential participants were even lower that in Study 1: this time they did not had to own a compatible smartphone, they were just asked to bring a pair of earphones with them, that they were comfortable to run with. The device with the prototype and an optional armband were provided.



6.3 Study 3 Website with the List of Available Sessions

There was significantly less interest for this study, compared to Study 1. In hindsight, I suspect that one of the reasons for that would be the unfortunate timing: the study was unfolding right before and then during the University examination period. Another reason would be the inconveniences related to running on campus: the participants would have to bring the change of clothes with them; moreover some potential participants wanted to run in the morning or around noon, but only after hours and weekend sessions were available. Nevertheless, eventually I was able to reach the number of participants required for data saturation.

Overall, 36 runners participated in the study, 12 of them decided to run twice (Table 6.1). There were 48 runs: 15 with each story and three failed runs (due to technical glitches). 25 participants were female, and 11 participants were male. The youngest participant was 18 (I did not recruit participants younger than 18) and the oldest was 55. 9 out of 36 participants reported that they were not running regularly at the time. Each run took place on the university campus, however the level of familiarity with the campus varied from 'very familiar' to 'none at all'.

The participants were choosing a story to run with, judging only by the titles. Similarly to an approach used by Marshall & Benford (2011), I decided not to tell the runners what the stories are about, nor in what way the MRS were meant to influence their running. This left the stories and the overall experience open to each participant's interpretation. I was aiming for a relatively number of participants for each story and willing to limit the choice to only two stories, in case one become significantly more popular than the others. Yet I did not have to do that, as the equal split between the stories happened naturally. The choice for the stories was limited to two only for the second runs, in which case participants were offered to choose between the two stories they had not experienced yet.

Coffee Break			*Horror Runner*			*Adam*		
№	Gender	Age	№	Gender	Age	№	Gender	Age
1	M	20	5	M	25	2	F	22
10*	F	28	6*	F	55	3	F	22
14	F	22	7*	F	31	4	F	20
15	F	31	9	F	24	11	F	19
16	M	31	10	F	28	12	F	19
17	M	34	13	M	20	21*	F	32
19*	F	20	15*	F	31	23	F	23
20*	F	18	16*	M	31	24	F	21
21	F	32	18	F	26	25	M	20
27	F	23	19	F	20	26	M	21
28	F	22	20	F	18	30	F	20
29	F	19	22	M	23	31	M	21
33	F	21	27*	F	23	32	M	20
34	M	24	28*	F	22	35	F	30
35	F	30	29*	F	19	26	M	26

6.1 Study 3 Participants' First and Second* Runs[1]

6.1.3 Data Collection

Interviews

Interviews were conducted in a manner similar to Study 1, with slight adjustments. I interviewed participants right after each run of their runs, with an exception for one participant (Runner №35 asked to do only one interview after both of her runs). Each interview was conducted in person, on campus. In the closing study, I was able to structure the interview around the themes from Study 1 and Study 2, and thus be more precise with the questions. I also used written questionnaires this time prior to starting the interview, which also helped to speed up the process. As a result, interviews were significantly shorter, with an average length being closer to 20 minutes (in Study 1 the average length of the interviews was around 45 minutes).

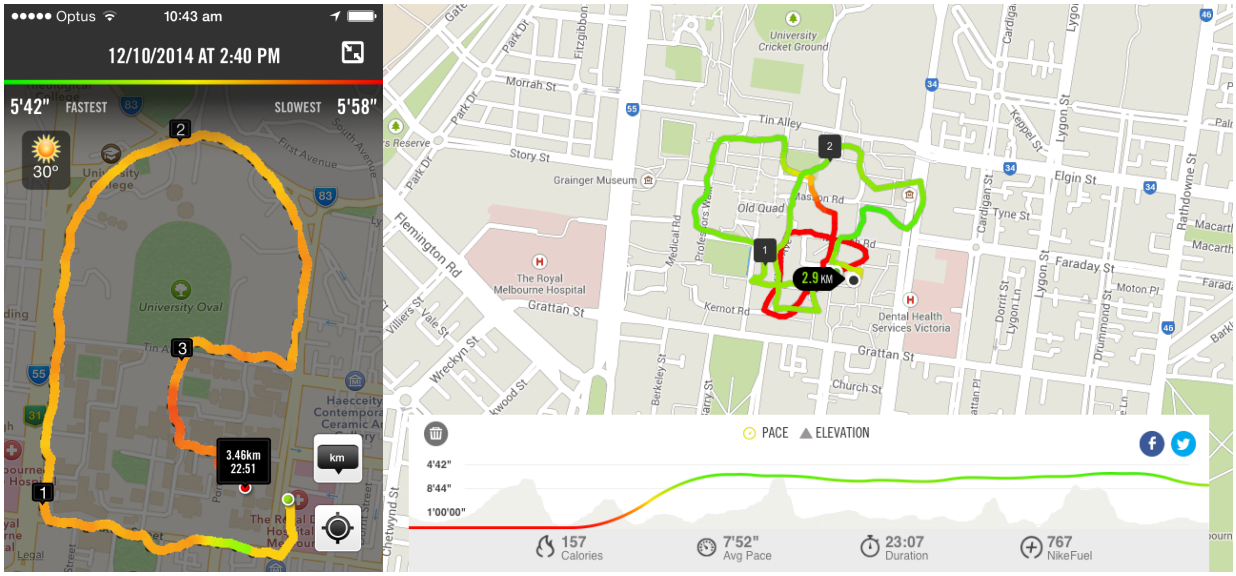
[1] There were also three failed sessions: for Runner №6 F 55; №7 F 31; №8 F 19. Runners №6 and №7 then had successful second sessions at another day.

Questionnaires

While research from the interpretivist perspective generally relies on the in-depth qualitative interviews (Crotty, 1998), in Study 3 I also used questionnaires (Appendix III.IV) in order to collect data that usually did not require an elaborate response, such as participant's age, occupation, or whether they listen to music while running (in Study 1 I would ask these questions at the beginning of each interview). Participants were asked to fill in the questionnaire after they came back from the workout, and prior to the main interview. I left the questionnaire on the table during the interview, in case anyone would still want to elaborate on any of the responses. Questionnaires also occasionally led me to some additional questions during the main interview, particularly in cases when participants indicated an extensive previous experience with running.

Running Logs

During each session, running data (route, length, time, and runner's pace at every point along the route) was logged with a Nike+ app[1] on the same devices that were provided to the participants. The running logs played a role similar to Study 1's logs. During the interview, I would leave the log from the run on the device screen or on a laptop, so that participants could see it and give a commentary if needed. For instance, when seeing a simple loop around the campus, I could ask if the runner had a clear route in mind from the beginning. Or when looking at a particularly tangled route, I could ask, if any of the turns were due to something happening in the story.



6.4 Study 3 Running Logs

[1] https://www.nike.com/member/profile

6.1.4 Data Analysis

For this study I collected three types of data: interviews, questionnaires, and running logs. Running logs were mainly used as props during the interviews. The questionnaires were used in a similar manner: I would look through the answers while the participants were on the run, and then, when they came back for the interview, I asked them to elaborate on anything that would catch my attention. Thus, my focus for Study 3 data analysis was on the interviews.

Due to a much higher number of these interviews I only selectively transcribed them, choosing fragments that seemed relevant to the research question, or which bore particular importance to the participants, or was unexpected information. I listened to each interview in full several times to get a better sense of the data (Patton, 1980).

While I already had themes and categories emerging from two previous studies, I deliberately did not start data analysis of Study 3 by looking for the existing codes. Instead, I wanted to validate whether the same themes might come 'naturally' from a more extensive study.

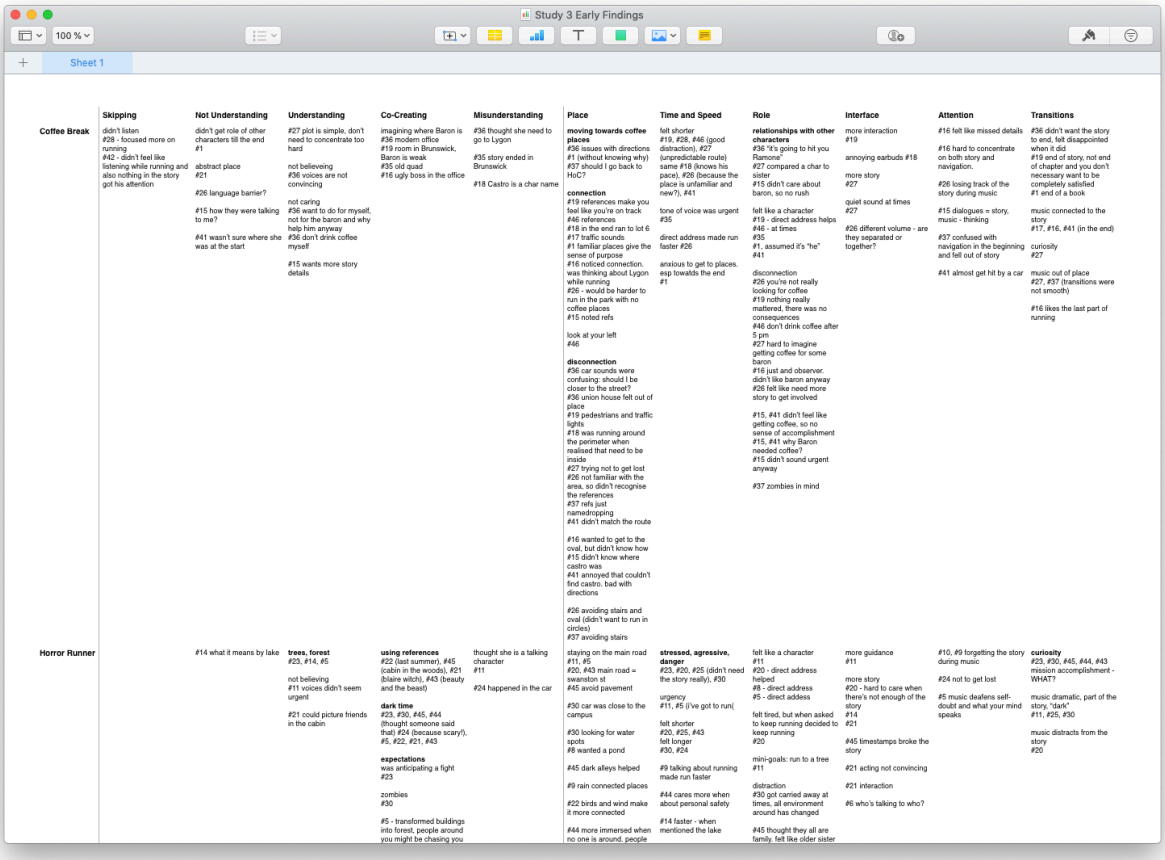
Thus, I started the data analysis the same way I had conducted it two previous times, by focusing on the research question first: '*How do runners perceive mixed reality stories while running?*'. Naturally, a major code that emerged from this approach refers to *perception*.

In addition to this, while looking for anything that would seem important to the participants, I noticed that *focus on the run* turned out to play a surprisingly large role in the formation of the overall experience.

Finally, after a couple of initial iterations, the same familiar themes and categories continued to emerge. However, this time an increased number of data fragments allowed me to further break down some of the categories, such as *voluntary changes*, *MRS elements* and *trajectory of a workout*.

Similarly to previous studies, I used DEVONthink and a paper-based approach for analysing and coding the transcripts, but due to a significantly larger amount of interviews it became harder to have a clear overview of the available data. Moreover, I wanted to see clearly which story each data fragment comes from, so I could compare three different MRS among each other.

Thus, I made a large spreadsheet to help me achieve a comprehensive overview. I dedicated each column to an early code relevant to Study 3 and each row to one of the stories. On the intersection I put brief summaries from the most significant interview excerpts and the corresponding interview number:



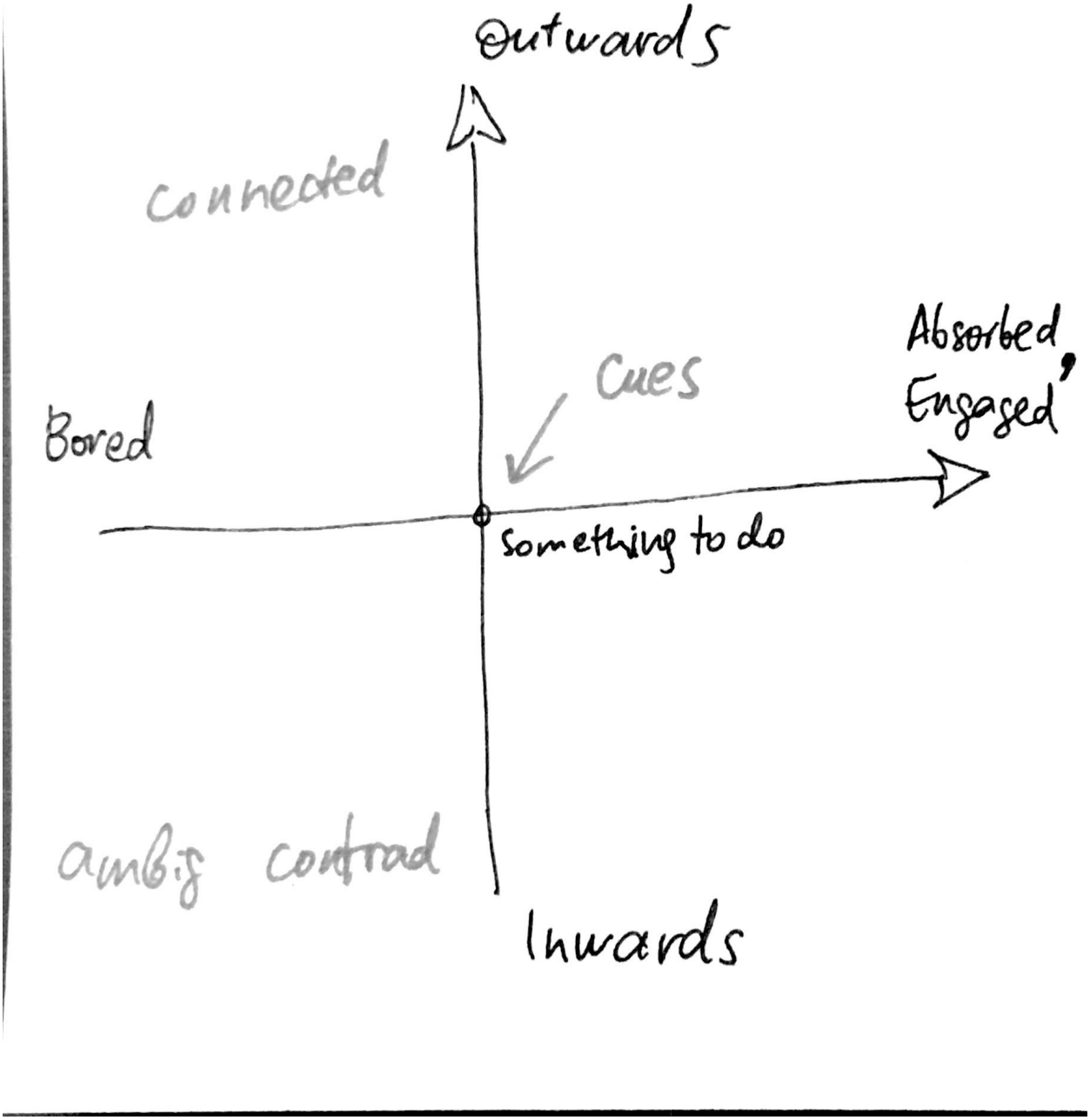
	Skipping	Not Understanding	Understanding	Co-Creating	Misunderstanding	Place	Time and Speed	Role	Interface	Attention	Transitions
Coffee Break	didn't listen #28 - focused more on running #42 - didn't feel like listening while running and also nothing in the story got his attention	didn't get role of other characters till the end #1 abstract place #21 #26 language barrier? #15 how they were talking to me? #41 wasn't sure where she was at the start	#27 plot is simple, don't need to concentrate too hard not believeing #36 voices are not convincing not caring #36 want to do for myself, not for the baron and why help him anyway #36 don't drink coffee myself #15 wants more story details	imagining where Baron is #36 modern office #19 room in Brunswick, Baron is weak #35 old quad #16 ugly boss in the office	#36 thought she need to go to Lygon #35 story ended in Brunswick #18 Castro is a char name	**moving towards coffee places** #36 issues with directions #1 (without knowing why) #37 should I go back to HoC? **connection** #19 references make you feel like you're on track #46 references #18 in the end ran to lot 6 #17 traffic sounds #1 familiar places give the sense of purpose #16 noticed connection. was thinking about Lygon while running #26 - would be harder to run in the park with no coffee places #15 noted refs look at your left #46 **disconnection** #36 car sounds were confusing: should I be closer to the street? #36 union house felt out of place #19 pedestrians and traffic lights #18 was running around the perimeter when realised that need to be inside #27 trying not to get lost #26 not familiar with the area, so didn't recognise the references #37 refs just namedropping #41 didn't match the route #16 wanted to get to the oval, but didn't know how #15 didn't know where castro was #41 annoyed that couldn't find castro, bad with directions #26 avoiding stairs and oval (didn't want to run in circles) #37 avoiding stairs	felt shorter #19, #28, #46 (good distraction), #27 (unpredictable route) same #18 (knows his pace), #26 (because the place is unfamiliar and new?), #41 tone of voice was urgent #35 direct address made run faster #26 anxious to get to places. esp towatds the end #1	**relationships with other characters** #36 "it's going to hit you Ramone" #27 compared a char to sister #15 didn't care about baron, so no rush felt like a character #19 - direct address helps #46 - at times #35 #1, assumed it's "he" #41 disconnection #26 you're not really looking for coffee #19 nothing really mattered, there was no consequences #46 don't drink coffee after 5 pm #27 hard to imagine getting coffee for some baron #16 just and observer. didn't like baron anyway #26 felt like need more story to get involved #15, #41 didn't feel like getting coffee, so no sense of accomplishment #15, #41 why Baron needed coffee? #15 didn't sound urgent anyway #37 zombies in mind	more interaction #19 annoying earbuds #18 more story #27 quiet sound at times #27 #26 different volume - are they separated or together?	#16 felt like missed details #16 hard to concentrate on both story and navigation. #26 losing track of the story during music #15 dialogues = story, music - thinking #37 confused with navigation in the beginning and felt out of story #41 almost get hit by a car	#36 didn't want the story to end, felt disappointed when it did #19 end of story, not end of chapter and you don't necessary want to be completely satisfied #1 end of a book music connected to the story #17, #16, #41 (in the end) curiosity #27 music out of place #27, #37 (transitions were not smooth) #16 likes the last part of running
Horror Runner		#14 what it means by lake	**trees, forest** #23, #14, #5 not believing #11 voices didn't seem urgent #21 could picture friends in the cabin	**using references** #22 (last summer), #45 (cabin in the woods), #21 (blaire witch), #43 (beauty and the beast) **dark time** #23, #30, #45, #44 (thought someone said that) #24 (because scary!), #5, #22, #21, #43 **expectations** was anticipating a fight #23 zombies #30 #5 - transformed buildings into forest, people around you might be chasing you	thought she is a talking character #11 #24 happened in the car	staying on the main road #11, #5 #20, #43 main road = swanston st #45 avoid pavement #30 car was close to the campus #30 looking for water spots #8 wanted a pond #45 dark alleys helped #9 rain connected places #22 birds and wind make it more connected #44 more immersed when no one is around. people	**stressed, agressive, danger** #23, #20, #25 (didn't need the story really), #30 urgency #11, #5 (i've got to run(felt shorter #20, #25, #43 felt longer #30, #24 #9 talking about running made run faster #44 cares more when about personal safety #14 faster - when mentioned the lake	felt like a character #11 #20 - direct address helped #9 - direct address #5 - direct address felt tired, but when asked to keep running decided to keep running #20 mini-goals: run to a tree #11 distraction #30 got carried away at times, all environment around has changed #45 thought they all are family. felt like older sister	more guidance #11 more story #20 - hard to care when there's not enough of the story #14 #21 #45 timestamps broke the story #21 acting not convincing #21 interaction #6 who's talking to who?	#10, #9 forgetting the story during music #24 not to get lost #5 music deafens self-doubt and what your mind speaks	**curiosity** #23, #30, #45, #44, #43 mission accomplishment - WHAT? music dramatic, part of the story, "dark" #11, #25, #30 music distracts from the story #20

6.5 Overview of Study 3 Findings

On top of that, I continued to extend my MindNode file to clarify how ties and relationships would change with the new categories and codes.

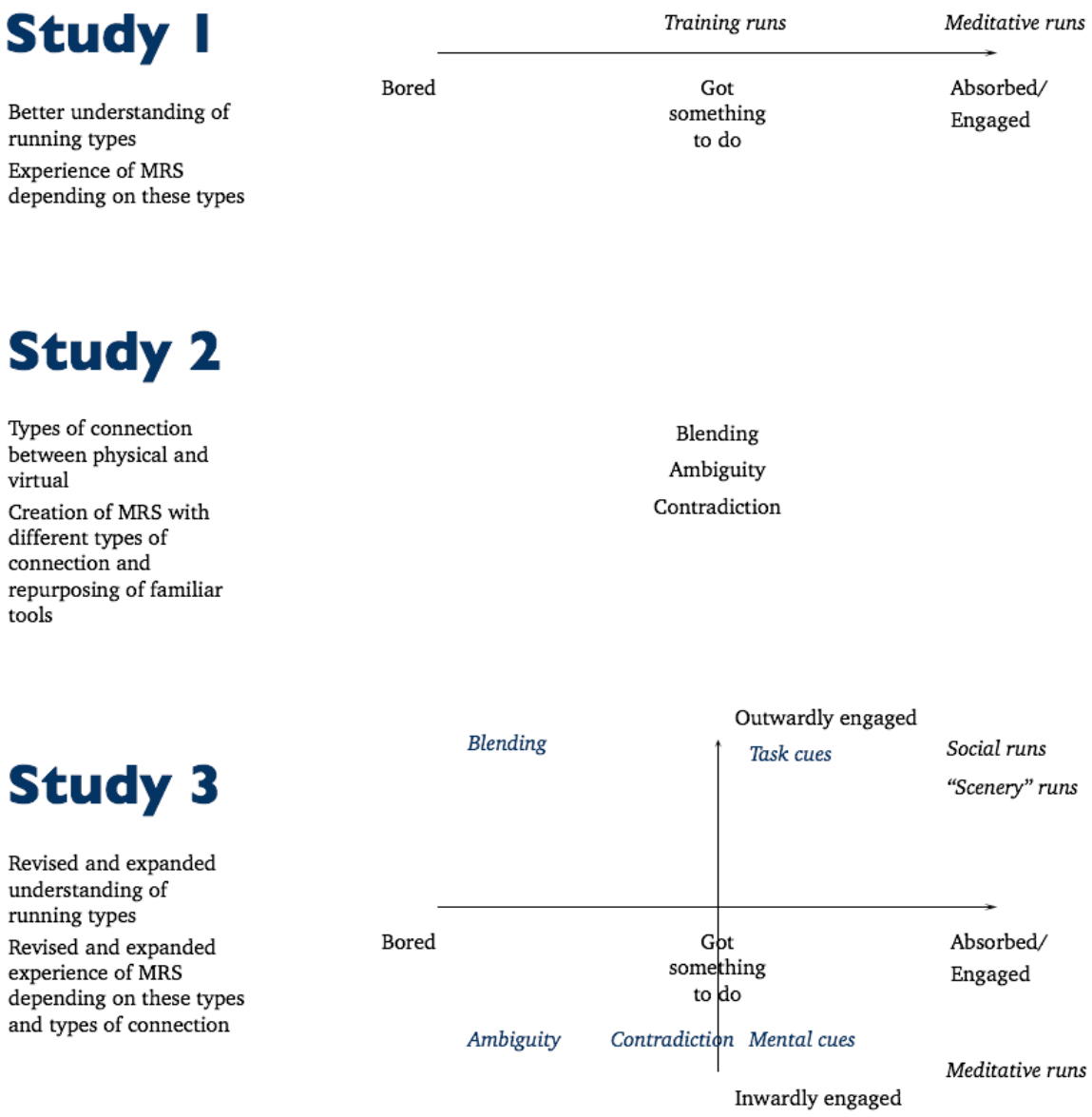
The aim of Study 3 was to validate and expand the earlier findings. Thus, no new themes emerged, only categories and codes which extended the understanding of the existing ones.

I used analytic memos to document the process of developing a grounded theory. Memos, especially paper memos allowed me to quickly capture my thoughts, which came in handy when dealing with some of the more complex relationships between codes, such as, for instance, the relationship between runners' attitudes towards the activity and their focus during the workout:



6.6 Study 3 Analytic Memo

In many cases analytic memos became a foundation for later presentations of the preliminary findings. For instance, the aforementioned paper memo became a graph that I used in further discussions with my supervisors and research peers:



6.7 Study 3 Presentation Slide

As this example demonstrates, during the data analysis of Study 3 I still kept going back to the earlier studies, sometimes rethinking their role in the overall process.

The set of themes, categories, and codes kept evolving until it was finalised for presentation in this thesis (*new categories and codes** italicised and marked with an asterisk):

THEMES	Categories	Codes
MIXED REALITY STORIES	**The Format**	– differences for runners – differences for creators
	Enhancing the running experience	– distraction – meaning
HYBRID EXPERIENCE		
VOLUNTARY ENGAGEMENT	**Benefits and Downsides**	– benefits – downsides
	Changes	– *route** – *length** – *pace** – *attention**
RUNNING	**Personal experiences with running**	– types of running – motivation and goals – schedule – reflection
	Trajectory of a workout experience	– *beginning** – *middle** – *end**
	Attitudes towards running	– enjoying – frustrated – in-between
	Focus on the run*	– *inwards** – *outwards** – *in-between**
	Writing for running	
STORY	**Environment**	– blended – ambiguous – contradicting
	Story mechanics	– curiosity – familiarity – empathy – closure
	Perception of stories*	– *listening** – *understanding** – *connecting** – *caring**
MRS ELEMENTS		– *emotions** – *props** – *rhythm**

6.2 Themes, Codes, and Categories

6.2 FINDINGS

This study expanded existing themes with two additional categories. It also extended three existing categories with more specific codes:

THEMES	Categories	Codes
STORY	***Perception of stories****	– *listening** – *understanding** – *connecting** – *caring**
VOLUNTARY ENGAGEMENT	**Changes**	– *route** – *length** – *pace** – *attention**
MRS ELEMENTS		– *emotions** – *props** – *rhythm**
RUNNING	***Focus on the run****	– *inwards** – *outwards** – *in-between**
	Trajectory of a workout experience	– *beginning** – *middle** – *end**

6.3 Study 3 Findings

This section is structured around categories and codes. The first subsection introduces a significant new category *perception of stories*, which is dedicated to four distinct stages of perception of MRS while running. The two following subsections break down existing categories, *voluntary changes* and *MRS elements*, into finer detail, thus providing more specifics to what changes runners make and what elements of MRS beyond the main story also contribute to the overall experience. The closing subsection introduces a smaller new category *focus on the run*, which complements the existing *attitudes towards running* category.

On top of that, throughout all four subsections are the examples of how the *trajectory of a workout experience* differs from the beginning, to middle, to the end.

6.2.1 Perception of Stories

Listening

Perception of an audio-story starts with active listening. Since Study 3 MRS only used the audio channel for delivering stories, it was impossible to understand stories without listening. However, there were occasions when listening did not happen, which provide insights into perception.

Running itself requires concentration, so it can be hard to pay attention to the story as well. 9 out of 35 other runners who listened to the story closely, stated that it was mentally challenging to run and listen to dialogue at the same time. Runner №19 undertook two runs with different stories, yet both times she was not listening to the dialogs: '*Not that it was a bad story. I just didn't concentrate*'. She did not think there was anything wrong with the stories themselves; it was just hard to follow the stories and run in the same time. Nevertheless, Runner №19 did not take her earphones off. She still heard the stories passively, without paying attention.

Interviews suggested that it was especially challenging to listen to the story at the beginning of a run. Six runners mentioned the issue and three of them actually missed the beginning of the stories for that reason. Yet, the stories' beginnings were important to understanding the setting. For Runner №34, missing the beginning was crucial, as he could not 'get into' the story after missing the premise: '*First I just enjoyed running, then I noticed—oh, there's some story—then I realised it's really hard to catch [up]*'. Eventually the runner decided to stop paying attention to the dialog and just focus on running. Another runner suggested it would be apt if MRS would start with a song, not with a dialogue. This would give the runner time to warm up properly without worrying about missing out on important parts of the story.

While some runners found it hard to concentrate on something other than running, other runners were more interested in suspending thought and letting go of concentration. Five runners stated that while they were listening to the story in the study, as required, in their regular runs they are trying to think as little as possible. Some call it 'a form of meditation', for others it is 'relaxation' and some just want to focus solely on running. For Runner №31 catching himself thinking during a run is a sign that he is not running fast enough.

Understanding

In this subsection, I will talk about understanding in a broad sense: everything that story was about for runners. This includes setting, appearances, motivations, visual references runners had in their minds while running, and so on.

Generally, it is harder to follow information in audio format, compared to textual (Daniel & Woody, 2010). Moreover, running while listening to MRS makes it even

harder to understand a story, even for people who managed to simultaneously run and actively listen to it. For instance, the writer of Adam mentioned in the dialogues that the runner needed to run in order to create wind. This was necessary for Anna to be able to keep talking:

> ANNA
>
> I feel you with the wind. Just keep running please. [...]
>
> Somehow you [...] have awoken the winds with your running, and the winds are willing to tell you their secrets. (Excerpt from *Adam*)

Still, all *Adam* runners except one revealed in the interviews that they did not understand why the story character needed to run. The writers of *Coffee Break* and *Horror Runner* used more straightforward motivations (the runner needs to find coffee fast in the former and the runner is being chased by a mysterious monster in the latter). With these two stories there were no runners questioning why the character needed to run.

Horror Runner also provided an example of dealing with runners' high cognitive load through repetitions. A few times throughout the dialog, the writer put the words 'cabin' (a safe meeting point where other characters were heading) and 'lake' (that was situated in the story near the cabin). While some runners could not recall in the interviews what was in the cabin or why they were looking for a lake, all of them understood that both the cabin and the lake were important.

Moreover, the gaps in the stories can also create a lack of understanding. Where are *Coffee Break*'s Baron and Ramone located? How do they communicate with the runner? Do the spirits from *Adam* have some kind of physical presence? Most runners had similar questions about different aspects of the stories. Interestingly though the lack of explanations did not always lead to problems with understanding. Runners also demonstrated ability to fill in gaps with their imagination. In many cases where there was no definite answer or image in the story, runners would come up with their own. For instance, the author of *Coffee Break* did not specify where Baron was located, yet three runners still had a vivid image of the place he might be in. For two of them that place was an office: '*It's really modern [building]. I thought of this big CEO guy, fat guy [...] It wasn't the place that I know of*' (Runner №28). And for another runner that was a particular location on the campus: '*they were in Old Quad. "The Baron" thing. That's the only building where Baron would sit*' (Runner №27).

The author of *Horror Runner* did not describe some aspects directly but used familiar horror story tropes throughout. In the study, titles with similar tropes were appearing in the runners' minds. *Cabin In The Woods*, *I Know What You Did Last Summer*, *The Blair Witch Project*, *The Beauty and the Beast*—to name a few titles that runners mentioned in

the interviews. These are different titles but all of them feature a dark forest of some kind. All runners actually mentioned that the events of *Horror Runner* were happening at night despite the fact this is was never mentioned in the story. Runner №27 even went as far as suggesting that one of the characters will die soon, because '*Sally is the girl who always dies first in horror stories'*.

Something similar happened during the sessions with *Adam*, although to a lesser extent. Five runners stated that, for them, spirits were related to thoughts of nature. Again, a forest (a jungle in two instances) appeared in the interviews, although there were no mentions of a forest or even trees in the story.

Connecting

Of particular interest during the analysis was how participants perceived and actively made connections between the story elements and the surroundings of their run.

It was easy to make connections to the surroundings when authors referred to actual places on campus. The writer of *Coffee Break* deliberately used names of real campus coffee places, such as 'Castros', as he knew that participants will be running there. Thus, runners did not have a hard time trying to connect coffee shops in the story to coffee places on campus: the author made the connection for them. One drawback of using this tactic was that for three runners unfamiliar with the campus the references did not make much sense (one thought that 'Castros' was a character's name). Even if they understood that names mentioned in the story were the names of coffee places, they still did not know what these places looked like and where they were located. Nevertheless, the other *Coffee Break* runners recognised the references and some of them noted that it made the story feel more connected: '*It was quite good just to be able to hear references and understand that you're running here*' (Runner №10).

The runners also made connections to ambiguous references about the environment. For instance, there was an ambiguous reference in Adam:

ANNA

> Look around stranger, isn't that beautiful? I used to love this place when I was a human. (Excerpt from *Adam*)

Seven runners mentioned that this dialogue made them look around and think that it is indeed a beautiful place: '*When she said something like "Oh, I used to like this place [...]" and I was in the middle of the campus and [I thought] "Oh, I like this place too*" (Runner №2).

The ambiguity of references also provoked some runners to find places that matched the plot. For example, in *Horror Runner* the runner was supposed to find a cabin by the lake. This made four runners think about what on campus might represent the lake. Runner №18 turned the university cricket ground into the lake in her imagination. Other runners needed the connection to be more obvious. Runner №13 was hoping to find something on campus that might represent the story-lake but lost hope by the end of the run as it seemed there was nothing on campus: '*I really don't know where the lake is on campus. I went around looking for it [...] just trying to think where the lake could be. [...] Maybe water near here*?..'. Runner №8 was also looking for 'something watery' to be the lake but could not find anything appropriate.

As the surrounding context can inspire connection between physical and virtual worlds, it can break the connection too. Four runners mentioned that other people present on campus were disturbing the story for them, but all four had different reasons. Runner №11 found that it was people smiling that felt out of place. For Runner №28 it was people wearing suits while she was supposed to be escaping a monster in a forest. Runner №25 just did not like that it was much more crowded in the physical world than it was in the story. Finally, Runner №27 just tried to avoid eye contact. Two other runners however found a way to involve other people on campus into the story world: '*There was a couple of people around and I felt like in that situation it kept you running faster too. [...] They might be the things chasing us. I involve that sometimes*' (Runner №5).

Imagination brought some runners quite far away from what the writers intended. *Adam* made one runner think of robots—quite a stretch from the spirits story world of *Adam*. Runner №24 took it even further. For her the events of *Adam* happened on an island after a plane crash: '*…we crash-land in some area. Maybe we have been on that island for some long time. So, Adam has gone crazy. And the girl died [in the plane crash], so he's missing her. Somehow, when we landed on that island we can listen to the girl*'. Nothing similar to this description was mentioned in the story.

And finally, imagination can be distracting too:

> *That's the power of imagination, I guess. My mind associated every sound of the story to a particular thought, so when I could hear a car, or a guy screaming, or a guy talking, everything near me became story. If I saw a car—that was the car of the story. If I saw a woman—the woman became the woman who was speaking to my earphones. [...] Listening to story is different to listening to music. If you're really involved in the story you start picture things and that distracts you from the route you're taking*. (Runner №22)

Caring

By caring here I mean any kind of emotional response to the story. Just as active listening does not imply understanding; understanding the stories and making connections to the environment does not imply caring.

One of the important factors that affect caring for characters is believability. This includes both (voice) acting and motivation. For instance, all runners understood that the characters of *Horror Runner* were in danger, yet for Runner №10 and Runner №18 it was hard to believe this because they did not find the voices convincing enough. Note that the same voice might be convincing for others, as it was for Runner №22.

The author of *Coffee Break* specifically stated that Baron desperately needed his coffee. The author even suggested why: Baron is at risk of falling into a deep sleep, from which there would be no waking. I observed how runners started to bring in their own life experience to justify the characters' motivations. Thus, Runner №10 found that she could relate to and understand Baron's need for coffee. Another runner recalled that it reminded her of sister's desperate need for coffee. This worked the other way around too. Five other runners did not feel that the reason was convincing, and two of them mentioned that they do not drink coffee themselves (at least not after 5 PM), which made it difficult for them to relate to Baron's needs.

Another factor was likeability. Four runners admitted they did not like Baron anyway, so they did not care whether or not he dies. Runner №28 suggested that she would care more for her own (her own character's) needs rather than for someone else's:

> *I'm doing something for Baron. I don't even know him. I don't care for him. In the zombie one [Zombies, Run!] it's you and you're personally being chased, so you're doing it for yourself. While here you're doing it for Baron, and you don't care.*

She then later ran with *Horror Runner* as well, and found out that for her it was indeed easier to care for the goal this time, as the goal (run for your life) related to her own character personally. In the interviews, I saw 10 out of 36 runners admitting that they tend to listen more attentively when other characters were talking directly to them rather than to each other. It might well be the case that the level of caring rises similarly.

Runners who cared about the story were also curious about what would happen next.

> *When he said "I'm going to find Sally" and it said "Mission accomplished", I'm like "What?! What happened to her?!* (Runner №27).

> *You've got to tell me how it ends!* (Runner №16)

Yet, for some runners, non-interactive stories were not enough to feel a sense of purpose: '*It doesn't really matter, wherever you run the story is gonna be the same*' (Runner №10). *Coffee Break* ends with the runner finding coffee for Baron. For two runners the feeling of finding coffee was not there since they had not actually found anything. One

of them elaborated that it did not have to be the coffee, but there should have been some kind of representation of coffee in the physical world to make it feel real. This would help to trigger the sense of achievement that the author was aiming for in the end of the run: '*It would be quite cool [...] if you had to find virtual coffee. QR-code or something and scan them. "Woo-hoo, I found coffee!". [In the current implementation] I felt like I achieved something without doing it*' (Runner №10).

6.2.2 Voluntary Changes

Route and Length

In this subsection I examine various ways in which runners changed the direction of their running route because of MRS. In 9 runs out of 48, runners had an established running route in mind before they started. Most runners, however, had no preconceived route, and below I show how references to places in the MRS influenced the routes they took.

The most prominent connection between physical and virtual places was in *Coffee Break*: the author used names of real coffee places located on campus. All runners (bar those unfamiliar with the campus) understood the connection, but not everyone decided to actually go in the direction of mentioned cafés. Even three runners who stated that they want to help Baron did not change their route. In some cases, that was simply inconvenient. For instance, Runner №28 heard about 'Castros' after she has already passed the place. Runner №17 was running around the perimeter of the campus and decided to keep that route instead of going in to search for coffee places: '*When they [characters] started talking about the story, I though maybe I should've been running inside the campus. And then I though "Oh well, stuff it, I'm already outside"*'. In a couple of other cases, runners might have been willing to change their directions, but they did not know how to find the cafes mentioned in the story. On the other hand, there was a runner who did not really understand what is in 'Castros' (he missed the beginning of the story) but decided to run there nevertheless. Similarly, in *Horror Runner* Runner №13 was looking for a 'lake' without fully realising why it was important for the character.

Six runners made a connection between 'the main road' in *Horror Runner* and Swanston Street on campus, and for Runner №29 any patch of pavement would serve as the main road to steer away from. In all of these cases runners reported actually trying to stay out of these areas. This was easier to implement since it did not require a big change in direction, just some adjustments.

There was also a runner who connected an area not to a particular place in the story but to the story itself. For him a certain area on the campus felt more connected to the story than others, thus he decided to do a few laps in that area to preserve the connection. Runner №2 did something opposite: instead of sticking to the same area, she was

changing direction every time the dialogue changed: '*Every time they started to talk, I felt like "oh, that's changing the phase-I'm changing my direction". And I didn't have exact direction, I just [changed it]*'.

Pace

Another prominent change was change in pacing throughout the run. All runners noted that just hearing fast-paced songs was enough to affect their speed. Yet in the interviews I also discovered instances when speed was changed for reasons directly related to the stories.

All three authors justified in the stories why runners need to run fast. In *Coffee Break* the runner had to hurry because Baron was at the risk of dying. In *Horror Runner* the runner was escaping a mysterious monster. Finally, in *Adam* running would summon the winds that allow Anna to talk further.

Despite Baron dying in *Coffee Break*, I still did not observed any sense of urgency during actual runs. When asked about the matter, runners provided two possible explanations: some runners just did not like Baron and would not run faster to save him and some runners stated they did not feel like speeding up matters since the ending would be the same regardless.

In *Horror Story*, the ending of the story remained the same despite the runners pace as well. However, the effect of the story on running pace was different. About two thirds of runners reported speeding up at some point due to the sense of danger instilled by the story. Interestingly, runners did not have to follow the plot too closely to get that feeling. Runner №22, for instance, missed a lot of details in the plot. He also reported however feeling chased and needing to run for his life: '*If you ask me why I was running, I have no idea what to answer you. [...] Goals? Escape... feeling of saving myself*'.

Attention

Running is an exhausting activity. Even 15 minutes of running can be physically demanding if a person is not used to running. In this subsection I will present instances when the stories helped to deal with this exertion.

Distraction itself was helpful for those participants who did not enjoy the physical aspect of running. With something to listen to they could distract themselves from the parts of running they found unpleasant.

> *Sometimes when I run it takes a lot of time to get into it. And this wasn't so bad, because I had something to listen to during that time.* (Runner №31).

> *I actually got some thinking during running. I hate just running for running. So, I liked it*. (Runner №19)

Runners, who did care about the events in the stories, also got curious about what was going to happen next. Curiosity worked on two levels. First, it made runners anticipate for the next bit of dialogue. Second, runners wanted to hear the next episode after the run, which could encourage them to go for another run soon. I only had one sample mission with each story, but I still registered the feelings participants had after their runs. The sense of curiosity was particularly strong after running with *Horror Runner*. The first episode of the story ends with the group of friends meeting in a safe cabin and then realising that one member of the group is missing. About half of the runners expressed particular interest in what would happen next, which did not happened with other stories to the same extent. In *Coffee Break* the coffee was found and Baron was saved by the end of the mission, hence, runners felt that the story was complete.

Stories also affect the way runners perceived time, although in an unpredictable way. For 6 runners it felt like the run was shorter than it actually was, for 4 that it was longer, and for the rest 26 it felt about the same. During the interviews, runners provided different explanations of why change in perceived time might have happened. I could not find a connection between perceived time and any other factor, such as running experience, the story they were running with, age or gender.

6.2.3 MRS Elements

I also observed that in some cases running was affected by the MRS, even when runners missed an important part of the plot or even when they were not following the plot attentively. In our analysis I found three elements that affected running in this way: *emotions*, *props* and *rhythm*.

Emotions

I found that MRS can provoke emotions even when runners do not follow the plot. The effect was particularly strong in *Horror Runner*, which managed to make runners feel 'stressed' and even 'anxious'. It pushed listeners to run faster at times. There were *Horror Runner* runners that were not able to explain why they needed to find the lake or what happened to the car, and one runner who could not remember how the mission ended. Nevertheless, all of them reported that they felt like they had to run fast in order to avoid the danger: *'When [I heard] "mission accomplished" I was like "I finished! I survived!'"* (Runner №20).

About half of the *Horror Runner* runners stated that music went well with the story and amplified the stories feeling. They further suggested that listening to the music with MRS was different to listening to music alone during their regular runs. For them the music felt like part of the story: 'dramatic', 'atmospheric', 'dark'.

Props

Some runners were able to extract props from short instructions in the MRS without following the story itself. In the most prominent example a runner went to 'Castros' without really knowing why it was important to the story. Similarly, Runner №13 tried to find something that could represent a lake, yet was not able to explain why finding a lake was important for the plot: *'There was more dialogue, the girl said: "We haven't got here yet". And I was thinking "Oh, I really don't know what they're talking about, what the lake is". I went back looking for it*'.

Similarly, several runners reported that a character saying 'Run!' directly to them was particularly inspiring to actually boost their speed, particularly in *Horror Story* due to the sense of danger instilled by the story. Something similar, but to a lesser extend, happened in *Adam* as well. Runner №11 noted that when Anna said 'run' directly to her (the protagonist), she sped up at the time. Interestingly, the runner still did not seem to care about Anna or the character's reasons to run.

The findings suggest that there were two purposes of a prop: to give runners something to think about (for instance, what could represent the lake on campus) and to give them something to do (change the route and head to the 'lake'). Interestingly, the two did not have to be tied together. In Study 3 about half of the runners who were reacting to props were looking mostly for things to think about, while another half looking for things to do. Either way, it was not necessary to understand the overall plot in order to engage with the props at any point of the workout.

Rhythm

There was also a rhythm to the structure of MRS, which affected the running experience. Each story consisted of five segments of dialogue and four songs in between. Five runners noticed that they tend to slow down during the dialogs (both because the tempo of the dialogues was slower and because they wanted to listen) and speed up when the music starts. Similarly, the attention split was different: *'During the dialogs I wasn't thinking about much else, because I was listening to what was said. And it was during the music bits when I was thinking*' (Runner №14). I observed the same effect across all three stories.

Music can also feel connected to the story, resulting in a more continuous experience. In the most prominent example, one runner of *Adam* called a particular song a 'jungle song', and mentioned that it supported his understanding of where the story was happening. Not every song, however, had the ability to blend in the story. Runners reported that mismatched music made them feel 'falling out of the story'. Two runners who study music stated that they understood that the music was intended to feel like part of the story, yet the song choice failed to reach that goal. Runner №31 explained it further: '*…it was "chasing' music, but there wasn't any chasing [in Coffee Break]*"'.

6.2.4 Focus on the Run

Study 3 findings suggest that during workouts runners are generally focused either internally or externally.

Runners of the former type are consumed by their thoughts. If they enjoy running, they would often enter a 'meditative' state during a workout or be focusing on the movement of their body. If they are bored with running, they are likely to look for props which might give them something to *think about*, for instance, imagining the story world or thinking about how the plot might develop the consequent segments.

Runners of the latter type focus on what is happening around them. If they enjoy running, they are more likely to be enjoying the scenery as well, or mixing up running with additional physical elements such as parkour. If they are bored with running, they might generally look for props that would give them something to *do*. The same prop might serve as both internal and external for different runners. For instance, when one runner hears that they need to find the lake, they might start imagining what the lake in the story would look like, while another runner would quickly think of something from their surroundings to run towards.

6.3 DISCUSSION

This section finalises the development of all six major themes of this thesis. Similar to previous chapters, this section is structured around themes. The first subsection is dedicated to the *story* theme, which is now complemented with ways to support each of the four stages of perception. The second subsection focuses on three particular *MRS elements* revealed in the findings of Study 3. The next subsection covers both *hybrid experience* and *voluntary engagement* themes, with a focus on the specific changes runners were voluntarily making during the study. The penultimate subsection returns to *running* for a discussion of a new *focus on the run* category, along with a more specific breakdown of *trajectory of a workout experience*. The section then closes with the *MRS* theme, further indicating that the MRS format is different from other audio-centric story formats.

6.3.1 Story

Listening

Running is an intense activity by itself, and requires concentration. Yet the intensity is not necessary a negative effect. First, some runners enjoy the challenge that makes run more intense and more interesting (Marshall & Benford, 2011). Second, listening may

distract from the process of running, which is something, as Study 1 suggested, that might be desirable for people, who are generally frustrated with running. But the difficulty of running and listening at the same time also means that runners often miss pieces of the story. Thus, it is important to facilitate listening in MRS.

Clarity of delivery is an essential aspect to consider. Voices and sounds should be loud and clear. Since runners still can easily get distracted, it might be beneficial to repeat the most important information in different forms throughout the story. The findings also suggested that participants were more attentive when characters were talking directly to them (the protagonist), especially when they used imperatives and were addressing characters by name or a nickname: 'Go, Runner!'.

Another aspect to consider is a runners' trajectory. It is often hard to concentrate on the story at the very beginning of a run. A couple of participants suggested that running should start with music, with the story starting later in the workout, when runners have warmed up and are into the process.

Understanding and Connecting

After runners have listened to a portion of the story, they start processing it. It is inevitable that different people will understand the same stories differently. Every story has gaps that listeners start to fill from their imagination and previous experience (Abbott, 2008, pp. 83–85). While the process is highly personal and subjective, this study helped to gain an understanding of how different kinds of gaps led to different ways of connecting stories to the environment.

When the story was aligned with the surrounding environment, as in the case of *Coffee Break*, runners were more likely to fill in the gaps from the surroundings. In the study all runners of *Coffee Break* reported that their character was running on campus. This kind of alignment is common for mixed reality systems. It is important to note, however, that in the case of alignment, runners become more sensitive to mismatches between the story and the surrounding reality. Thus, attempting to find coffee while running nowhere near a cafe felt 'disconnecting'.

The author of *Horror Runner* was aiming for a particular atmosphere in the story, and thus decided to sacrifice connection to the actual running location. Consequently, runners of *Horror Runner* were bringing up references to horror movies and games when describing the dark forest the protagonist was trapped in. This is somewhat similar to the use of familiarity in Human-Computer Interaction (Raskin, 1994). Here too, the author brought familiar elements from previous experiences in order to facilitate understanding of the setting, mood and location. Interestingly, such approach creates a potential for establishing a stable virtual place that is independent of the runner's actual location. This, for instance, can be useful when runner moves places, especially in case they relocate to a country with different culture (e.g. Ronkainen et al., 2014). While it can feel alienating to run in an entirely new place, running with the same MRS can create a

sense of familiar location, since the runner will return to the same lake they had already been to.

Adam was ambiguous with regard to where the story was unfolding. This turned out to be the most unpredictable case. Some runners reported that the character was still on campus. Some thought of jungles, forests and nature just because, for them, these were associated with spirits. And some brought up very personal connections, such as plane crashes or robots. Gaver et al. (2003) suggest that ambiguity can inspire imaginative interpretations, and that was certainly the case with *Adam*. McCloud (1993) notes that the more ambiguously information is presented, the easier it can be to personalise it. Yet ambiguity can be confusing. Not everyone can (or wants to) easily fill in the gaps from their imagination when there are no obvious prompts. Some runners did not fill in these narrative gaps and were left wondering where the story was actually happening until the very end of the run.

Moreover, findings from both Studies 1 and 3 suggest that serendipitous connections between the story and the physical world strengthen the connection between the two. For instance, a character mentioning an epidemic, while the runner actually recovering from the cold can make it easier for the runner to feel more like the protagonist. While it might seem that such connections are completely unpredictable, and thus, beyond the designers' control, Leong (2005) argues that designers still can facilitate serendipity.

Caring

After runners have built the story world in their mind, they start to develop a relationship with that world. The quality of writing and production is crucial at this stage. Even if the writing is clear, and listeners understand the characters' motivations, they may not necessary believe in them. Similarly, even if the writing is convincing, poor voice acting or mediocre sound effects can break involvement in the story for the listener. Thus, during this stage it is particularly for runners to be able to suspend their disbelief in order to fully experience the effects of MRS.

Runners draw extensively from their personal experience when they believe in stories. For instance, the findings revealed how they start comparing characters to themselves and to the people they know. Runners who can relate a story to personal experience are also likely to find the story believable. If runners believe that they are being chased by a monster, they are more likely to speed up; if runners care about Baron, dying for lack of his coffee, they are more likely to race towards coffee outlets, and so forth.

If runners care about an unfamiliar story, they are also likely to be curious about what happens next. This works both in between story fragments and between the workouts themselves. As the study suggested, an interesting story creates anticipation during the music breaks. And an intriguing end to a mission can even motivate runners to go for another run sooner than they otherwise might.

From this perspective, the goal of a mixed reality story is not different from the goal of a traditional story, which is to make the audience care (Stanton, 2012).

6.3.2 MRS Elements

Moreover, Study 3 highlighted a number of instances where changes were caused by particular features of MRS that could work independently from the story plot itself. Following Deterding, Dixon, Khaled, & Nacke's (2011) notion of independent elements that can be used to gamify the experience, I similarly name such instances *MRS elements*. The findings identified three MRS elements: *emotions*, *props* and *rhythm*.

Emotions

Mixed reality stories can provoke emotions even when runners do not understand or care about the story, which was particularly noticeable in the *Horror Runner*. Similar effects are described by Marshall & Benford (2011). In their study some participants reported that they heard the poem more as a 'mood' that was underlying their running experience. The 'mood' of the story is supported with music (more on this aspect below), voice acting and sound effects. Thus, it is important each MRS mission to focus on a precise set of emotions, so that they would support the overall experience rather than break it.

Props

In mixed reality stories, writers can create props that might work separately from the story. Runners listen for props on the go, and engage with them, even when the main story is not appealing to them. In a way, runners create goals for themselves that work similarly to how goals work in games (Salen & Zimmerman, 2003). For instance, just mentioning a green door can prompt some runners to start looking for a green door in their physical surrounding, even if they do not know what role the door has in the story.

It is important to note that just having a prop is not sufficient for everyone. Some runners reported that in order to act on a prop they would need their action to have some form of consequence. For instance, few runners suggested that finding coffee for Baron would be more interesting if the MRS could actually tell if you 'found' coffee or not.

Rhythm

It is known that music has an affect on running experience (Tenenbaum et al., 2004). Southerton (2013) in her autoethnographic study notes how music drowns out her heartbeat, thus affecting her tempo. All of the participants in Study 3 also reported that fast-paced music affected their speed. There is however a different dimension to music when it is added to a MRS.

First, juxtaposition of music and story can create a connection between the two. The effect is particularly strong when music's rhythm and mood matches those of the story.

Among the three stories, *Horror Runner* had the highest report of feeling continuous with the soundtrack, as both were considered 'dark', 'fast-paced' and 'anxious'. Similarly, mismatching between the music and story rhythms breaks the connection. For instance, a couple of runners of *Adam* felt like the soundtrack implies a chase whereas there was no chase in the story.

Second, alternation of music and story creates a rhythm for the entire experience. During the study, it was common for runners to speed up during the songs and slow down (to listen up) during the story segments. This rhythm can be used to alter the duration and structure of the run. For instance, in *Zombies, Run!* runners can choose between 30 and 60 minute runs. In both cases the story will be exactly the same, it is the breaks between the story segments that fit more or less music depending on the choice.

As with the previous cases this combination of music and the story can be noticed even if runners do not follow the story closely. Thus, it is important to carefully consider the choice of music for mixed reality stories. A matching song choice can make MRS feel like a continuous experience and facilitate transitions. If music feels disconnected, runners feel as if they are 'jumping in and out' of the story. Moreover, Study 1 suggested that runners' familiarity with the soundtrack also makes a difference, as runners familiar with the soundtrack are able to pace themselves more accurately.

6.3.3 Hybrid Experience and Voluntary Engagement

Study 1 revealed that participants were willing to bring changes to their runs along the way, even though it was not required in order to keep the story unfolding. For instance, a couple of participants decided to run at a later time (changing schedule), while another participant ran two missions back to back as they were curious about what was possibly going to happen next (changing length of the run).

This study extends the understanding of what kinds of changes runners are most likely to make *during* a workout. First, runners were adjusting their **routes**. For instance, runners could decide that the 'main street' they should be staying away from is Swanston Street, and then adjust they running route accordingly. Witkowski's study (2013, 2018) suggests that runners also change routes to rediscover familiar locations: 'My usual orientation toward the straight paved paths started to deviate into previously unexplored terrain, and through such explorations I cultivated new perceptions and transitions that augmented my experience of being within this local environment'. Second, runners were adjusting their **pace**. For instance, runners would speed up when sensing danger in *Horror Runner*. Third, runners were adjusting the **length** of their workouts. For instance, runners were able to halt the mission at any point and come back to the follow-up interview without listening all the way through. Some runners reported they were close to doing that, as they were not used to running and became exhausted. Even so they still wanted to find out what might happen in the end, and thus, decided to run longer than they otherwise would. And finally, the MRS gave runners something to shift their

attention to. This, for instance, could make the workout felt shorter overall, which was particularly useful for runners who are generally frustrated or bored with running.

6.3.4 Running

Study 1 revealed that the running experience consists of different parts, some of which, such as goal setting or scheduling, go beyond the workout itself. This study investigates the trajectory within each workout. The findings identified the distinctions between the beginning, the middle, and the endings of the workouts. At the start, participants reported needing some time to 'get into' running. Middles are the longest part of running, and can be particularly boring for people who do not enjoy running. Finally, endings could benefit from providing additional motivation for the runners to keep going, since runners most likely would be tired at this point.

These findings revealed an interesting clash between the running and the story: as mentioned above, at the beginning, it can be particularly difficult for runners to be paying attention to what is happening in the story. Yet, in the beginning of the story, writers would often put a crucial information regarding the story world and character motivations. Such insights indicate why it is important to better understand the experience of the activity itself, which is currently missing from the literature on similar research (Woźniak et al., 2015).

This study also highlighted the importance of runners' focus: some runners keep an internal focus, and some are focused outwards. It is important to note that while most runners would fall more on one side or another, the focus can be also shifting throughout the run. Thus, for instance, a runner, who focuses more on the surroundings at the beginning would shift to internal focus closed to the end of the run, and be thinking about something that would motivate them to finish

6.3.5 Mixed Reality Stories

This study further indicated that the experience of running with mixed reality stories is different from the experience of running with audio-stories or mixed reality performances. It also clarified how distractions, provided by MRS, can enhance the experience of running.

Running is a physically demanding activity, which many people find unpleasant. With MRS runners have something else to focus on and think about. The findings suggest how because of that, many runners felt that the workout finished faster than they expected. Mixed reality stories can also make a familiar place and context feel different, thus helping people who grew bored with running.

6.4 LIMITATIONS

Novelty Effect

Similarly to Study 1, the novelty effect could colour the results coming from the study. Most participants had not tried running with a MRS before, nor did they have experience with running at the University of Melbourne campus. Some participants, however, did undertake two runs during the study, conducted in two different days, and no participant reported having a significantly different experience with their second run. Moreover, I noticed many similarities and the same recurring themes compared to the interviews from Study 1. Thus, while the novelty effect most likely affected the experience of the runners, I argue that this effect did not significantly distort the findings.

Constrained running

In this study running was constrained in a number of ways. First, participants had to run on campus, which could seem unnatural to them, or just different from their regular workouts. Second, participants were not free to schedule their workouts at any time they like: they could only pick a session at after-hours or weekends. Third, there was only one mission in each story, thus, for instance, if a runner realised that this kind of story would be better experienced at night, they would not be able to schedule their next mission for later time. Moreover, the songs in MRS were pre-chosen, and thus, would not always match runners' taste in music. These limitations prevented the further explorations of parts of running experience that expand beyond running, such as aforementioned scheduling.

I argue, however, that these limitations could be justified, considering the nature of this study. The objective of this study was to focus on the perception of MRS in situ. Thus, it was beneficial to focus on the most essential part of the running experience, which is the workout itself. Moreover, having only one mission in each MRS facilitated the comparison of different stories and differences in their perceptions.

The multi-project nature of this study allows for combination of different priorities within each study. While Study 3 somewhat constrained the activity, Study 1 was designed to make running for the participants as natural as possible: they were free to choose when, where, and how often they want to run, and also, what music to listen to. Study 2, in turn, focused on the storytellers' perspective. Thus, all three studies were deliberately designed in different ways, so that align best with their different objectives, and ultimately complement each other.

Reluctance to criticise a research prototype

Runners could be reluctant to criticise the research prototype when interviewed by the researcher. To mitigate that issue, I tried to explicitly assure the participants that I look specifically for criticism, and would welcome any feedback, including negative. On multiple occasions, I mentioned that findings from Study 1 featured many participants who did not enjoy running with *Zombies, Run!*, and that their responses still provided valuable insights, and informed the course of the consequent studies. I hoped, that after hearing this, Study 3 participants would become less uncomfortable with providing their honest feedback, even at times when it was not favourable.

6.5 SUMMARY

The objective of this study was to gain a better understanding of how runners perceive mixed reality stories during the workouts. Furthermore, as the final study of the project, Study 3 was set to validate and extend the findings from the previous studies

First, Study 3 suggested that the actual experience of running with mixed reality stories is based on runners' co-created version of the stories, not the original intentions of the authors. Hence, runners' subjective perceptions are essential for constructing the user experience of running with MRS. The study then identified four major stages of perception: listening, understanding, connecting and caring. It showed how each stage builds on top of the previous one, and how each of them influences the overall experience.

Second, this study further explored how runners voluntary engage with mixed reality stories to balance the hybrid experience. The findings helped to brake down four major ways in which people might change their runs: adjusting route, pace, length, and controlling attention.

Third, the study provided a more detailed understanding of how MRS elements can influence the user experience not only in addition to the main story but also independent of it. It identified three distinct MRS elements: emotions, props, and rhythm.

Forth, Study 3 complicated the understanding of the relationships people have with running. It suggested that different parts of the running workout trajectory require different design considerations. Moreover, it revealed that some runners focus mostly internally during a run, while others focus mostly externally, which in turn, also has a significant impact on the overall experience with the MRS.

Finally, Study 3 provided more examples of how mixed reality stories enhance running by creating distractions and changing meaning of the workouts.

7 DISCUSSION

Chapter 7 brings the studies back to the overall research question (7.1). It gathers together findings from all three studies and connects them to the literature, thus putting the contributions of this thesis in a broader context (7.2). This chapter also discusses the main limitations of the whole project (7.3), as well as provides suggestions for future work concerning mixed reality stories (7.4). Finally, the chapter ends with a summary of the contributions of this thesis (7.5).

7.1 RECAPITULATION OF THE RESEARCH QUESTIONS

The research question for Study 1 was: *What is the current user experience of running with mixed reality stories?*

Study 1 explored the user experience of running with an existing, commercially successful mixed reality story *Zombies, Run!*. It investigated two major aspects of the hybrid experience: running and story. In particular, Study 1 highlighted the importance of participants' attitudes towards running and the highly subjective nature of runners' perception of mixed reality stories. It also suggested that MRS can influence the overall experience even when runners do not get into the main story. Furthermore, Study 1 revealed how participants used voluntary engagement for balancing hybrid experience while running. Finally, this study suggested that MRS format is significantly different from other audio-stories and mixed reality systems.

The research question for Study 2 was: *How do storytellers address the user experience of running when writing mixed reality stories?*

Study 2 investigated how creative writers address running when working on mixed reality stories. It discussed how writers use blending and ambiguity to connect runners' physical environments to the digital story world. Moreover, it introduced a novel way for connecting the environments, namely is a deliberate use of contradictions. Furthermore, Study 2 revealed how writers adjust familiar story mechanics for running. The findings of this study show that the MRS format is different in how it is created as well as experienced.

The research question for Study 3 was: *How do runners perceive mixed reality stories while running?*

Study 3 aimed to understand how people perceive mixed reality stories while running. It introduced four stages of MRS perception. It also introduced yet another aspect of participants' relationship with running. Furthermore, it clarified which aspects of MRS can work outside the main story. Finally, Study 2 detailed the main ways in which participants adjust their runs with voluntary engagement.

Together the studies addressed the main research question of the thesis:

How can the user experience of running with mixed reality stories be supported?

7.2 INTEGRATION OF THE FINDINGS

This section integrates the findings into a holistic overview of the runner's experience.



7.1 Integration of the Findings

It starts with **mixed reality stories**. MRS create a unique running experience, different from running with an audiobook or during a mixed reality performance. The main ways mixed reality stories enhance running are providing welcome distractions and changing the meaning of the run.

Mixed reality stories create a **hybrid user experience**, which means that users simultaneously move along different threads of experiences.

Runners use **voluntary engagement** to balance these threads. They might change route, pace, length, and also shift attention on the go, yet these changes are not forced as is often the case in interactive digital stories or exertion games. Designing for voluntary engagement allows the creators of MRS to use less technology, to simplify the interface, to not rely on human-curated orchestrations, and also to have more creative freedom while making the stories. Still, this approach requires runners to suspend their disbelief, and can lead to frustrations for runners when their expectations are not met.

The three most significant aspects that constitute the hybrid experience of running with mixed reality stories are running, story and MRS elements.

The first aspect of MRS experience is **running**. By itself running can already create a rich and meaningful experience. Running does not provide a monolithic experience. There

are many facets to running experience itself and many types of run. With MRS the running experience begins to interact with other aspects of the MRS experience, sometimes supporting them, sometimes creating a conflict. Somewhat unexpectedly, people's attitudes towards running (frustrated, engaged, or in-between) and people's focus during running (internal, external, or in-between) displayed a significant influence on how runners perceive the MRS.

The second aspect is **story**. Creative writers use blending, ambiguity and contradiction to connect the virtual story world to the runner's physical environment. They also repurpose traditional story mechanics, such as curiosity and familiarity, for running. Then runners create their own perception of MRS, following four stages: listening, understanding, connecting and caring.

The third aspect consists of **MRS elements** that can work outside the main story. Thus, a runner's experience might be influenced by story props, emotions and rhythm even when the runner does not follow the story.

This understanding of the mixed reality stories experience extends Benford & Giannachi's description of the hybrid experience of mixed reality performances (2011). MRS also create hybrid space (e.g. running both on campus and in the forest), time (e.g. running simultaneously during the day and at night) and role (e.g. preparing for a marathon and being a hero on a mission), all controlled by the interface—as described in Benford & Giannachi's work. Yet with MRS the state of each facet at any given moment depends on the balance between running, story and MRS elements. Thus, waiting at a traffic light can push a runner 'out' of the story forest, while voluntarily deciding to search for the lake on campus, or on the contrary, turn the runner into more of a hero.

7.2.1 Mixed Reality Stories

Before this project started, there was no indication that the experience of running with mixed reality stories is different from the experience of running with a regular audiobook or a podcast. It was also unclear whether this experience is different from the experience of running within a mixed reality performance. Moreover, if the experience was no different, it was unclear what it might be closer to: an audio-story or a mixed reality performance.

Study 1 indicated that because MRS are designed specifically to support the activity, they enable enhanced opportunities for creating user experience significantly different from both audiobooks and other mixed reality systems.

Unlike audiobooks, MRS deliberately invite the listener to 'synchronise' their running with the running of the protagonist. This, in turn, provides more opportunities to 'feel like a hero'. Yet, unlike being a hero in a mixed reality performance, MRS runners are not 'locked' in the role: they can easily get in and out of character during the workout without affecting the story.

Also, unlike mixed reality performances described by Benford & Giannachi (2011), mixed reality stories do not rely on orchestration, thereby allowing users to run when they want to and as much as they want to. This aspect supports the regular nature of running, which is missing from many mixed reality systems.

Furthermore, unlike running apps and special apps such as Nike+, and devices such as FitBit, mixed reality stories do not focus on extrinsic rewards such as points, badges or competitions with friends (Juul, 2011). Instead, MRS use a story-centric approach.

Study 1 also revealed that while people can listen to a mixed reality story even when they are not running (as it would not affect the story), no participant chose to do just that. Some runners specifically mentioned that they would find running without *Zombies, Run!* too boring, yet also that they would not enjoy listening to *Zombies, Run!* without running. It was both running and listening to *Zombies, Run! at the same time* that created the desired experience.

Study 2 validated the claim from the writers' perspective: it indicated that for writers the process of creating a mixed reality story for running is also significantly different from the process of creating a regular story.

During the discussions, participants explicitly stated that the medium felt novel and noticeably different from what they were working on before. The findings from the study then helped to further break down what the difference was. The format of MRS provided a number of limitations for the writers: they wanted to include running in their stories, they wanted the runner to experience being the protagonist, and they also wanted the story time to match the running time. Moreover, while writers used many of the mechanics from traditional storytelling, they would often have to adapt them for MRS. For instance, writers could end a story with a cliffhanger so that the runner would be more eager to go on the next workout.

Study 3 further supported the claim that the experience of running with mixed reality stories is significantly different. Interestingly, Study 3 also extended the findings from Study 2 by revealing what aspects of the MRS experience writers did not consider in the development process. First, writers did not employ voluntary engagement; in particular, they were not deliberately providing story props for the runners to engage with. Second, writers were also thinking about running in general terms, without breaking down the trajectory of the running experience or considering people's complicating and subjective relationships with running. These insights suggest that these parts were not considered because they depart from writers' usual ways of creating stories and thus also describe the differences in mixed reality stories formats.

Enhancing the Running Experience

The existing work on running in Human-Computer Interaction (HCI) generally focuses on creating a novel experience (e.g. Marshall & Benford, 2011; Mueller et al., 2010). In contrast, mixed reality stories aim to enhance the existing experience of running, rather than replace it. This thesis highlighted two major ways in which mixed reality stories enhance running: first, they provide welcome distraction, and second, they provide the experience of running with additional meaning.

Distractions

Menzies-Pike (2017) noted how the pain of running can be a good distraction from something that occupies one's mind. As Study 1 showed, many runners would actually prefer it to be the other way around: they find running boring or displeasing, and thus, would like to be distracted from it. Consequently, runners who feel naturally engaged by running are less likely to benefit from using MRS: for them the distractions are frustrating. Furthermore, Study 3 revealed that being distracted could make the workout feel shorter, which is particularly welcomed by people who want their run to end as soon as possible. The study also revealed how MRS could make a familiar place, such as the University of Melbourne campus, and a familiar activity, such as running, feel novel, which helps to make the experience more interesting for those runners who tend to become bored.

Meaning

Running by itself can be a deeply meaningful activity (e.g. Menzies-Pike, 2017; Murakami, 2009; Oates, 1999), but not all runners feel this way. Study 1 suggested that mixed reality stories could change the meaning of the run for those who generally do not like running on its own or are bored with it. With MRS they might imagine having 'a bigger purpose' when doing the workout. The sense of having a purpose helps such runners to engage with the activity, and it also creates a bigger sense of accomplishment afterwards. They did not only finish an exercise, but they also saved a city! Feeling responsible for helping the story characters is also what repeatedly draws runners back in, and what creates long-term goals: as some runners reported, they now need to finish the whole story otherwise they would not be satisfied with themselves. On top of that, mixed reality stories change the meaning of familiar locations, allowing runners to experience anew what otherwise would become mundane and unexciting (Witkowski, 2013, 2018).

Solitary running can feel lonely at times (Murakami, 2009, pp. 13–16), yet many runners prefer not to run in pairs or in groups due to feelings of self-consciousness or difficulty scheduling mutually available time (Marshall et al., 2016). Interestingly, running with MRS can feel like a social experience where runners get into the story and feel connected to other characters. This helps them feel less lonely than they would

during a regular solitary run, while still not feeling self-conscious, or not needing to align their running schedule with other people.

Study 3 supported this finding by providing more examples of how the meaning was changed with the introduction of mixed reality stories.

7.2.2 Hybrid Experience of Running with MRS

The experience of running with mixed reality stories is hybrid, consisting of several important aspects: the running itself, the story, and MRS elements that can work independently of the story. Thu{Citation}s, MRS do not replace the existing experience of running but rather complement and enhance it. This is similar to how portable music players did not cancel out the city experience but created an additional layer on top of it (Du Gay et al., 2013; Thibaud, 2003). Hence, this thesis aims to extend the work by Benford & Giannachi (2011) on the user experience with mixed realities. Previously, they discussed space, time, role, interactions, transitions and trajectories in regards to the overall hybrid experience, thus leaving the role of the activity unclear.

Study 1 revealed how runners have to balance different aspects on the go. The importance of each aspect changes constantly throughout the run. Sometimes these aspects would support one another: a runner would get a sense of accomplishment from finishing a run, as usual, but also some additional satisfaction from advancing the story. Sometimes different aspects contradict each other: a runner might want to keep a stable pace throughout, but the story nudges them to speed up as zombies approach.

Study 3 complicates the understanding of the hybrid experience of running with MRS: runners do not just ‘switch’ from one aspect to another, they actively co-create the story in their minds, and make connections between the story, the activity, and their surroundings. Thus, the actual experience with MRS comes not from the story as it was created but with the co-constructed version each runner has. Furthermore, Study 3 broke down different MRS elements and revealed that they can affect the running experience even in cases when the main story fails.

7.2.3 Voluntary Engagement

To balance different aspects of the hybrid experience, runners use voluntary engagement. Studies 1 and 3 revealed how runners look for props when they are ready to engage. For instance, they hear that someone the story needs help and thus speed up. The same prop later in the story might not have an effect, as, say, the runner has become tired and is now less willing to engage. It is important to note that in either case, their decision to speed up or not does not affect the story outcomes: runners make adjustments because they want to, not because they would be ‘punished’ otherwise.

Thus, in that sense the runners' decisions to change some parts of their experience are always voluntary.

Relying on runners engaging voluntarily is different from the approach used in most interactive stories (Crawford, 2012), mixed reality performances (Benford & Giannachi, 2011) and exertion games (Mueller et al., 2011). It is, however, similar to the type of control that a portable music player gives to an urban walker. Thibaud (2003) and Bull (2005) described how a walker can switch tracks on the go, or take a longer route, just so they could listen to a whole album before they get home. While such actions might seem small, they play a significant in creating the sense of control of the city experience.

Benefits

Relying on voluntary engagement provides some benefits to the creators of MRS.

First, such an approach requires less technology, e.g. accurate sensors or constant and reliable internet connection. Technology is used to deliver the story while people are running but is not needed to track exactly how and where they are running. This is significant, particularly in the context of the activity, because technology can often be unreliable, inconvenient to have to fiddle with during the run (e.g. Witkowski, 2018) or just expensive (e.g. Benford et al., 2003). Thus, writers, for instance, could include a chase, without checking whether the system would be able to track whether runners were actually speeding up or not. Similarly, in Study 2 a writer was able to refer to actual places in the story without needing to require a technology that would actually track a runner's location on campus. Voluntary engagement allows runners to decide in-situ whether they want to 'play along' or not: the story continues in the same manner regardless.

Second, it allows for a drastic simplification of the interface. The user interface can often be the source of confusion and frustration (Cooper, Reimann, Cronin, & Noessel, 1995), but the main screen in *Zombies, Run!* had only one large 'Continue Story' button, which significantly simplified the process for runners. Furthermore, no gamepads or other controllers were required for guiding the protagonist. The MRS were designed is such way so that the running itself *is* the way to make the protagonist run. As one participant noted, standing still while the protagonist kept running felt 'unnatural'. Such an approach goes in line with the recent research of natural user interaction (Liu, 2010), that also explores ways of getting rid of 'artificial' controllers, and letting the activity itself guide the experience.

Third, this approach does not require orchestration. Human orchestration requires a lot of resources and organisation, which makes it hard to scale or repeat (Crabtree et al., 2004). On the contrary, mixed reality stories that rely on voluntary engagements can be played at any time and at any place where runners can listen to the story, as indicated by Study 1.

Finally, voluntary engagement provides more creative freedom to the makers of mixed reality stories as this approach eases the tension between storytelling requirements and interaction (Crawford, 2012; Howard, 2008; Jesper Juul, 1999). Most notably, storytellers do not need to create alternative endings for every turning point, as the story will be unfolding in the same way regardless of whether runners engage or not. Two out of three writers in Study 2 were able to avoid explicitly mentioning the University of Melbourne campus, as it would not match with the stories they wanted to tell. This approach also allowed the authors to centre their stories on people instead of objects, which is often the case with interactive stories (Crawford, 2012) and story-centric video games (Howard, 2008).

Downsides

Nevertheless, there are also downsides to relying on voluntary engagement.

First, the lack of supervision can lead to frustrations. For instance, imagine a runner who tries to time their run to arrive home at the same time the hero in the story arrives back at the base, as they usually do every mission. Except this time the mission ends with the hero getting lost in the forest. For the runner who made an effort to arrive home at the precise time, the 'twist' can be frustrating, as the effort becomes 'useless'. Similarly, the runners in Study 1 were frustrated after not being able to precisely time their runs when the story length depended on the music in their playlists. There were also cases of the 'real world' breaking the story. In Study 1, there was someone interrupting a runner with a request for directions, not being able to see that the participant was being chased by zombies. In Study 3, a few participants mentioned that people wearing suits on campus look particularly misaligned with the stories. When the experience is controlled by sensors (Benford et al., 2003) and orchestrators (Crabtree et al., 2004), the running experience is more predictable and controlled, and such frustrations could be mitigated.

Second, voluntary engagement requires a stronger suspension of disbelief (Ferri, 2007) than a conventional story would. Mixed reality stories invite the runner to experience being the protagonist, but this also leads to runners being more aware of the aspects of their surroundings that contradict the story. While runners were generally willing to play along, for some the inconsistencies became too hard to believe. For instance, one runner kept trying to make sense of the scale, but the distance he covered during his run just would not make sense in the story, thus, making the runner distrust the other aspects of the story. Another runner could not bring herself to pretend that there were zombies nearby when no actual zombies were present in her actual run.

Third, some runners just do not feel satisfied with voluntary engagement that does not affect the story. Modern mixed reality systems create an expectation of some interaction, and for some runners learning that their actions would not affect the story was disappointing. Furthermore, Study 3 suggested that the lack of interaction lowered the stakes for a number of runners: they felt there was no point in, for instance, hurrying to get coffee for Baron, since it would not affect the outcome either way.

Voluntary Changes Along the Way

Study 1 provided a few examples of runners engaging with the story in somewhat unexpected ways (unexpected, as they were not required by the MRS). For instance, runners would change their usual schedule so that they could run at after dusk to match the story mood.

Furthermore, Study 3 focused specifically on changes that occur during the workout.

First, runners change **route**. On of the most prominent example of this behaviour was runners 'overlaying' physical and digital locations and adjusting their route accordingly. For instance, a runner might decide that the story lake is the running oval on campus and head there when the characters in the story ask them to find a cabin by the lake. Runners also change routes to rediscover familiar locations, which now gain a different meaning due to a juxtaposition with the story (Witkowski, 2013, 2018).

Second, runners change their **pace**. Here, the most prominent example would be runners speeding up when a monster or a horde of zombies is approaching, even though they know that increasing their speed will not change the course of the story.

Third, runners change the **length** of their workouts. Several runners in Study 1 and Study 3 admitted that they got tired and generally would end their workout at this point, yet they decided to preserve a bit longer as the mission had not yet ended. Sometimes a runner might be so interested in hearing what happens next, they would start another run right after they completed the previous one. Again, it is worth noting that runners might have listened to the rest of the story at home. It did not matter plot-wise whether they were running or not, yet listening to a mixed reality story without actually running felt 'wrong'.

Finally, runners control their **attention**, and decide what to focus on at any particular moment. Exertion during running can be painful or at least unpleasant (Marshall & Benford, 2011), and shifting attention to something else allows runners to get distracted and feel less exhausted compared to running at the same intensity but without a mixed reality story. Still, it is important to note that this also makes running with a mixed reality story even less safe than running while listening to music. As the runners are constantly distracted by the story, it is important that the physical environment around them be as safe as possible.

7.2.4 Running

Study 1 suggested that running activity itself was an important aspect of the overall hybrid experience of running with mixed reality stories.

The study showed that the existing running experience by itself consists of distinct parts. There are different types of running, such as single and social runs, running for general well-being or as a 'stress-relief', running as training for other physical activities, competitive running, and so forth. Runners may have certain motivations for running

and different goals for their workouts. Runners need to schedule their workouts, and, if they run together with other people, make sure that the schedule works for every member of the group. Runners reflect back on their experience with the activity (Woźniak et al., 2015). Both Study 1 findings and Literature Review indicate that together these parts can build up to a deeply personal and meaningful experience with running (e.g. Menzies-Pike, 2017; Murakami, 2009; Oates, 1999).

Even people, who did not run regularly prior to participating in the study had certain motivations and goals in mind. They also had to choose a location and time for each run. Thus, before even starting their first workout they had already established some personal relationship with running.

This thesis mainly focuses on the running workouts themselves. Study 3 helps to further break down the trajectory of a workout, identifying the differences in the experience of beginning, middle, and end. At the start of a workout a runner needs some time to 'get into' the activity and might be less capable of paying attention to what happens in the story. During the middle, those runners who become bored with the activity would be particularly frustrated as this is the most tedious part of the experience for them. By the end of a workout, the runner becomes exhausted and might welcome additional encouragement to complete their run.

None of these findings might come across as particularly ground-breaking. It is natural to assume that people run for a variety of reasons or that they might become tired by the end of each run. Yet, in this thesis I argue that the importance of the existing experiences people have with running is generally overlooked in HCI research that involves this activity.

Generally speaking, researchers, particularly in the context of mixed realities and exertion games, are interested in building novel experiences that involve running (e.g. Marshall & Benford, 2011; Mueller et al., 2010) rather that enhancing the existing experience. Moreover, the existing research has a tendency to focus on the practical and social benefits of running. As a result, in the existing literature within HCI running is usually discussed in broad terms, without the acknowledgement of the diversity of runners' types, and their complex and personal relationships with running. For instance, Benford & Giannachi's (2011) work on mixed reality performances (which often involves running) breaks down the trajectory of experience without considering the activity's own existing trajectory.

In this thesis I hope to extend the existing body of work by drawing inspiration from a different area of research: urban walking with portable music players. The personal experience people have with music is interesting to the researchers not because of the potential health benefits of walking. Nor do they try to create a novel experience of walking, quite the opposite: it is the blending of the urban experience with the music listening experience that is of interest to this branch of research (Du Gay et al., 2013; Thibaud, 2003). By bringing these insights to the area of running with technology, I aim

to complement the current understanding of trajectories of experience (Benford et al., 2009). Thus, the focus of the thesis is not on whether people would begin running faster or more frequently, but whether MRS can make the experience of running richer, more personal and more meaningful.

Writing for Running

While MRS can ease the tension between storytelling and interaction, they do not remove it entirely. With mixed reality stories the runner is not quite a commander, as they would be in conventional game (Calleja, 2011), yet they are also not passive listeners as would be the case with a conventional story (Abbott, 2008). Study 2 identified a number of limitations that writing for running placed on the participants.

Writers needed to integrate a motivation for running into their stories, and it could be challenging to make that motivation fit the story naturally. Because of that, writers were shoehorned into matching the story time and the run time, which made it hard, if not impossible, to use time cuts common in other forms of storytelling. They wanted to make the protagonist as relatable as possible, which meant they did not want to make them too specific. On top of that, writers wanted to avoid adding too many sound effects since it could complicate the production.

There is also a requirement, not covered in Studies 2 and 3, that MRS are meant to be experienced repeatedly, since running is a regular activity. The creators of *Zombies, Run!* addressed this aspect by creating a large number of missions[1]. Another way to address this would be by creating stories that are meant to be heard over and over again, akin to game levels designed for replayability (Juul, 1999; Mukherjee, 2015, p. 124).

Attitudes Toward Running

Study 1 highlighted a surprising importance of people's personal attitudes towards running. For some people running is enjoyable on its own, and they are already engaged in the process. For others, running is a boring, frustrating or otherwise unpleasant activity. For the rest, running is experienced somewhere in-between between these extremes, with at times a sense of enjoyment, at times boredom.

The findings from Study 1 suggested that mixed reality stories are most beneficial for runners who do not like running, especially if they find the activity by itself boring. Such runners most welcome the distraction that MRS provide and enjoy the additional meaning MRS create. Findings also suggested that attitudes towards running influenced the overall experience with mixed reality stories more than any amount of previous experience with running. In other words, experienced runners who are bored with the

[1] In about seven years since the initial release there are now more than 250 missions across six seasons.

activity are more likely to enjoy running with a mixed reality story than novice runners who found the activity engaging on its own.

It may come as no surprise that runners who enjoy running by itself dislike adding other elements to it; and runners who are frustrated with the activity look for opportunities to enhance it. And yet the distinction between 'frustrated' and 'engaged' runners, which proved to be so essential during the course of this project, is not reflected in the current literature. Designing technology for runners with different attitudes towards running come with significantly different requirements, yet currently runners are usually seen by designers as 'just' runners, with no significant distinctions between them.

Focus on the Run

Study 3 supported earlier findings on the importance of considering people's attitudes towards running. Furthermore, Study 3 highlighted yet another aspect of people's relationship with running, which significantly influenced their experience with mixed reality stories. The findings showed that some runners are mainly focused inwards, meaning they focus on their thoughts. Other runners' attention is mainly focused outwards, on the surrounding physical environment. The experience of the rest lies in between the two extremes.

When people are bored with running, they seek distractions, yet there are different preferences for what kinds of distractions they want. Runners who focus on their thoughts want mixed reality stories to provide more things to *think about*; while runners who focus on the surroundings want more things to *do*.

Similarly to the findings on people's attitudes towards running, this finding extends the understanding of the running experiences people already have and puts them in the context of supporting such experiences with mixed reality stories.

7.2.5 Stories

Connecting a Story to the Environment

Study 2 revealed that writers can blend physical and virtual worlds together, intentionally contradict the connection, or remain ambiguous regarding the relationship.

The previous literature demonstrates that **blending** is a somewhat natural and expected choice in mixed reality systems (Benford & Giannachi, 2011, pp. 27–70). Thus, a writer might put references to some actual places in the hope that hearing them would help runners immerse themselves in the story.

Ambiguity is commonly used in storytelling (Abbott, 2008, pp. 83–85), inviting the audience to fill in gaps in with their imagination. Similarly, Gaver, Beaver, & Benford (2003) proposed adapting the use of ambiguity as a resource for HCI design. They

suggested that ambiguity could help create richer and more meaningful experiences for the user. Study 2 introduced yet another use for ambiguity: to facilitate the connections between the story world and the running environment. Thus, writers can insert a line such as 'Look around, isn't this place beautiful?!' and expect that many runners would actually start looking around and appreciating the physical environment they are running in. This is different from, say, novel writers who do not commonly expect the reader to actually be looking around when stumbling upon a similar sentence in a book.

Most interestingly, Study 2 revealed that the makers of mixed reality systems might also choose to intentionally **contradict** the connection between the physical and the story world in cases when it can help enhance the story. Thus, a writer can rely on familiar tropes even when such scenarios contradict the actual environment. To the best of my knowledge, the uses of this approach were not previously described in the context of creating mixed reality systems.

Repurposing Traditional Story Mechanics for Running

Study 2 showed how writers use familiar mechanics in mixed reality stories for running.

Curiosity is one of the essential story mechanics. Traditionally it is used to keep the audience interested in returning back to the story, or finishing it faster. In a TV series curiosity can work on multiple levels: between the story segments within an episode, between the episodes within a season, and also between the seasons (Barbour & Stirling, 1979). Study 2 revealed how writers repurposed this mechanic to make running more appealing. Studies 1 and 3 revealed how runners would actually keep going on to find out how an episode ends, would anticipate their next workout to listen to the next mission (one runner in Study 1 decided to keep running after finishing the workout, just so she would hear yet another mission), and potentially would be looking forward to the next season after completing the first one.

Storytellers also use **familiarity** to simplify stories. The use of familiar tropes makes it easier and faster for the audience to understand what is happening. This can be particularly welcome during a run when it is harder for people to pay attention to what is happening in a story. For instance, in Study 2 one of the writers built his story around a number of recognisable tropes from horror movies in the hope that they would help the runners get a quicker understanding of what is happening in the story. Study 3 then suggested that the horror story was the one which was the easiest for runners to understand. It is important to note, however, that too much familiarity can be detrimental to the story as it can make the plot too predictable and therefore boring. Interestingly, in MRS the use of familiarity clashes with the use of ambiguity: by bringing familiar structures to the story, the creator decreases the level of uncertainty.

Another story mechanic adopted by the writers was **empathy**. All three writers in Study 2 used empathy to create a deeper connection between the runner and the protagonist, and with other characters. Studies 1 and 3 indicated that runners who empathise with the characters in the stories experienced a stronger sense of accomplishment at the end

of each mission and were also more willing to come back to the story as their help was needed. Study 3 also suggested that runners are more willing to empathise with the needs of the protagonist, rather than the needs of other characters, such as Baron.

Finally, writers in Study 2 advised against using **closures** in mixed reality stories (Abbott, 2008, pp. 51, 52). In conventional stories closures are meant to create an emotional satisfaction from experiencing different parts of the story coming together, thus resolving the main conflict of the story (Arndt, 2017; McKee, 1997, pp. 303–316). With MRS, writers suggested, there is a risk that runners might not want to go back to running with MRS if they fell the story is complete. Despite that, Study 3 showed that some *Coffee Break* runners still felt that the story is over, and therefore there is no need for another mission. The findings suggest that writers ought to be particularly careful to leave at least some story arcs open so that runners feel there is still something else for their protagonist (and therefore, them) to do in the story.

Perception of Stories

Study 1 gained the initial insight on how runners connect stories to surrounding environments. Study 2 then showed from the creators' perspective what types of connections writers use while creating stories. Finally, Study 3 revealed that the overall experience of running with mixed reality stories is based not on the stories as they were intended by the writers but on the stories as they were perceived by the runners. This is similar to Calleja's (2011, p. 8) observation on video games: '…a game becomes a game when it is played; until then it is only a set of rules and game props awaiting human engagement'. Furthermore, Study 3 identified four main stages of perception. First, runners **listen** to the story, which might be hard to do while running, particularly in the beginning. Second, runners build their own **understanding** of what is happening in the story. Third, runners start **connecting** the story to particular parts of their surroundings. Finally, runners build personal relationships (**caring**) with the characters in the story. The stages follow each other but also keep repeating throughout the run: thus, a runner could be listening to the story at the beginning of the workout, stop listening in the middle, but then get back to it closer to the end.

The three studies together provided an understanding of what types of mixed reality stories are most beneficial, depending on the personal relationships people have with running:

	Bored Looking for distractions	***in-between*** Want occasional distraction	**Engaged** Not likely to enjoy MRS
Outwards Looking for things to do	***Connection***		Enjoying scenery or having a conversation
in-between	***Ambiguity***		
Inwards Looking for things to think about	***Contradiction***		Meditation or thinking about personal life

7.1 Relationships with Running × Perception of Stories

The findings suggest that mixed reality stories would be most beneficial for runners who are frustrated or bored with running.

Out of those, runners who prefer to focus externally during their workout would enjoy running with MRS that feature a blend of the virtual world with their physical environment. Those connections allow runners to keep focusing on the surroundings and also provide suggestions for things they can do, such as running to find a particular place. Consequently, these runners are most sensitive to mismatches between the story and their surroundings.

For runners who prefer internal focus a better fit would be a mixed reality story featuring more contradictions between virtual and physical. These types of runners are most willing to suspend their disbelief, allowing them to enjoy making non-obvious connections between the environments, such as imagining that a running oval resembles the lake in the story.

Finally, runners who are bored but do not clearly belong to either extreme would be more likely to enjoy MRS which feature deliberate ambiguities. Such stories provide more flexibility and allow the runners to keep shifting their focus throughout the workout. Still, it is important to note that Study 3 revealed that too much ambiguity leads to uncertainty and frustration, as runners cannot understand what is happening in the story and why. When the story is too ambiguous, a runner's understanding of the story can also result in something very different from the writers' original intentions.

7.2.6 MRS Elements

Study 1 revealed that, at times, mixed reality stories may affect runners even when runners stopped paying much attention to the story. Thus, one runner from Study 1 reported that she at some point decided not to follow what is happening in the story, and yet she still felt scared due to the overall mood of the narrative.

Study 3 with its increased number of runners broke down further three specific MRS elements that can have an effect on running, even when the main story fails.

First, runners can still be **emotionally** affected by MRS. This was the case with the run from the first study, which similarly occurred to a several runners of *Horror Runner* in Study 3: they reported not paying much attention to the story, yet they still felt scared.

Second, runners can still extract **props** from the story. For instance, a runner in Study 3 was looking for something that might serve as a lake that he wanted to reach. During the follow-up interview, however, he could not tell why would he need to reach the lake and how was it important to the story.

Finally, runners can still follow the **rhythm** of MRS. This aspect includes both the rhythm of the music between the story segments but also the rhythm of the MRS itself. For instance, one runner in Study 3 decided she would change direction every time she heard a new song. The change of direction was not related to anything in the story, it was done solely in response to the rhythm of the MRS.

7.3 LIMITATIONS

Mixed realities

Over the course of the thesis I presented preliminary findings from the studies to different audiences, including a seminar in the research department, a doctoral colloquium, an academic conference and an industry conference. A common question across different presentations was whether MRS are indeed of *mixed reality*.

There is an argument to be made that, strictly speaking, stories such as *Zombies, Run!* do not mix with the physical environment in the same way as, for instance, *Pokémon Go* does. One can listen to a whole season of *Zombies, Run!* while resting on a couch. It is as if the digital story does not mix with the physical reality but exists separately from it.

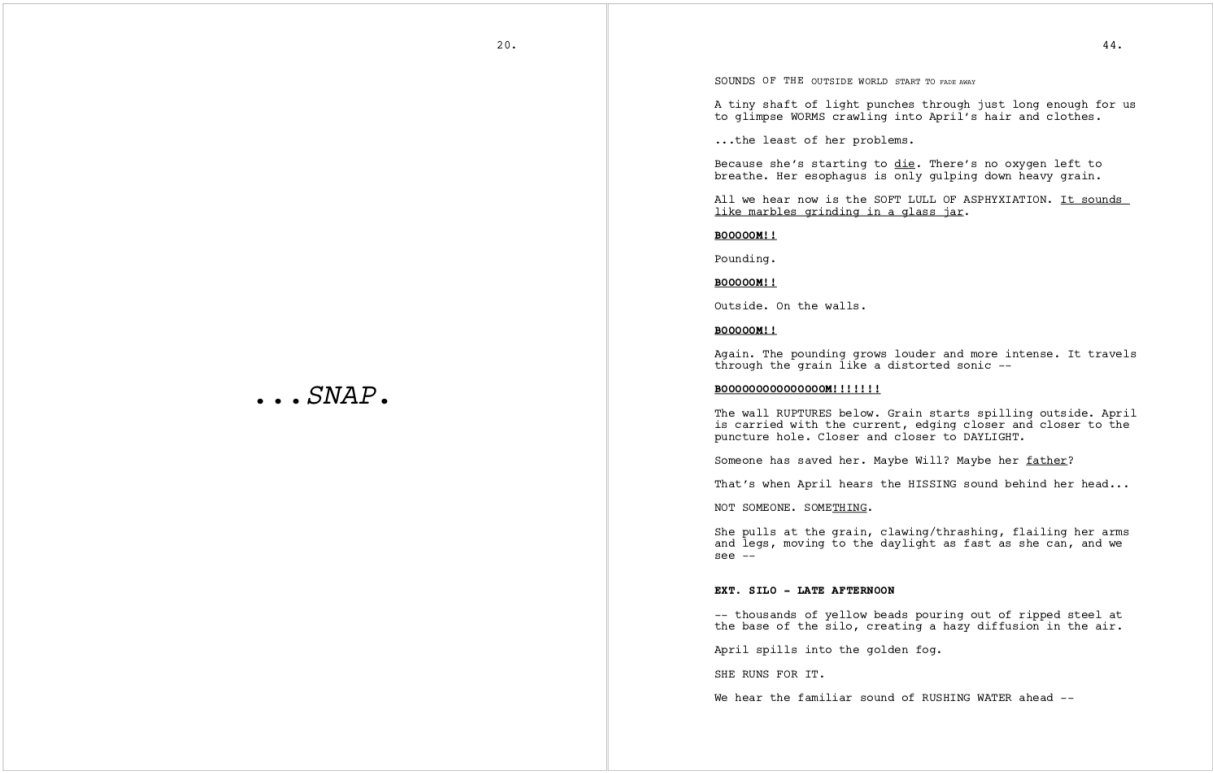
I would, however, argue against such a limiting view of what mixed reality could be. In that regard I adopt Steuer's (1992, p. 75) suggestion that mixed reality can be defined in terms of the result experience, 'the sense of being in an environment'. This thesis suggested that most participants *experienced* the stories as mixing with the surrounding

context and blending with the activity, not as something existing separately. Thus, these stories deserved to be called *mixed reality stories*.

The quality of the prototypes

John Krasinski's 2018 film *A Quiet Place* is a post-apocalyptic horror movie featuring monsters with a heightened sense of hearing, which they use to locate their prey. This is a good example of a movie experience with a particular emphasis on audio. To reflect that, the screenwriters abandoned some of the conventions of movie script format so that they could emphasise the importance of certain sounds. For instance, they would begin shrinking the font when describing a scene in which sounds begin to fade away. Or they would dedicate a whole page to a single sound to make sure that its significance would not go unnoticed (Figure 7.2).

This example demonstrates the tension inherent in the adaptation from one medium (e.g. textual script) to another (e.g. live action movie). Film is a good medium for transferring sound, whereas a printed script is not, and thus the screenwriters felt they needed to compensate, so that even at an earlier stages of production everyone who read the script would realise how essential the sound design would be for the upcoming movie. Abbott (2008) warns that '[If] the creative leeway between script and performance is wide in the production of plays, it is enormous when adaptation crosses media boundaries' (p. 105).



20.

...*SNAP*.

44.

SOUNDS OF THE OUTSIDE WORLD START TO FADE AWAY

A tiny shaft of light punches through just long enough for us to glimpse WORMS crawling into April's hair and clothes.

...the least of her problems.

Because she's starting to die. There's no oxygen left to breathe. Her esophagus is only gulping down heavy grain.

All we hear now is the SOFT LULL OF ASPHYXIATION. It sounds like marbles grinding in a glass jar.

BOOOOOM!!

Pounding.

BOOOOOM!!

Outside. On the walls.

BOOOOOM!!

Again. The pounding grows louder and more intense. It travels through the grain like a distorted sonic --

BOOOOOOOOOOOOOOM!!!!!!!

The wall RUPTURES below. Grain starts spilling outside. April is carried with the current, edging closer and closer to the puncture hole. Closer and closer to DAYLIGHT.

Someone has saved her. Maybe Will? Maybe her father?

That's when April hears the HISSING sound behind her head...

NOT SOMEONE. SOMETHING.

She pulls at the grain, clawing/thrashing, flailing her arms and legs, moving to the daylight as fast as she can, and we see --

EXT. SILO - LATE AFTERNOON

-- thousands of yellow beads pouring out of ripped steel at the base of the silo, creating a hazy diffusion in the air.

April spills into the golden fog.

SHE RUNS FOR IT.

We hear the familiar sound of RUSHING WATER ahead --

7.2 Pages from *A Quiet Place* Script

MRS prototypes in this thesis delivered the stories exclusively via the audio-channel, which suggests the importance of ensuring good sound quality. Unfortunately, no

professional sound designers participated in creating the prototypes. Furthermore, the limited opportunities for communication with writers (due to their busy schedules) effectively meant that none of the writers participated in the adaptation of their script for an audio-centric medium. Moreover, the writers were new to the format, and one of them did not have any professional experience with writing fiction.

Overall, the above factors suggest that the quality of prototypes used in Study 3 would likely affect the findings of the study. I would note, however, that the analysis of the interview transcripts in Study 3 contained almost all of the major themes from Study 1. Furthermore, Study 3 not only helped validate the existing themes but also meaningfully extended them. As Study 1 was focusing on the experience with a professionally made and commercially successful MRS, it is reasonable to assume that while Study 3 would likely benefit from an enhanced quality of the prototypes, the existing ones were still sufficient to provide a meaningful contribution and bring the thesis to a close.

7.4 PRACTICAL IMPLICATIONS AND FUTURE WORK

7.4.1 Design for the Existing Experiences with an Activity

As this project indicated, running is a complex activity, and people form personal and meaningful relationships with it. Many distinct parts form the running experience, and the review of the relevant literature reveals that many of these parts are currently under-explored. Thus, this subsection provides several suggestions for future researchers of running in the context of HCI.

Consider Different Types of Runners

Different people have different attitudes towards running: some enjoy the activity, while others are bored or frustrated with it. Moreover, some prefer to focus on their inner thoughts or their body movement while running, and others look around, observe and enjoy the scenery. Different type of runners would benefit from different design approaches. This thesis explored MRS that work particularly well for runners who are bored or frustrated. For them mixed reality stories provided welcome distractions and additional meaning when running. But that does not make it impossible to design a

compelling MRS for runners who already enjoy the activity. Such mixed reality stories would come with a different set of design requirements. For instance, a mixed reality story for engaged runners could support the meditative experience; it would require a calmer, more slowly paced story, as opposed to a fast-paced monster-filled horror story.

Consider Different Stages of Running Trajectory

The research revealed that writers instinctively place some of the essential parts of exposition towards beginning of the story. It is at the beginning where they explain what role the protagonist plays in the story, why they need to run, what characters surround them, and so forth. Yet the commencement of the workout is when it is particularly difficult for many runners to concentrate. During that time, they want to 'get into' running and focus on that aspect first before they are able to pay much attention to what is unfolding in the story. Thus, it is important to design stories with specific workout trajectories in mind. For example, *Zombies, Run!* aligns well with interval training, which requires runners to slow down (and listen closer to the story segments) and speed up (and run away from approaching zombies) throughout the whole length of the workout. On the contrary, a runner who wants to keep a stable pace throughout the run could benefit from a mixed reality story with a more uniform format.

Consider Parts of Running Outside the Workout

The experience of running goes beyond the workout. There is something that motivates people to start, and then continue, running. Running set long-term goals people set for themselves. They need to pick a location and schedule for running. They also reflect on previous workouts and the consequent learning and adjustment process. While this thesis revealed how *Zombies, Run!* could encourage runners to shift their schedule to nighttime, or provide additional motivation for running, the main focus in the studies was on the workout itself. Future work might explore how MRS could also support aspects of running which lie outside the workout.

Consider Other Mixed Reality Story Formats

As mentioned in the Introduction, while *Zombies, Run!* provided the most successful MRS format to date, this does not mean that it is the only format that can support the experience of running. I believe that the insights from this thesis can be applied in consideration to other MRS formats too, for instance, formats that employ geofences, or offer the runner to be actively 'choosing their own adventure' with the story changing depending on the choices. Moreover, mixed reality stories are related to a number of other overlapping media formats, such as locative media, interactive fiction, augmented reality games, live action role play, playful cities, and interactive theatre—and thus I hope that this thesis might inspire researchers and developers to explore new directions even outside MRS

Consider Other Activities

Finally, while this thesis focuses only on running, there is an opportunity for future researchers of MRS to consider how the stories might enhance other activities, such as walking or doing chores.

7.4.2 Design for Voluntary Engagement

This thesis suggested ways in which runners use voluntary engagement to balance different aspects of their experience. This approach provides certain benefits for the designers of mixed reality stories, as it requires less technology in the form of trackers or reliable internet connection. It allows a simplification of the interface; it does not require human orchestration, as mixed reality performances would; it also provides more creative freedom for the storytellers. This subsection recapitulates three main points for MRS designers to keep in mind when they want to employ voluntary engagement.

Provide Props

The findings suggest that voluntary engagements are triggered by story props. For instance, a character in the story might mention a location or an object, which would in turn influence the runner to adjust their route or to engage their imagination. Different runners might react differently to the same story prop. Broadly speaking, some runners look for things to do, while others for things to think about. Thus, it is might be beneficial for MRS designers to either provide props that can trigger both external and internal engagement, or to choose specific types of runners and design compelling story props that would most appeal to them.

Support the Suspension of Disbelief

Runners are less willing to engage voluntarily if they dismiss the story. Logical inconsistencies or low quality of the production can break potential voluntary engagements. Thus, it is highly recommended for MRS designers to ensure the best possible quality of production. Designers also ought to consider the audience for which they create a mixed reality story. For instance, fantasy genre fans would be more likely to appreciate a story with dragons compared to an audience that prefers non-fictional stories. Moreover, it is important to note that MRS elements can work even when the main story fails, thus leading runners to engage with the MRS elements directly while ignoring the plot. Consequently, it is important to design not only the story itself but also the supporting elements so that they could sustain the experience on their own when necessary.

Ensure Runners' Safety

Voluntary engagement requires an increased attention span from runners since ultimately they need to self-orchestrate their experience. Thus, it is particularly important to consider safety features. For instance, designers might provide safety reminders for the runners, similar to those in other mixed reality apps that involve running around the city (e.g. Figure 7.3).



7.3 Safety Warning in *Pokémon Go*

Such explicit and repeated reminders to keep away from traffic, however, might be redundant and even annoying for runners. Instead, MRS creators have an opportunity to integrate more gentle reminders. For instance, in *Horror Runner* one of the characters would mention that the protagonist must stay off the main road. This sounded natural to the story, yet it also acted as a subtle reminder for participants not to cross Swanston or Grattan Streets, whichever was closer to them at the moment.

7.4.3 Explore the relationships between designers and storytellers

In Study 2 I provided the participants with very little explanation of the mixed reality stories besides the minimal description of the format. The main objective of the study was to explore the storytellers' understanding of MRS, thus it was important not impose a pre-conceived notion of how they might employ the format. This decision, however, left the exploration of relationships between designers and storytellers outside the scope of this thesis.

Since, as a medium, mixed reality stories are relatively new it is likely that storytellers will be coming to it from other areas, as was the case with *Zombies, Run!* (Alderman,

2013). It is still unclear, however, how MRS should be presented to storytellers and how the responsibilities should be split between designers and storytellers. Thus, this project encourages researchers to further explore the process of creating MRS, particularly the roles of designers and storytellers.

7.5 CONTRIBUTIONS

The aim of this thesis was to examine how to support the user experience of running with mixed reality stories. In fulfilling this aim I hope that this thesis will provide contributions on three different levels.

On a theoretical level, this thesis gained a deeper understanding of how the user experience of running with mixed reality stories can be supported. It identified ways in which MRS are different from other types of stories and other types of mixed realities, and how they enhance running by creating meaning and providing distractions. This thesis also deconstructed three main aspects of the complicated hybrid experience of running with MRS: the running, the story and the MRS elements. Finally, it revealed ways in which runners use voluntary engagement to balance those aspects on the go.

In addition, this thesis addressed smaller gaps identified in the Literature Review. It explored the subjective and emotional aspects of audio-centric mixed realities that are currently under-studied. Furthermore, it moved away from a general focus on health and social benefits of running, and instead focused on how the experience of running itself can be addressed. It has also provided examples of how traditional story mechanics can be repurposed to address the running experience, and suggested how the use of voluntary engagement eases the tension between stories and interaction, thus providing more creative freedom to the storytellers.

On a practical level, this thesis provided a detailed description of the process behind the creation of three new MRS prototypes. It also provided concrete suggestions on how theoretical findings from the research could be put into practice.

On a research design level, this thesis presented three different study designs that could be used as foundations for future empirical studies of mixed reality stories. The thesis also included an example of how MRS scripts themselves could be treated as data points and analysed together with other sources.

8 CONCLUSION

This thesis introduced mixed reality stories (MRS), a new format of mixed reality systems designed to enhance specific activities, such as running, by creating a mixed reality experience.

Mixed reality stories that were featured in this thesis are different from most mixed reality systems covered in the existing literature. They rely on audio-stories rather than advanced displays and trackers, human orchestration, and gamified elements. Moreover, they were designed to enhance the existing experience people have with running, rather than creating novel types of experiences.

While there were already indications that such an approach can be beneficial for some runners, there was no understanding of how the experience of running with MRS can be supported, and whether MRS format was significantly different from traditional audio-stories. Thus, the aim of the thesis was to address this gap in our understanding by examining how to support the user experience of running with mixed reality stories. To that end three studies were designed and deployed.

Study 1 explored the experience runners have with an existing commercially successful mixed reality story, *Zombies, Run!*. The study revealed the experience to be hybrid, combining together different threads of experience. The findings of the study also showed how runners balance these threads by voluntarily engaging with the story. Moreover, Study 1 highlighted the significance of people's personal attitudes towards running to the overall experience of running.

Study 2 then investigated the process of designing mixed reality stories for running from the perspective of creative writers. The findings of the study revealed how the format of MRS affects the creative process for storytellers. Moreover, it explored three different ways that writers use for relating the stories to the surrounding environments. Finally, Study 2 indicated how storytellers repurpose familiar mechanics to address the experience of running.

Study 3 focused on gaining an enhanced understanding of how runners perceive mixed reality stories. This study revealed that the overall experience of running with MRS is based not on the stories as they were envisioned by the creators, but on the stories as they were perceived by the runners. Study 3 explored four stages of perception, and revealed how each stage follows the previous one. Moreover, the study evaluated and extending findings from two previous studies: it deepened our understanding of voluntary engagement and the relationships that people have with running. On top of that, Study 3 introduced three types of MRS elements that can influence the experience of running independently from the main story.

Overall, the three studies supported the claim that mixed reality stories are different from traditional audio-stories, such as audiobooks and podcasts. Moreover, they revealed two major ways in which MRS can enhance the experience of running: by providing welcome distractions for people who find running unpleasant, and by creating additional meaning for the activity.

This thesis provided contributions to the field of Human-Computer Interaction on three different levels. On a theoretical level, the thesis addressed the gaps in the existing literature on the user experience of running with mixed reality stories. On a practical level, the thesis documented the process of creation of three MRS prototypes, and provided a number of practical implications for future researchers and practitioners. On a research level, the thesis provided three study designs, and suggested how MRS scripts could be used for strengthening data collection and analysis.

* * *

The runner has escaped the mysterious monster and arrived at the cabin. She is safe now. One of her friends, however, is not: Sally did not get to the cabin, no one knows where she is, and her phone is dead. The group decides to go and search for Sally.

The runner leaves the story here and carries on with her life, which hopefully does not feature mysterious monsters, or friends in danger. But she will keep wondering about what happened to Sally and think about getting back to the story someday, right to the point where she left off. Then she will need to leave the cabin then…

…and run again.



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APPENDIX I: STUDY 1

I.1 PLAIN LANGUAGE STATEMENT

THE UNIVERSITY OF MELBOURNE
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

PROJECT TITLE:	**Exploring game-like fictional elements to promote non-gaming activities**
INVESTIGATORS:	**Dr Martin Gibbs, Dr Bernd Ploderer, Aleksandr Kan**

The Project
The purpose of this project is to explore how usage of fictional elements similar to ones in digital games (e.g. narratives, avatars, etc) can encourage non-gaming activities, like running in this case. This study is a part of Aleksandr Kan's MPhil research project.

Your Participation
If you agree to participate, you will be asked to use an app called "Zombies, run!" over a 4 week period. This application offers a story based on Zombies to motivate you to run more regularly. Pieces of the story are divided into missions and appear in the headphones while you're running. Each mission lasts about 30 minutes during which you are expected to walk, jog and/or run outside. You can go on a mission anywhere you want to, as often as you'd like to and to run at any pace comfortable.

Prior to beginning the project, we will ask you to ensure that your health is of a standard that you can safely participate in a jogging program.

In addition, we would like you to record a short (less than 3 minutes) audio comment after each run, regarding your run and interactions with the app.

To better understand your experience two interviews will be conducted, one in the beginning and another one at the end of the 4 weeks period. Each interview will last about an hour. Both interviews will be audio recorded so the data can be used later in the project.

With your permission, researchers will be able to access running logs, which include distance, time, average speed, average pace, and location of your runs.

If you have a dependent relationship with any of the researchers that are involved in the project (for example: teacher/student or colleges from the department of Computing of Information Systems), your participation in this study, will not affect in any circumstance ongoing assessment/grades or management relations.

Your participation is voluntary. It will always be up to you whether you want to go for a run, record an audio or answer to a particular interview question. You are free to withdraw at any stage and also to withdraw any unprocessed data provided.

Why Should I Participate?
We hope that "Zombies, run" will improve your running experience by providing some additional motivation to exercise and diversifying your running routine. Every participant will get the app for free (regular price is $8.49).

HREC # 1238894.1

1

Potential Risks
Walking, jogging and running are physical activities that are undertaken outdoors and can involve health and injury risks. In taking part in this project you acknowledge those risk and take full responsible for any health and injury problems that develop, and undertake to always engage in these activities in a safe manner.

As this study involves outdoor running, we will ask you to always pick a safe route to run, without any traffic on your way, and also to take all necessary breaks during and in-between the runs.

Privacy
We aim to protect your confidentiality within the limits of the law. All the information you supply will be anonymised. Your name and contact details will be stored separately from the data you provide in a password-protected computer file. If we chose to use any materials related to you in the reports and presentations, we will try to contact you before doing so. Only researchers listed above will have access to collected information. The data will only be used for the research purposes and will be kept securely for five years after the last publication arising from this study, before being destroyed.

Furthermore, you should consider that although we won't use your name in any findings arising from this study, there is still a chance that due to the small number of participants it will be possible to identify you by contextual information.

Further Information
If you have any questions please contact any of the researchers:

Aleksandr Kan	kana@student.unimelb.edu.au	(04) 2381 3059
Martin Gibbs	martin.gibbs@unimelb.edu.au	(03) 8344 1394
Bernd Ploderer	ploderer@unimelb.edu.au	(03) 8344 1511

This project has been approved by the Human Research Ethics, Committee The University of Melbourne (project number: 1238894.1). If you have any concerns regarding the conduct of this research please contact the Executive Officer, Human Research Ethics, The University of Melbourne, VIC 3010 ph: (03) 8344 7507 fax: (03) 9347 6739.

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I.II CONSENT FORM

THE UNIVERSITY OF MELBOURNE
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

PROJECT TITLE:	**Exploring game-like fictional elements to promote non-gaming activities**
INVESTIGATORS:	**Dr Martin Gibbs, Dr Bernd Ploderer, Aleksandr Kan**

1. I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written plain language statement to keep.

2. I understand that after I sign and return this consent form it will be retained by the researcher.

3. I understand that my participation will involve two interviews, runs with the "Zombies, run!" app and take audio comments for approximately 4 weeks. I agree that the researchers may use the results as described in the plain language statement.

4. I acknowledge that:
   (a) the project is for the purpose of research.

   (b) I have been informed that I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data I have provided.

   (c) I have been informed that my runs will be logged and that the interviews will be audio recorded for later analysis. The records will be stored at the University of Melbourne for five years after publication and destroyed afterwards.

   (d) I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements. I am aware that that due to the small number of participants in this research project, there is a possibility that individuals can be identified by contextual information;

   (e) I will be referred to by a pseudonym in any publications arising from the research.

   (f) I hereby certify that I am not aware of any medical condition that may increase the risk of illness or physical injury to me as a result of my participation. Participation in running exercises can involve a minor risk, and I acknowledge that I will not hold the University liable for any illness or injury incurred during this study.

If you wish to receive a copy of the project summary report at the conclusion of the project,

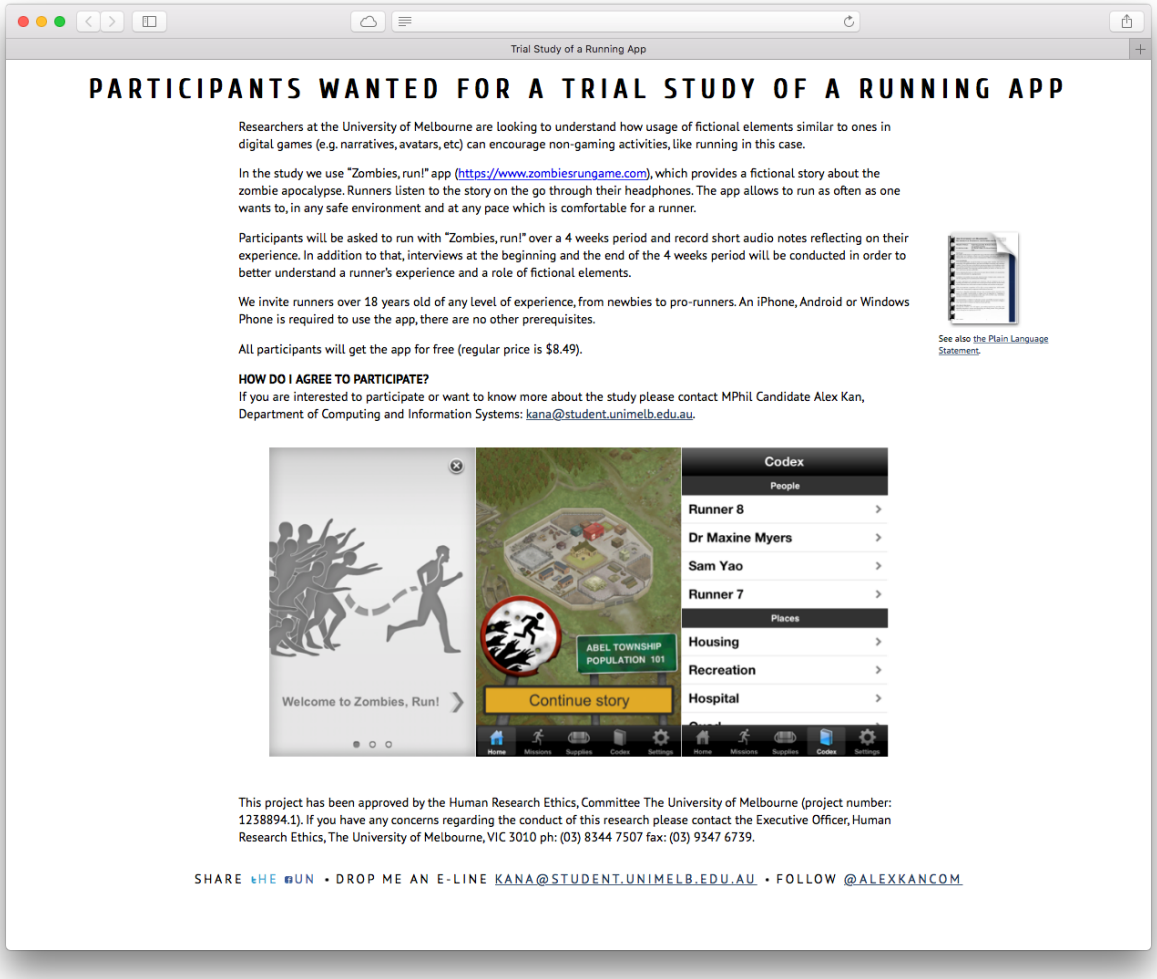
please provide your email address: _____

Name (please print):

Signature: Date:

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I.III ADVERTISEMENT



Trial Study of a Running App

PARTICIPANTS WANTED FOR A TRIAL STUDY OF A RUNNING APP

Researchers at the University of Melbourne are looking to understand how usage of fictional elements similar to ones in digital games (e.g. narratives, avatars, etc) can encourage non-gaming activities, like running in this case.

In the study we use "Zombies, run!" app (https://www.zombiesrungame.com), which provides a fictional story about the zombie apocalypse. Runners listen to the story on the go through their headphones. The app allows to run as often as one wants to, in any safe environment and at any pace which is comfortable for a runner.

Participants will be asked to run with "Zombies, run!" over a 4 weeks period and record short audio notes reflecting on their experience. In addition to that, interviews at the beginning and the end of the 4 weeks period will be conducted in order to better understand a runner's experience and a role of fictional elements.

We invite runners over 18 years old of any level of experience, from newbies to pro-runners. An iPhone, Android or Windows Phone is required to use the app, there are no other prerequisites.

All participants will get the app for free (regular price is $8.49).

See also the Plain Language Statement.

HOW DO I AGREE TO PARTICIPATE?
If you are interested to participate or want to know more about the study please contact MPhil Candidate Alex Kan, Department of Computing and Information Systems: kana@student.unimelb.edu.au.

This project has been approved by the Human Research Ethics, Committee The University of Melbourne (project number: 1238894.1). If you have any concerns regarding the conduct of this research please contact the Executive Officer, Human Research Ethics, The University of Melbourne, VIC 3010 ph: (03) 8344 7507 fax: (03) 9347 6739.

SHARE THE RUN • DROP ME AN E-LINE KANA@STUDENT.UNIMELB.EDU.AU • FOLLOW @ALEXKANCOM

I.IV INTERVIEW STRUCTURE

Basic Structure for the Open-Ended Semi-Structured Interviews

At the beginning of a 4 weeks period

What was the last book you've read or movie you've watched?

What did enjoy about the story in this book/movie?

How often do you play video games?

What is your favourite game?

How playing this (or any other) game makes your life better?

When was the last time you went for a run? Could you tell me more about your run (where you went, who was with you, how you felt afterwards, etc.)?

What do you like about running?

What do you know about the theory behind running? (How to run properly, how often is it recommended to run, etc.)

What goals do you have regarding running?

How do you think "Zombies, run!" app can help you with running and achieving these goals?

At the end of the period

What has changed for your running during these weeks?

Which running-related, but not game-required, activities you were doing?

Could you tell me more about the last time you used the app? Where did you run? What was the story? How did it feel like, to be inside the story while running?

Which game missions do remember the most?

Which features of the story did you share or would like to share with your family and friends?

How the app helped you?

How this experience changed your opinion about games?

Will you continue running? Would you like to use similar apps in the future?

HREC # 1238894.1

1

I.V DIARY STRUCTURE

Diary

We will ask participants to record short audio note after each run (less than 3 minutes). Each note will be structured around three issues:

1. Could you tell about the latest mission (fictional part)? Did you enjoy the story this time? How did it make you feel? Which bits you especially liked or disliked?

2. Could you tell about the latest run (physical part)? Did you enjoy running this time? What was different about this run?

3. Did you notice that story anyhow influence your running? In what way?

We suggest audio diaries because audio recording is more convenient in this scenario (on the go, after a 30 minutes run) than typing or shooting video. Build-in voice recording application in participant's phone aligns well with this task.

I.VI OZCHI 2013 PUBLICATION

Being Chased by Zombies! Understanding the Experience of Mixed Reality Quests

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ABSTRACT
Both researchers and practitioners show increasing interest in exploring mixed reality games: games, where physical environments blend together with digital technologies. In this paper we have extended earlier work by bringing attention to the role of narrative in mixed reality games. For our case study we chose a mobile phone application *Zombies Run!*, which is designed to support actual running. This application contains a fictional story about a zombie apocalypse and provides runners with various quests (in the form of missions) to complete during their run. We investigated different aspects of participants' experience with the application and how it changed their running. Our findings show how the app changed running in three major ways. Firstly, it changed the way runs were organised. Secondly, it shook up established running routines. And lastly, it shaped the meanings associated with running.

Author Keywords
Mixed reality, quest, narrative, meaning, jogging, running, zombies.

ACM Classification Keywords
H.5.2 [Information Systems] User Interfaces

INTRODUCTION
HCI research has shown a growing interest in mixed reality games: games that blend physical and virtual environments (Bonsignore et al., 2012; Montola, 2011). Game researcher and practitioner Jane McGonigal claims that mixed reality games are "becoming more and more central to discussions about the future of games" as designers are looking for new ways to combine the most enjoyable aspects of digital games with existing activities of the physical world (2011, p. 125).

Due to their real-world setting, mixed reality games offer enhanced opportunities to deliberately influence people's everyday life activities through so-called serious games (Abt, 1970) as well as through gamified systems (Deterding, Dixon, Khaled, & Nacke, 2011). Research on serious games has investigated how games can be designed to deliberately influence people's activities to motivate them to exercise more, do chores or even to encourage library exploration (Jensen, Krishnasamy, & Selvadurai, 2010; McGonigal, 2011, p. 120; Fitz-Walter, Tjondronegoro, Koh, & Zrobok, 2012). Gamification, on the other hand, uses game elements such as badges, points and scoreboards to encourage non-gaming activities ranging from being more productive to living healthier (Deterding et al., 2011). The running application *Nike+*[1] supports both personal tracking as well as competitions between different users and rewards through points and scoreboards. While motivators like competitiveness and extrinsic rewards have been studied and critiqued (Kohn, 1999; Xu, 2011), less is known how other essential game elements such as the narrative of a game influence a person's everyday activities.

This research addresses this issue by investigating how the narrative of a mixed reality game influences people's real-life activities. We conducted a field study of the smartphone app *Zombies, Run!* which provides runners with an interactive story through their headphones. The narrative of *Zombies, Run!* is structured as a quest: a series of challenges, i.e., to run away from zombies, that are part of a larger journey of surviving the zombie apocalypse. Our findings show that the narrative influenced the running activities in various ways: it changed how the participants organised their runs; it shook up their routines and influenced the meaning they attached to running.

This paper offers several contributions to HCI. The findings extend current understanding of people's experiences with mixed reality games, i.e., how these experiences are orchestrated (Benford, Magerkurth, & Ljungstrand, 2005) and the meanings people attach to mixed reality quests (Howard, 2008). Furthermore, the findings offer insights for practitioners on how to align physical and virtual environments of these games to further enhance people's experiences of real-life activities.

RELATED WORK
This investigation is based on two theoretical concepts. It draws from the concept of hybrid experiences to analyse core aspects of mixed reality games (Benford, Giannachi, Koleva, & Rodden, 2009) and uses Howard's (2008)

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OzCHI'13, November 25 - 29 2013, Adelaide, Australia
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[1] http://nikeplus.nike.com/plus/

concept of quests to describe the relationship between games and narratives.

Hybrid Experiences

Benford & Giannachi (2011, p.3) in the introduction of their book "Performing Mixed Reality" mentioned the "virtuality continuum" (Milgram & Kishino, 1994) and noted that it allowed the possibility of bringing together many environments of different nature (real, augmented reality, augmented virtuality and virtual). This raised a question of understanding an experience of such complex systems. To address this, Benford, et al. (2009) presented a set of four core facets, which form an overall experience – *hybrid [of real and virutal] experiences*:

Space. Spatial structure, "the stage", is one of the most essential parts of user experience. Physical and virtual locations can be connected in different ways: *adjacent* (experienced sequentially), remote, but *connected* (with communication happening in between) or *overlaid* (experienced in the same time).

Time. Temporal structure consists of five different layers: *story time* (fictional temporal structure in chronological order), *plot time* (the order events are unfolding in the narrative), *schedule time* (when the narrative is available to participants), *interaction time* (when participants actually interact with the narrative) and *perceived time* (how participants feel the time of the interaction).

Roles. The main roles are: the *participant* (central target of the experience), the *spectator* (a member of the public), the actor ("who perform to members of the public"), *operators* and *orchestrators* (who guide the experience)

Interfaces. Computer interfaces blend together the structures of space, time and roles. There are different kinds of interfaces: those used by the participants, interfaces for spectators and interfaces for orchestrators, which help to shape the experience.

Transitions. On top of these key aspects, there are transitions, the moments when the continuity of the experience can be broken. Among others there are transitions in the beginnings and endings (the most important ones), transitions between roles and interfaces, transitions between physical and virtual.

Meaning in Quests

Howard (2008, p. xi) defined a *quest* as "a journey across a symbolic, fantastic landscape in which a protagonist or player collects objects and talks to characters in order to overcome challenges and achieve a meaningful goal". He did not consider the concept as a way to bridge digital and physical, but rather saw it as a way to connect "game and narrative; gaming and literature; technology and mythology; meaning and action".

In the Quest theory *meaning* always has "a sense of valuable significant that complements the pleasure of action for its own sake" (Howard, 2008, pp. 24-25). There are different types of meanings, Howard discusses three of them: meaning as *initiation* (step by step uprising through "levels"), meaning as *narrative* (explanation of the events, which happened because of the player's actions) and *thematic* meaning (profound themes that expand to the real world).

The Quest theory provided a framework for understanding and creating meaningful activities. We suggested that this framework can expand our understanding of mixed reality games. While the research body on these games is growing, less is known about the role of narratives in mixed realities, which aim to change our experience with existing activities. In order to address the gap, we explored the following question: *How do mixed reality quests change the experience of an existing activity*?

CONTEXT AND METHODS

Running and Zombies

Zombies, Run![2] is a running application for mobile phones. It provides a fictional setting that places the runner in a zombie apocalypse with the runner being the main character in the story ("Runner #5"). Its intended use is for runners to listen to the story through headphones, while running. Each running session is framed as a "mission". During each mission a handful of short narrative segments occur that tell the story of the mission and the broader narrative that ties the missions together. There are two types of missions: 30 and 60 minute missions, however, the exact duration of the missions vary.

There are a variety of missions for the runner to complete. Completing the missions advances the story. The missions are presented to the runner in a sequential order. In addition, while completing a mission, runners also "collect" random objects. These objects can be used to upgrade the runners virtual base in the *Zombies Run!* application. In addition, there is an option to turn on the "zombie chase" feature. With this feature enabled, runners will occasional be "chased" by zombies. In order to avoid zombies the runner needs to increase her speed by 20% and maintain it for one minute. There are no "deaths" in the app and chases do not affect the overall story in significant way. However, players lose collected objects if they are caught. During a 30-minute mission two to three chases occur.

The main screen (see figure 1) consists of an image of the base, a big "Start story" / "Continue story" button and a tab bar with additional information and settings. The simplicity of the main screen make it easy for runners to begin using the application.

The app logs data about the runs, including time, distance, pace, playlist and location. All data is collected and stored on the device and in the cloud.

[2] https://www.zombiesrungame.com/

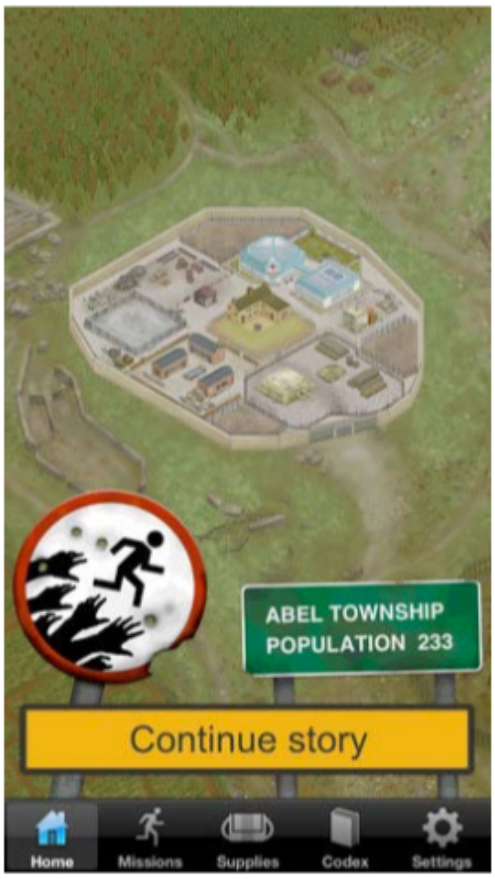


Figure 1. Main screen of *Zombies, Run!* with the base.

Data Collection and Analysis

For the study we recruited 14 participants. This number was aligned with similar qualitative studies in HCI (e.g. Barkhuus, & Rode, 2007) and evaluation of games (e.g. Väätänen, & Leikas, 2009), thus, we expected this amount to be enough to lead to data saturation for our qualitative analysis. Participants were recruited through the advertising on the notice board on a university student portal. One participant was recruited through personal contacts of the researchers. We used purposive sampling strategy (Neuman, 2005, p. 267) and recruited participants with different running experiences, ranging from people who just wanted to start running regularly, to individuals who already were running few times a week, including a marathon runner. The two youngest participants were 19 years old, and the oldest was 42. We made sure that participants did not have any health issues and warned about the risks of running with headphones on.

Participants in the study were asked to use the app for three weeks. We did not give any directions on when to use it or how often, but asked them to have at least one run with the app. Two 45 minute open-ended semi-structured interviews were conducted, one in the beginning and one after the three-week period. We asked participants to record short audio messages immediately after some of their runs to capture right-after-a-run experiences and impressions. In these messages we asked them to reflect specifically on the mission (fictional part), the running (physical part) and any changes that they noticed. We also asked participants to give us access to their running logs.

Interviews were audio-recorded and then transcribed, along with the audio messages from participants. We then used a qualitative approach to analyse the data. Interview transcripts were coded with the following pre-defined codes: *space, time, role, interface, meaning, transition* from the work of Benford et al. (2009) and Howard (2008). We completed a number of iterations to make sure that these codes covered all significant findings and that no new findings emerge (Miles & Huberman, 1994).

From the 14 participants, 11 completed the study. All participants completed at least one run with the app. Two participants, who went furthest through the story, completed 11 missions (see Table 1 for a full summary).

#	Gender	Age	Accomplished missions	Intent to continue with the app
1	F	30	1	No
2	M	24	4	No
3	M	39	1	Yes
4	M	42	10	No
5	M	34	9	No
6	Dropped out			
7	Dropped out			
8	F	40	1	Yes
9	F	19	11	Yes
10	F	19	6	Undecided
11	M	33	2	No
12	F	26	5	Yes
13	F	36	11	Yes
14	Dropped out			

Table 1. Results after the three-week period.

Note that participants #3 and #8 could only start running towards the end of three week period due to personal circumstances. Both mentioned that they would accomplish more missions during the period, if they were able to. Of the 11 participants who completed the trial, 5 stated that they did not wish to continue using the application, 5 intended to keep using it, and 1 was undecided.

FINDINGS

We organised the findings presented here around the core facets proposed by Benford et al. (2009): *space, time, role, interface, transition.* In order to better understand the role of the narrative in the app, we extended this set by adding another aspect – *meaning*.

Space

All participants ran outdoors. During the trial, Runner #10 ran inside on a treadmill, but after that continued outside. There are certain criteria people consider when choosing a place to run. Most times this place must be close to home, and if there was a park nearby, people preferred to run there. Among other criteria taken into account were complexity of a terrain (e. g. whether there were hills), and shade is important when running in hot weather: *"I like to run in the shade and avoid uphills."* Runner #8. Scenery was also considered important: *"I just gaze it. I must look like a moron. I just gaze. I like looking at things."* Runner #13.

The app forced the user to choose a safe environment for running. For instance, in order to escape a zombie chase, a user needs to sprint for one minute, so she wants to make sure that she would be able to sprint at any given time on any point in her route. Participants who had established running routes had to revise them and reject those which were busy and had traffic lights on the way: *"The first time I used it, there were too many traffic lights. And there'd be zombies and I had to stop and stand."* Runner #12.

Participants tried to relate virtual and physical spaces in different ways and were confused when experiencing inconsistency. It was not clearly stated in the app what relationship the two worlds would have over the duration of use. For example, when a character in the story said "Head East", Runner #8 was not sure if she literally had to head East or it would not matter (in the app it would not).

Similarly, runners tried to get a sense of the virtual space by applying parameters from the physical world (e.g. the distance they had covered): *"And very quickly, we've got back to Abel Township, so seem like the two towns were incredibly close - just few hundred meters apart? Still getting a bit of sense of the scale..."* Runner #5.

An idea of a fictional world map came up in the interviews as a way to address the issue: "*... it tells you where to go: go to the hospital, and go to this, and go to that. And it'd be really cool, if you had a little map of how much of that you had done, just so you get an idea of the environment.*" Runner #8.

"It could just show you the way you were running [in a fictional world] across the map, you would've been like involved in it, I think." Runner #10.

Objects, which runners were collecting on their way, were often not related to the story at all, which created more confusion: "*Why would I stop to collect a bra?"* Runner #5.

In a hospital mission objects were more related to the story and Runner #4 noted that it felt right: "*It was a run through a hospital, the app was... to pick up more... medical equipment. And that was good, because that was related to the story... that was a really good aspect."*

Similarities between digital and physical environments helped to feel that the two worlds were connected: "*...so I ran along this river [...] I felt it synced with the part of the story I was, where we were kind of running through a forest and it started raining. And I started feeling like I'm really getting into the story."* Runner #13.

Another way to connect virtual and physical spaces was to find pairs of corresponding locations in physical and digital worlds, "base - home" is a typical example of such a pair: *"I quite enjoyed the fact that the first mission ended with you running into a base and then I sort of timed my run so I arrived back home."* Runner #3.

Yet again, when a person was unable to reach two locations simultaneously, inconsistency occurs: *"I wanted to plan my run so that I'd finish off at home. Instead, because it finished short, I end up still five minutes from home, and so I keep running after the mission had finished, which seem kind of out of place with kind of getting back to the base."* Runner #5.

Lastly, familiar locations can be seen differently after the app is introduced. That happened to Runner #1, who runs in a park next to a cemetery. After trying to run with the zombie story, Runner #1 reported that she felt more scared to run near cemetery and she does not like to be frightened like this.

Time

Story and Plot Times

The 11 missions used in this study were all in chronological order, there were no flashback missions or missions happening on a parallel time track. The big "Continue story" button on the main screen launched the story from the point where it was left off. So, although it was sometimes possible to pick a mission out of order, all participants went to the missions in chronological order. All missions are designed in a way so the mission time matches real-time in a run.

Schedule and Interaction Times

Similarly to picking a location for a run, there are usual criteria regarding time, such as work/study schedule, weather, and other commitments when it comes to social runs and training sessions. Participants who feel that they have problems with motivation prefer to run earlier in the day: *"Do it in the morning, otherwise you won't do it."*

Runner #8. Runner #9 mentioned that she had to walk with her dog, but there was no strict schedule for that and it did not necessarily have to include running. No social runs with the app happened during the trial. A couple of runners also mentioned that because of the trial they probably ran more frequently, and specifically, had more runs with the app. We took Hawthorne effect (James & Vo, 2010) into account while analysing the data and avoided any assumptions on whether the app influenced the frequency of running.

Zombies, Run! did not add any limitations for a running schedule, and participants were able to run whenever and as often as they wanted. However, this meant that the app did not commit those people who admitted postponing runs, to running. Instead of commitment, there was an anticipation for those who enjoyed the story: *"And I was actually wondering sort of what happens further on [...] It's really cool that it's episodic, I'm actually wanting to get to the other ones."* Runner #8.

As happened with matching spaces, there were attempts to match time with the story. Overall, the zombie theme feels more appropriate for evening/night time when it is dark: *"I intentionally chose to run in the evening because I though it would be more interesting than running during the morning."* Runner #3.

And specifically, there was a mission, which happens during night-time: *"There was one mission which was specifically for night, so I make sure I ran that at night."* Runner #5.

If participants wanted to run for shorter periods, they could interrupt a mission to continue later (it only happened once during the trial). Participants had three options if they wanted to run for longer than 30 minutes: continuing to run after mission in the radio mode, switch to one hour missions, or start another mission immediately after finishing the previous one. All options were used during the trial by different participants.

Although the app says "30 minute missions", actually it always was about 30 minutes and it was hard to say how long a mission will take exactly. If timing was important for a participant, this unpredictability became an issue. We mentioned that this made it difficult to arrive home simultaneously with arriving at base, and on a broader scale it also made it hard to pace oneself: *"When I was running, it was like you never knew when it was going to stop,... or how you have to pace yourself to do a longer run, or a shorter run. And it got really annoying."* Runner #4

While the app did not necessitate commitments for starting the runs, the end of a mission can clearly be seen as a goal for finishing one: "*Couple of days ago I went for an hour long run, instead of a half an hour... I felt kind of energetic, so I decided to try that. But, um, towards the end, it got like really hot and I was really tired, I was like 'I just kind of would've gone home'. But because I didn't finish the mission yet, I felt like I needed to keep going. [...] If I try to run normally, then when I'm tired, I go home."* Runner #9.

Due to software malfunctions, sometimes the app did not mark the end of a mission. A glitch like this made Runner #5 to run for extra half an hour before realizing that there was something wrong with the app and finally stopping.

Perceived Time

One of the most common findings was that *Zombies, Run!* affected the way participants perceived time on a run. Often on a run people were focused on running itself, thinking about their bodies, enjoyed the views and took some time to reflect:

> *I'm thinking about my posture. How I move my feet. How I'm holding my head up. The speed which my feet are moving. My stride. Where I'm placing my feet on the ground.* Runner #11.

> *I will focus my movement and energy on parts of my body the size of which I want to reduce.* Runner #1.

> *I run to the ocean... and I was like looking at the scenery along there.* Runner #12.

> *Often, I will mentally go to a place where I think about my, like, relationship with my partner. So I use that time maybe sometimes to go over things. And then think about my family and I have little conversations with myself about things.* Runner #13.

The app provided distraction in form of a story to think about, and we found that for different people this distraction had different connotations: in some cases positive, in some cases negative.

It can be helpful for those who do not like exercising and only doing that to get or keep fit:

> *With the application I sort of forgot I was doing exercises, sort of you kind of get into the story.* Runner #10.

> *I did find it quite distracting. It was good in that respect. When I ran with the "Get Running" app, then it was [...] like 'come on, the 25 minute mark, or the 30 minute mark is going to be here soon, come on'. [...] I didn't feel lack of enthusiasm towards the end of the missions, cause it was distracting.* Runner #4.

And it is especially helpful for runners who are self-conscious: *"I didn't feel quite so self-conscious, because I wasn't worried about things, I was busy listening. Because you can feel a bit self-conscious when you need to lose a bit of weight, you're not very fit. And it just kind of took my mind of it. It'll make it easier to go again, I think."* Runner #8.

However, when it is important to think about the run itself, the distraction is not inappropriate: *"This is probably [...] why I only used it couple of times. Because*

I value every time I go out running... I felt it could be a bit distracting for me." Runner #11.

It was not always the case that beginners enjoyed the stories while experienced runners did not. Even those who do not enjoy exercising might prefer to focus on their running, just they want to make it more effective. Contrary, even experienced runners, who love running for the sake of it, can appreciate doing something differently now and then. Runner #12 was one of the most experienced runners in the trial, and yet said she intend to continue to use the app: *"It breaks up what can sometimes be a very repetitive activity, so variety or a bit of spice to the running [...] cause you do get tired of doing the same thing."* Runner #12.

Role

After participants downloaded the app, they became both performers and orchestrators. It was up to them to decide when and where to run; for how long and how often. Creators of *Zombies, Run!* provided the story, interface, rules, they update the app regularly, but they do not interfere in the running in any way.

Furthermore, participants also had their own running goals so not only they were "performing" running and being a hero on a mission, they were also running for themselves and being a regular runners. Bystanders were only able to see the latter, as *Zombies, Run!* is what Reeves et al. (2005) call "suspenseful" interface, which in this case means that observers cannot see that participants were interacting with *Zombies, Run!* and not just listening to music: *"Someone asked me for directions and I wanted to tell: 'Can't you see I'm running away from the zombies?!'."* Runner #12.

Interface

The main part of the interaction with *Zombies, Run!* was running and listening. As mentioned above, on a mission participants are running simultaneously in two worlds: physical and digital, but only during zombie chases when the app is really responding to their running. In order to escape zombies the user needs to sprint for a minute and, for those who preferred to have chases turned on, it affected running routine. Chases did not work for those who already were running on full speed and for people for whom running was already a challenging activity and they did not want to have extra pressure. Runner #4 was also dissatisfied with the inconsistency of chases: *"You wanted to be prepared and have some energy to be able to run, to get chased by the zombies. So I was holding back a lot. And there were some runs that had three zombie chases and some that had two zombie chases, so I couldn't moderate my running..."*

With *Zombies, Run!* it is necessary to take a phone on a run and put headphones on. While using the app is almost no different for those who got used to running with music, it can be a burden for those who did not get used to run with a phone and a headphones. Firstly, it just can feel inconvenient and odd and may have hindered people from using the app:

I don't really want to ... put headphones on and a wristband, so I won't bother this time, but might do next time. And then ... oh I don't want to do it this time, I'll do it next time... and then it's like oh, it's January..." Runner #11.

Having headphones in and holding the phone was a bit different. So the headphones I wear, they feel tightly in ears, so I can hear my heartbeat the whole time holding the phone. Runner #5.

Secondly, the app can be restrictive if a person wants to go beyond conventional running: *"It had a big impact on being able to mix up my run with doing things like parkour and stuff, and stopping my run half-way through during the length of my run. I felt really limited in my run."* Runner #5.

While the minimalistic interface made it easy to understand how to use the app, most participants felt that they would like to have more interaction with the fictional world - this is another major theme, which appeared repeatedly in diaries and interviews. Participants were not necessarily sure what kind of interaction exactly they want from the app, but they were certain saying that they want more: *"I'd like to interact, I'd like to make some choices, I'd like to be a little bit more involved."* Runner #12. And one runner was able to describe in detail what kind of interaction with the app he would like to have: *"The idea of being able to run to a particular place, based on you GPS navigation and Google Maps, would make a real difference [...] It is saying you can run to location A to pick up a medical kit - it's closer, but there are more zombies. Or you can run further to get the same thing from location B. It might be less zombies..."* Runner #11.

Meaning

Participants who got into the story reported feeling like a hero on a mission - an experience, which listening to music or to usual audiobook would not easily provide: *"I really feel like I'm running from something and to something, and I was, like, imagining myself as a bit of a hero... 'Look at me going to rescue some people...'"* Runner #13.

However, this was not reported by the entire group. In order for a story to have meaning it is important for participants to accept the premise of the story. Runner #1 had difficulty doing this: *"My surroundings didn't match the story. I didn't have water, first aid package to collect on the way. Therefore, just after first few unrealistic requests. I preferred to look around me - grass, people, birds - instead of listening to what people were talking in the story. I just let myself relax and walk instead of running because the zombies haven't appeared."*

Runner #9, on the other hand, did not have difficulties with accepting the story: *"I have a pretty vivid imagination, so I was thinking about the story [during the run], I was 'Oh, the church is right ahead!'"*

Those participants, who accepted the unwritten rules, had a desire to imagine themselves running in a fictional world. For instance, they were increasing their speed, when it would make sense story-wise, even if there were no "formal" zombie chase: *"I don't think it's interesting if you just have to walk. Walking away from zombies seems a bit boring. Doesn't match the story really, you want to run."* Runner #3.

However, it's not enough to have a desire to believe in the fictional part. Runner #5 made a lot of effort to make fictional world feel more realistic, he would run a night mission at night-time and he tried to arrive home simultaneously with arriving the base. And yet game conventions and the quality of production made it impossible for him to accept the virtual world: *"I though the zombie chasing was pretty stupid, really. [...] The way that [...] you outran the zombies even if zombies like couple of meters behind you. [...]. You just suddenly evaded zombies and then you could stop running and zombies wouldn't catch up with you. [...] I thought it [the story] wasn't very interesting, wasn't very well written, wasn't very believable. Just kind of another cliché zombie story, which is probably worse than average, I think."*

Runner #2 was excited at first, but then felt bored as he felt that he already knows what will happen in the story (although this was an incorrect assumption).

Of course, these aspects are highly subjective. While Runner #5 was disappointed with "*logical flaws*" and "*overacting*", Runner #11 admitted that he was impressed with how the story was done, mentioning "*depth*", "*good jokes*" and "*TV program*" quality.

Still, participants demonstrated tendency to bring different aspects - from both fictional and physical worlds - together and combine it into one experience. Among other aspects, participants mentioned frustration with an inability to use weapons they had picked up or how strange it was to hear a voice in the forest keeping on the same volume level even after they ran three kilometres closer towards it. Only the minority of participants fully accepted game conventions, and thus did not mind collecting e.g. bras, while running away from zombies.

Participants noted and even enjoy serendipitous matches or mismatches between the digital and physical:

> *I had a cold for the last week. [...]. Then I started the mission ... during the mission ... they sent runner 8, who has a cough and a cold [...] and that gave me laughing fit, I though about the irony [...] that was quite funny*. Runner #4

> *One bit, where the guy, that's on the radio: 'You pace is really good'. And I'm like 'No, it's not', but it was really funny to hear, it's still a nice thing to hear. 'Not at all, but it's very nice of you to say'*. Runner #8

The app proved that it can provide meaning, which complement the running. And again, the trial showed that it is highly subjective, with different people extracting different meanings and some getting none at all. These are just some examples of variety of meanings, which participants gained in the study:

> *It was... um... felt like I have a reason to run, rather than, sort of, being in a park with nothing to do.* Runner #3.

> *It's like a good excuse to do exercise, rather than just doing it for the exercise, because that feels like a chore to me and I don't like doing that.* Runner #9.

> *It's hard to just go by yourself, and it didn't feel like going by myself, because I had the application*. Runner #8.

> *I think, I sort of weirdly felt more engaged with a run, like I felt maybe the greater sense of accomplishment, because it was tied to something else, it wasn't just a run for the sake of it.* Runner #13.

> *I'm up to the next level now, as well as "I just gone for a run", "pushed myself" or whatever. You can tick something off and you're up to the next stage.* Runner #12.

We started with people who already ran or who wanted to start, whether with the app or not. So, for participants running by itself already had meaning and many have clear goals towards it. Thus, it is important that the app provides real stats, such as distance and pace. As much as one can enjoy fictional part, if running is important for her, she wants to get real data regarding her runs, not fictional.

Interestingly, not only did the story provide meaning for running, running made the story more meaningful. When asked if they would listen to the same story in form of audiobook, most participants said that it was the story and running, which worked for them:

> *I think I would find it boring [listening to a story without running].* - Runner #3.

> *I might now, I wouldn't chosen before to just to listen to it, I don't think. I think it was the element of interacting with it that was good for me.* - Runner #13.

> *Both.* - Runner #12.

Transitions

As noted before, it was not hard for participants to get started with *Zombies, Run!*. Running with zombies did not require much equipment: all participants already had running shoes, a smartphone and headphones. The app has a big button "Start story" or "Continue story" on the main screen.

On a mission transitions to and out of the story happen several times, the narrative does not go in headphones for the whole run. Players listen to parts of the story, and between the passages they could choose to listen either to their own music or to nothing. Aside from story bits,

there are notifications on zombie chases and collected items, and also information about the running distance and pace - the only bits that do not have anything to do with the fictional world. Although runners were constantly getting in and out of the story, they were talking about the missions as a continuous experience.

For those who enjoyed the story there was a curiosity between the mission parts when they wondered what would happen next: *"And when the song came in, I was like, I want the song to finish so I can listen to the next bit."* Runner #10.

Interestingly, listening to familiar songs help to maintain anticipation as runners had a feeling of how much approximately left till the next section.

Runner #3, who has dancing background, mentioned also pacing to a song: *"All songs that I knew pretty well, so I didn't have to think too hard when the next segment will be arriving [...] So I knew, I could easily pace myself to the song."*

As the whole run was experienced as run in "zombie" world, it was only after a mission ended that the participant felt they were finished with the story world. But similar kind of curiosity made some of them anticipate the next run, or rather next mission.

In the current instance, there is no way to figure out how much time participant spent between the missions, so the app did not try to match that time period. On the other hand, running on a mission always felt as though it were in real-time. There were some examples of how participants tried to get the sense of time while using their real running parameters (such as distance and pace measures).

While a "minimum explanation" approach made it possible to quickly start with the first run, some participants were left confused as they did not have a sense of how much of their running would be taken care of and which part they have to do on their own. Participants were uncertain if they should, for example, warm up before starting the app or what to do after mission ended.

As reported above, finishing a mission could be a goal for people, who feel that they should not stop until mission ends, even if they would have usually finished a run earlier. Similarly, finishing all missions can become a goal of its own: "*I like completing things, so probably I'll finish. 99% per cent chance I'll finish."* Runner #9.

And the overarching story yet again provokes curiosity, this time on an even bigger scale: *"I wonder how it all ends."* Runner #8.

DISCUSSION

This paper aims to contribute to HCI by providing a better understanding of users of mixed reality quests. In this study we looked particularly at how the running application changed the experience of running for participants. Our findings showed that *Zombies, Run*! changed the experience of running in three different ways. Firstly, it changed how people organised their runs, e.g. how they choose when and where to run. Secondly, it changed the running routine itself, thus, for instance, some people were pacing their runs differently when running with the app. And thirdly, it changed how people perceived running. The following sections discuss how these three changes in people's experiences of running contribute to knowledge and practice in HCI.

Organising Runs

Firstly, we observed how some participants changed the way they organised their runs. We saw how runners, who were intrinsically interested in using the app made a visible effort to re-organise their runs. They changed locations for their runs to make sure they would not get distracted by passers-by, ran at night time to match night mission time, tried to arrive home simultaneously with arriving back at the base, etc.

The main motivation behind such changes was to align the digital and physical worlds together, particularly, to make connections between *space* and *time* in two worlds. As we mentioned in the findings, inconsistencies between the worlds led to confusion and frustration. For instance, participants were disappointed that the weapons they picked up were impossible to use or that zombies would just completely disappear after the chase was completed. On the contrary, we noted how even serendipitous connections between the digital and the physical were embraced, which was similar to how people attributed meaning to chance while listening to music in shuffle mode (Leong, Vetere, & Howard, 2006).

Interestingly, participants made the changes to their runs voluntarily. In *Zombies, Run!* there were no professional orchestrators, who would guide the experience from "behind the curtains" (Benford et al., 2009). Traditionally, orchestration is seen as one of the main challenges with mixed realities (Benford, Magerkurth, & Ljungstrand, 2005), yet in the study we saw how participants were willing to and able to make changes to their runs, when they wanted their runs to match the story better. Rather than to provide a strict guidance, the app's main function was more to provide the fictional world and to help users to match it with the physical world.

From a practical perspective, this highlights importance of inventing ways to align the virtual environment to the physical world rather than on controlling players' actions. For instance, we mentioned earlier the idea of digital map, which would help to understand the scale of the virtual world and which could be adjusted to provide a better match with the preferred running route. A further opportunity would be to align some of the characters in the narrative with the runner's personal contacts, using the list of contacts from the smartphone. Careful inclusion of personal contacts and increased overlaps of physical and virtual space may create opportunities for serendipitous experiences while running with the app.

Changing Running Routine

Secondly, we saw how *Zombies, Run!* became a part of the running routine for some participants. We were interested in how mixed reality can intervene with an existing routine. This is important as most of the prior work has examined short-term event games (Montola, 2011) and games that create entirely new types of exertion activities (for instance, Mueller, Agamanolis, & Picard, 2007).

In alignment with the work of Marshall & Benford (2011), we found that the main reason why these participants preferred to keep running with the app was the change of *perceived time*. The story bits occurred only in short segments during the run, but they kept runners' attention busy for much longer. Among other things, runners were thinking about the story or about themselves being heroes. Furthermore, they were also anticipating the next part of the story and also zombie chases.

By looking at participants' interaction with the *interface*, we saw how zombie chases changed the way runners paced themselves and if a runner had specific pacing goals or habits, chases become unacceptable. Yet for those, who preferred to keep chases turned on, they were a mild influence, which did not transform familiar running routine to a new activity. We also saw how some participants turned the chases on only for some of their runs, depending on how they felt on that particular day.

We discovered that an intention to continue running with the app was not indicative of the participants' running experience. However, it was important, that the app would not break the established routine for participants who had one. For instance, one participant did not like how the chases made him holding back during his runs.

From a practical perspective, this shows the importance of keeping game features separate and optional. Even with the same activity, different people would have different preferences and goals. Furthermore, their willingness to use a particular feature can depend on a mood, route, weather and other conditions. Thus, if designers want to create an app to enrich an existing activity rather than create a new one, it can be important to let users control app's features individually, adjusting the app to suit their own routines.

Making Meaning

Thirdly, we discovered how for some participants *Zombies, Run!* created new meaning in regard to their running. In order to better understand these experiences we added Howard's (2008) notion of *meaning* to four facets of mixed reality experiences introduced by Benford et al. (2009).

As suggested by Sengers & Gaver (2006) we let participants interpret the purpose of the app for themselves, we did not provide background information on the app apart from describing it as a running app, which provides a story for their run. We found that people were very flexible in making meaning out of the quest (Howard, 2008). In our study, runners tended to construct meanings that were beneficial to their running. Self-conscious runners found a way not to worry about being unfit. Those, who were bored with running, reported feeling more excited about their runs. Experienced runners enjoyed new challenges. The story also provoked a heroic feeling and curiosity (Klimmt, Roth, Vermeulen, Vorderer, & Roth, 2012).

When the mixed reality quest was seen as meaningful, it was able to provide constraints and goals, which are core elements of games (McGonigal, 2011, p. 21). As we mentioned earlier, runners, who became engaged with the story, made an effort to act as if the story was real. Therefore, they felt constrained to running, although the app would actually work with cycling or even with standing still. Mission completion can become a goal in itself and it was different from the usual time-limits some runners set for themselves, as with a *Zombies, Run!* mission a runner cannot know exactly when it will end. And running through the entire season of *Zombies, Run!* can similarly become a long-term goal.

From a practical perspective, we want to note that there were no points, badges and leaderboads in *Zombies, Run!* From this, we suggest that the use of narrative only can be sufficient for gamification.

Interestingly, not only the story made running better for many participants, but in the same time running actually enhanced the story. As we mentioned before, some runners noted that they would not listen to the same story in form of an audiobook without being on a run. We observed that an activity added to a story can make it more enjoyable. As it is arguably expensive to create a high-quality story, we speculate that a high level of quality in the narrative might not always be needed, when the story is combined with an activity.

CONCLUSIONS

In this paper we have started to explore how mixed reality games influence people's everyday life activities such as running. Unlike previous work on gamification and serious games, the game examined in this research did not rely on leaderboards and trophies but rather used the narrative structure of a quest to influence running activities.

We found that the mixed reality quest changed running in various ways: the way people organised their running, the running routine itself and their perception of running. Our findings extend current understanding of people's interactions with mixed reality games and offer some guidance to practitioners who design systems that blend virtual and physical environments.

ACKNOWLEDGMENTS

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APPENDIX II: STUDY 2

II.I PLAIN LANGUAGE STATEMENT

THE UNIVERSITY OF MELBOURNE
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

PROJECT TITLE:	**Creating a Story for Mixed Reality Games**
INVESTIGATORS:	**Dr Martin Gibbs, Dr Bernd Ploderer, Alexander Kan**

The Project
Mixed reality games blend together digital technologies and physical environments. The purpose of this project is to better understand the process of creating stories for mixed reality games. This study is a part of Alexander Kan's PhD research project.

Your Participation
If you agree to take part we ask you to participate in the following activities:

1. Participating in the first workshop (up to 3 hours)
   - We will invite you and other participants for a walk around The University of Melbourne Parkville Campus to tell you more about the area, so that you could use this information in the stories.
   - This will be followed by an indoor discussion of your initial thoughts and ideas.
   - The discussion will be video recorded.
   - The discussion will be conducted in the usability lab at The University of Melbourne.

2. Developing a script for a mixed reality game (up to 10 hours during a period of 2 week)
   - We will ask you to develop a script during the following 2 weeks.
   - The setting for the script will be the University of Melbourne Parkville Campus.
   - You will be able to work on your own or in a small group, depending on your preferences.

3. Participating in the second workshop (up to 3 hours)
   - The workshop will start with a general discussion of participants' experience with writing a mixed reality game story.
   - This will be followed by the detailed discussion of the stories.
   - The workshop will be video recorded.
   - The workshop will be conducted in the usability lab at The University of Melbourne.

If you have a dependent relationship with any of the researchers that are involved in the project (for example: teacher/student or colleges from the department of Computing of Information Systems), your participation in this study, will not affect in any circumstance ongoing assessment/grades or management relations.

Your participation is voluntary. You are free to withdraw at any stage and also to withdraw any unprocessed data provided. Video data can also be deleted at any time by request.

Why Should I Participate?
We hope that workshops will help you to meet other creative writers, learn from their experience as well as share your experience and knowledge with them. At the end of the workshops you will have created a finished short script.

HREC # 1341249

1

You will receive a "Reading" gift card (value: AU$ 20) to acknowledge your contribution.

Your participation will help to better understand the process behind creating more engaging stories for mixed reality games.

Potential Risks
To preserve your anonymity, we will use code names for participants in all written work. Yet due to the small number of participants there is a possibility that people could be identified through contextual information.

Privacy
We aim to protect your confidentiality within the limits of the law. All the information you supply will be anonymised. Your name and contact details will be stored separately from the data you provide in a password-protected computer file. If we chose to use any materials related to you in the reports and presentations, we will try to contact you before doing so. Only researchers listed above will have access to collected information. The data will only be used for the research purposes and will be kept securely for five years after the last publication arising from this study, before being destroyed.

Furthermore, you should consider that although we won't use your name in any findings arising from this study, there is still a chance that due to the small number of participants it will be possible to identify you by contextual information.

Ownership
We will ask for your expressed agreement for using your real name to acknowledge the authorship of the created stories. If you decide not to reveal your real name, we can use your penname for that purpose.

Further Information
If you have any questions please contact any of the researchers:

Alexander Kan	kana@student.unimelb.edu.au	(04) 2381 3059
Martin Gibbs	martin.gibbs@unimelb.edu.au	(03) 8344 1394
Bernd Ploderer	ploderer@unimelb.edu.au	(03) 8344 1511

This project has been approved by the Human Research Ethics, Committee The University of Melbourne (project number: 1341249). If you have any concerns regarding the conduct of this research please contact the Executive Officer, Human Research Ethics, The University of Melbourne, VIC 3010 ph: (03) 8344 2073 fax: (03) 9347 6739.

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II.II CONSENT FORM

THE UNIVERSITY OF MELBOURNE
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

PROJECT TITLE:	**Creating a Story for Mixed Reality Games**
INVESTIGATORS:	**Dr Martin Gibbs, Dr Bernd Ploderer, Alexander Kan**

1. I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written plain language statement to keep.

2. I understand that after I sign and return this consent form it will be retained by the researcher.

3. I understand that my participation will involve participating in two workshops and writing a story. I agree that the researchers may use the results as described in the plain language statement.

Participation in the workshops

4. I acknowledge that:
   (a) the project is for the purpose of research.

   (b) I have been informed that the study is voluntary and that I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data I have provided. I am aware that video data can be deleted at any time, if I request so.

   (c) I have been informed that the workshops will be video recorded for later analysis. The records will be stored at the University of Melbourne for five years after publication and destroyed afterwards.

   (d) I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements. I am aware that that due to the small number of participants in this research project, there is a possibility that individuals can be identified by contextual information;

   (e) I will be referred to by a pseudonym in any publications arising from the research,

Ownership of the produced work

5. I acknowledge that:
   (a) I understand that the work I produce during the study will remain my property. I will allow to use my work for the purpose of this PhD project.

   (b) I want my real name to be used to acknowledge the authorship of the created script:

   ☐ Yes ☐ No, I prefer to use the following penname: _____

If you wish to receive a copy of the project summary report at the conclusion of the project,

please provide your email address: _____

Name (please print):

Signature: Date:

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HREC # 1341249

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II.III INTERVIEW STRUCTURE

BACKGROUND
What kind of (writing) work have you done in the past?
What do your previous projects have in common?
To date what is your favourite project?

CREATIVE PROCESS
Could you walk us through your usual creative process? (How do you know you want to write this specific story? Where do you write? How do you plan? etc)
In your previous projects what part of the process was the most unpleasant for you?
When was the last time you felt inspired to write?

THOUGHTS ON MIXED REALITIES
Imagine yourself writing a story for a mixed reality, how do you think it be different from your usual process?
What new opportunities this format would provide to you as a writer?

RUNNING
What is your previous experience with running?
What features of a story can be beneficial for runners?

GENRES
What genres do your previous work fall into?
What kind of genres would be most appropriate for that kind of project?
What kind of genres you think wouldn't work well (mystery story? comedy? etc)

SETTING
(similar questions as in GENRES section)
zombies, ghosts, werewolves, robots, fantasy environment with wizards, elves and such, etc

CHARACTERS
What could help runners feel like a main character in the story?
How characters could interact in a mixed reality game designed for running?

TIME
How do you think about story time when you're writing? Could you walk us through your thought process?
What kind of "tricks" with story time you used in previous projects?(Flashbacks, cuts, story-within-a-story, etc)
How do you think the nature of this project will affect story time?

SPACE
(similar questions as in TIME section)
How could you make your story feel more related to physical location?

THE CAMPUS
What features of the campus you think you could use in the project? (buildings, personas, facts, etc)
What about the campus you think might be limiting?

CHALLENGES
What parts of this project that make you feel unease?

II.IV WORKSHOP PLAN

0. PREPARATIONS
Buy Readings gift cards.
Book the lab.
Prepare recording equipment.
Provide the snacks.

Print out handbooks and campus maps.

Rehearse during the weekend to check what's open.

1. INTRODUCTION (15-20 MINS)
Consent form and PLS.
Aims of the project.
Video of "Zombies, run!"

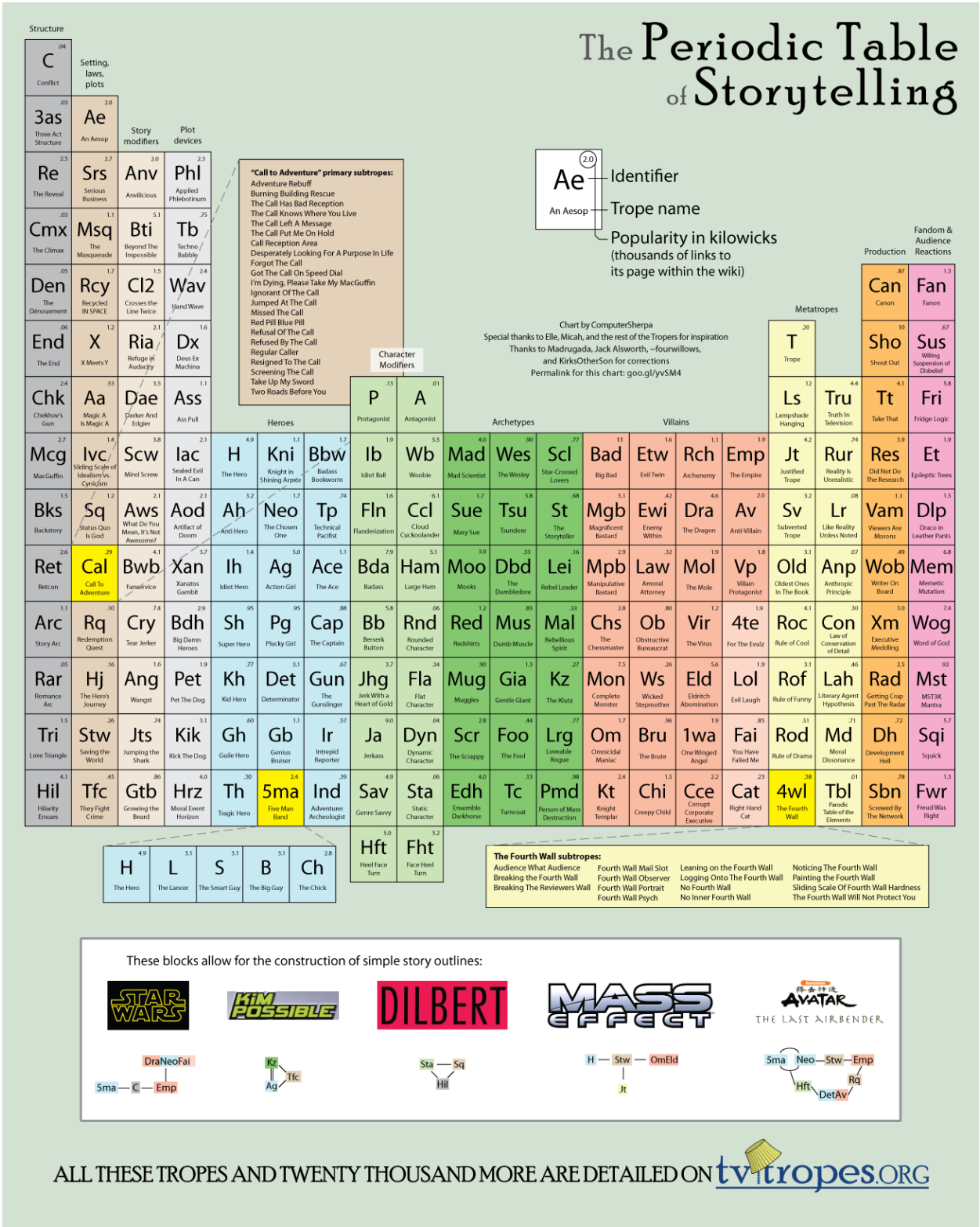
2. WALKABOUT (30-40 MINS)
Start discussing how certain features could be used. Provide examples.

The Route:
- 1888
- Underground Car Park
- Baillueu Library
- Old Arts
- Deakin Court
- University House
- Union House
- Elisabeth Murdoch
- Doug McDonell

3. DISCUSSION (1-1.5 HRS)
Background of the writers, how they organise creative process?
Initial thoughts.

4. BRAINSTORM (30 MINS)
Big poster with the campus map.
Photos of different points of interest.
Cards with random plot sentences.
Whiteboard with ideas.

II.V PERIODIC TABLE OF STORYTELLING



II.VI EXCERPT FROM 'ZOMBIES, RUN'

1. THE HELICOPTER

FX: CHOPPER NOISE

The player is sitting in a helicopter buzzing over zombie-infested territory. In the plane is also a PILOT, female, mid-20s. They're heading towards Abel Township, a small isolated settlement in a sea of zombie-land.

PILOT

So, you can see the city now as we loop round. Well, they call it a city… Not much more than a few fences to keep the zoms out.

<slightly mocking>

Sea of Zombies, Tiny little island of humanity. I just don't know how they live like that.

<decisive. But ambiguous: does she mean 'we're here to help' or 'we're here to kill them all'?>

Well, I guess they won't be living like that much longer.

<to you>

"So I expect you're not allowed to say what you're being dropped into the township for, huh?

<Pause>

Nah, I thought not. I know how it works. They don't even tell you till you get there.

1

<on radio>

Abel Township, Abel Township, this is Jolly Alpha Five Niner from Mullins Military Base. We're 5 miles out approaching from the east at one thousand one hundred feet, bringing in med supplies, some vac-packs, shelters and a temporary loan of one of our people. Abel Township Jolly Five Niner requesting permission to land?

YAO

Got that. Er, I mean, roger that. You're clear to… yeah you can come on in.

PILOT

Roger Abel Township, heading down now.

<to you, more quietly>

I can see clear as day we haven't got half the supplies we usually bring. That means we've lied to the township.

<pause>

Yeah. I know. You don't know anything."Project Greenshoot"? Need to know basis? — oh yeah, I heard them tell you that just as you boarded — and then you'll find out what your mission really is. But you know if you and me pooled info maybe we could…

FX: Noise of gunfire. Rocket launchers.

Someone's shooting at the chopper.

PILOT

What the hell…? They're shooting! That's not coming from the township! Who the hell has a rocket launcher in this sector, who the hell has…?

FX: A crash of engines, the high-pitched whine of something going very badly wrong. One of the rockets has hit the chopper.

PILOT

We're hit. I've lost the tail rotor. Mayday.

Mayday Mayday.

<This should be said fast maydaymaydaymayday, but calm - you want to remain cool and calm on the radio so your calls can be understood>

Jolly Alpha Five Niner is going down three miles east of the township. Two souls on board. Aircraft is grey with black lettering and trim.

We're going in hard brace brace brace.

FX: MASSIVE CRASH

A voice comes over the radio.

YAO

This is Abel Township calling, this Abel Township calling. Supply copter can you hear us?

3

<Aside>

They're going down fast, holy moly.

<to us>

Can any of you hear us? Open your chutes! Jump! Jump!

FX: A rush of air. The chute opening. A crash through undergrowth.

FX: Heavy breathing. In your ears. Your breathing.

FX: Crackle of static

YAO

Hey, hey. I um. This is Abel Township calling, over.

<Aside>

They're not answering. Their comms equipment coulda been fried.

FX: sound of your parachute unclipping, a heavy fall to earth. You landed in some trees but you're OK, on the ground now.

YAO

Listen, if you're alive, if there's anyone alive. This is Sam Yao from Abel Township. I'm just the… I'm just the radio operator man, I'm not supposed to handle this stuff.

FX: crackle of static

You've come down in a nest of hostiles. They've heard the noise. They're coming. There are… thirty.

4

No, forty. No… crap. Your only safe path is towards the tower, you should be able to see that from where you are. If there's anyone alive there, just run.

FX: very faint, distant moan

Run!

<play opening track>

Excerpt From: Six to Start and Naomi Alderman. "The Runner's Guide." iBooks.

5

II.VII COFFEE BREAK

COFFEE BREAK

by

Writer №4

SCENE 1

RAMONE
Where are you? Wait... are you... are you at the University campus? Here? Here is where you want to search for it? With all of Lygon street's riches behind you?
Fine, fine, have it your way – but don't say I suggested it. I thought it was a bad idea from the start.
Okay, now let me take a look at the map. There should be Tsubu on your left, can you see it? Right. I don't think they'd have any coffee left though - Tsubu is too obvious of a target. But there are other cofee shops around, hell even the staff rooms might have something.

BARON
Are you talking to that runner?

RAMONE
Yes my leige, he's on his way already, we'll find some coffee very soon!
(Quietly)
Listen up runner, the Baron is not doing good at all. I think we have about 15 minutes before he falls asleep and you know from that there might be no waking...
(Normal voice)
There's no time to lose. Keep running and I'll come down to Tsubu in 15 minutes.

BARON
Let me talk to that runner!

RAMONE
What would you...

BARON
Go runner! Past the buildings, the tress, perhaps even personnes, people. You go through, through, through. Getting me my brown beans of caffeine riches.
Don't you come back without my coffee.

SCENE 2

RAMONE
Sweet Brunswick tram, that's why I don't want him talk to runners. Anyaway, as you can see, he's not getting any better. How are you doing there?
You know, you were probably right about coming in here rather than the streets of Italian Burghers. Fancy lot, think they're some sort of merchant royalty (snorts) and very protective of their coffee. They're still very active in the area and wouldn't appreciate anyone grabbing coffee for someone up in Brunswick…
(Quetly)
Especially THE BARON
(Normal voice)
There are quite a few coffee places nearby. Castros should be right in front of you. And there's also House of Cards to your... left? or maybe to your right.
Okay, okay, I'm useless with maps. But that's why we have you! And you're doing great by the way, keep up the good work and we'll find that coffee for the Baron.

SCENE 3

BARON
You were talking about Castro! What a man he was. Cofeee... all of Cuba coffee plantations. Now, there's a man you can admire! And they worship him even here in Parkville, 15 thousands kilometers away from his island home. Now that is what I call establishin authority. That's what I want runner, do you understand that? I want my coffee.

RAMONE
BARON please sit back over here. There'll be something, don't you worry. Can I get you some tea?

BARON
I want no tea! Coffee! Bring me coffee!

Sounds of shuttered glass.

SCENE 4

RAMONE
You know you can just follow hipsters if you want to find coffee. Altohugh there probably won't be much left after them. So you need to be ahead, you hear me? Any luck there?
(Sigh)
I see.
Okay, have you been to that Castros place yet, it looks promising.
If you find anything, you have to make sure it's not decaf. The BARON HATES decaf more than he despises the lack of cahfee.
There's not much time left. The Baron might fall into the deep sleep any minute now. And where would we be then? Without leader, without suburb, without blessed cahffe.
No, this cannot be our fate. Find the cahfee RUNNER, find the cahfee.

SCENE 5

Sounds of heavy traffic.

RAMONE
I can see why we have you running is definitely a lot quicker than... this.
I mean, look at them all rushing to and from the city, to Royal Parade, to...
Sweet Brunswick! You've found it! Of all places runner? Well what are you waiting for? PICK IT UP!
BARON, did you hear? Did you hear what our RUNNER has gained? A bag of Victorian coffee beans.
Baron!

GUNFIRE pistol, low calibre, WildWest-ish.

RAMONE
It looks like I was too obvious for once. Now where are yo-?

GUNFIRE, wild neighing from the horse.

RAMONE
Ah, there you are hold on. This'll be a quick pickup.

GALLOPING, with the odd pistol shot. Sound changes to less distorted radio, as though you're face to face with RAMONE.

RAMONE
(To horse)
Come on Machiato! Away!
(To RUNNER)
You did good. Now quickly back to Brunswick, we need to try and save the BARON.

MISSION ACCOMPLISHED

II.VIII HORROR RUNNER

HORROR RUNNER

by

Writer №5

MARY
Jesus Christ!!!

The car spins out of control.

JOHN
What did you hit! What was that?!

Groans

JOHN
Do you see that? What the hell is that?

MARY
Get out of the car! Get out! Go! You two at the back, get out now! Run! RUN!!!

SCENE 2

Ringtone sound.

JOHN
Oh my god! Did you see that... that… animal? Was it an animal? Did you see?
We're all split up, but I think I just saw Mary near the lake. Do you know that lake? Just keep running and we should all meet somewhere there. I think it's better to stay off the main road, where that thing can easily see us.
Also, turn that damn sound off! I think every animal in the forest could hear you!

SCENE 3

MARY
Hey, it's Mary. I'm with John now. We've found the cabin, so we're safe... I guess. You need to get here ASAP. Do you know where you are?
(Beat)
Dammit, how can I give you directions if you don't know where you are? Are you close to the lake at least? Maybe call me or John from there and we'll try to steer you.

SCENE 1

Obnoxious music.

MARY
Turn that off.

The volume lowers.

MARY
Dammit John, all the way. I can't see anything.

JOHN
How does turning off the radio make you see better?

MARY
Just turn it off. You know what, fine, here, I'll do it for you. Why do you have to be like this?

Music cuts off.

MARY
Hey, in the back. You two doing alright?

JOHN
They can't hear us.

MARY
Why are they asleep right NOW? I need to find the cabin. I can't see any of the god damn road signs down here, it's the middle of the god damn night. I really need them to be awake. Wake them up.

JOHN
We can always pull over. Sleep in the car... If you know what I mean.

MARY
Chrissake John, we just need to find the cabin. Would you help me out here or are you gonna keep acting like a fu--

The car hits something.

There are roars through the mission at random times.

SCENE 4

JOHN
You're very close, we can see you now from the cabin. I think that the monster went off in other direction, but better keep running I guess.
Just keep going by the lake and you'll see the cabin very soon. And yeah, definitely keep off the main road, I think we can see some movements there.

SCENE 5

MARY
Get it! Quick!

JOHN
Where is Sally? I thought that Sally is with you! Oh Jesus Mary, why didn't you call her?!

MARY
Her phone is dead.

JOHN
So where the hell is she now?!

MARY
John! Be quiet!
Sally will be fine. It was just a weird animal. Just an animal. It'll go away.

JOHN
Just an animal?! I can't deal with this. I need to sit down.
(Beat)
We need to go back there and find her. Well, I'm going back there to find her, you can stay in, if you like.

MARY
We're going with you.

MISSION ACCOMPLISHED

II.IX ADAM

ADAM

by

Writer №7

SCENE 1

ANNA
Adam? Adam, it's Anna...
Dear Adam, I miss you so much! I keep thinking about the day we met. This weather always reminds me of how we met. You were so cute Adam, the first time I saw you. Do you think about me at all? Why haven't you talked to me since the incident?
Oh, but it doesn't matter Adam. I'm not angry at you at all. I just want to talk, I've been so lonely. And now it's all good, because I can feel you again. I can feel...
(Sounds intense now)
I can feel that you're not Adam! Who are you?! Can you hear me?!
Oh, you can hear me!
I don't understand... What is happening? Adam was the only one who could hear me and the only one who could talk to me. Can you talk to me?
(Beat)
I can't hear you, I'm sorry. But I can certainly feel you there. I feel you with the wind. Just keep running please, just keep running.

SCENE 2

ADAM
Anna? Anna?!
Dammit Anna if that one of your little games...
I'm sorry okay, I said I'm sorry, I said it a thousand times and I'm saying it again. Anna talk to me please. I need to tell you something.
I think I've made a huge mistake. Something is different. Something went wrong.
I've got a terrible feeling Anna. Could you just talk to me please?

SCENE 3

ANNA
So you can hear me, but I can't hear you? Huh! That means I can talk as much as I want to and... you won't be able to shut me up!
(Laughing)
Look around stranger, isn't that beautiful? I used to love this place when I was a human. I used to come here often. Sometimes just wandering around, exploring, something having a run just like you.
But I've never talked to any spirits here back then.
Somehow you, like Adam before you, have awoken the winds with your running, and the winds are willing to tell you their secrets. If you go to some places around here, you might hear secrets that people have left. You might even find some of Adams.
'If you reveal your secrets to the wind, you should not blame the wind for revealing them to the trees.'
Do you like that? Adam taught me that. It's by a human poet.
It's so exciting talking to you, I never thought it's possibible that someone else would be able to hear me! Adam had awaken the winds before you, but Adam was very special. You must be special too.
And I didn't even introduce myself - how rude! My name is Anna. And I... and I... and I don't even know what to tell you about myself. I wish I could hear you too. I wish I could know your name and know how you are.
You have no idea how much this all means to me. I've been here for so long without no one to talk to. I'm so glad to have met you, I'm so excited.

SCENE 4

ADAM
Anna! Anna!
Don't talk to me. It's good if you're not talking. But you need to listen up. Listen to me Anna. There are people coming here, they're coming for us and for all the other spirits. These people will be able to hear us, can hear everything that we say.
I don't care about other spirits, I don't care about myself, I only care about you Anna. You need to hide Anna. Do not talk. Do not say a word my love, not to me, not to anyone. Stay quiet and hopefully they will never know that you are here.
Do not talk to anyone Anna.
(To himself)
Oh Lord, what have I done?!

SCENE 5

ANNA
The winds are calming down. I'm not sure if I'll be able to talk much longer.
Can you hear me? Please come again soon and I will tell you more about me, and about Adam, and the spirits, and the winds. I want to talk to you, I missed that so much. Just promise you'll keep coming here and you'll keep running. Could you do that for me please?

MISSION_ACCOMPLISHED

II.X OZCHI 2014 PUBLICATION

Mixed Reality Stories: How Creative Writers Integrate Virtual and Physical Realities

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ABSTRACT
Mixed reality stories (MRS) unfold simultaneously in the physical and the virtual world. Advancements in digital technologies, which are now able to capture more contextual information about our physical environments, are enabling novel ways of blending the two worlds. To explore the process of creating stories from this perspective, we conducted a study with creative writers, in which we asked them to write a MRS script for outdoor running. While we saw instances of intentional connections between physical and virtual worlds in their work, we also observed the use of ambiguity or even deliberate contradiction with available contextual information. In this paper we discuss how these approaches can be beneficial for MRS and propose directions for future work.

Author Keywords
Serious games; mixed reality; storytelling; workshop; creative writers; running.

ACM Classification Keywords
H5 m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
The idea of blending virtual and physical realities is not new. The term *mixed reality*, describing the phenomenon, appeared about 20 years ago [1]. To date there have been numerous instances of projects that blend virtual environments with different aspects of the physical world. For instance, in one of the classical examples of mixed reality games *Can You See Me Now?*, street players are supposed to chase online players who move through a virtual model of the same city [2].

In *mixed reality stories* (MRS), technology is used to blend together virtual stories with physical environments.

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One of the most prominent examples of MRS is a running app called *Zombies, Run!* [3]. In this MRS, users listen to a fictional zombie apocalypse story about a runner on a mission, while actually running themselves. An important difference in the *Zombies, Run!* story from a "regular" audiobook is that listeners take on the role of a character in the story. Thus, running is happening in both worlds simultaneously: in the physical world, users do their running routine and in the virtual world, their character runs to accomplish a variety of missions.

One of the driving forces behind recent developments of mixed reality applications (including MRS) is the advancement in wireless communication and sensing technologies [4]. Modern sensors can gather a variety of contextual information about the physical world, such as a user's location, movement and proximity to other people, objects and places, the type of activity (e.g., running or cycling), and physiological data such as a user's heart rate. All that information can potentially be used for creation of mixed realities. It is also important that these sensors are built into connected mobile or even wearable devices so they are able to track changes in situ and immediately adjust the mixed reality setting accordingly. Chittaro and Zuliani [5], for example, developed a MRS in which a runner is required to keep going at her current speed for a certain amount of time in order to escape a dinosaur in a virtual world.

Naturally, mixed reality researchers and practitioners are interested in exploring ways to create relationships between the physical world and the virtual world (e.g. [5, 6]). While many of them describe the process of creating mixed reality projects (e.g. [5], [7], [8]), the work in this field tends to be technology-focused rather than story-focused. However, the heart of each MRS is a story and we argue that interesting and meaningful relationships between the physical and the virtual can be created through the manner of storytelling itself. Despite a growing number of mixed reality stories being created, little is known about how they integrate contextual information about the physical world with the virtual world of a story. The creation of MRS requires a tight collaboration between storytellers and HCI designers (although the roles might be combined in a single person), therefore it is beneficial for designers of MRS to understand the capabilities of storytelling and to use its features in their projects.

To explore the process of creating MRS from this perspective we conducted a study with creative writers, in which we asked them to create stories to support running, in a format similar to *Zombies, Run!* We focused particularly on how creative writers deal with contextual information about the physical world and we found that they connected physical and virtual realities in a variety of ways: they adopted ambiguity in cases of insufficient information and, interestingly, they deliberately broke the connection between physical and virtual in some special cases. We discuss how these techniques used by storytellers resonate with previous work in HCI. In the conclusions, we also outlay grounds for future work in this direction.

STUDY WITH CREATIVE WRITERS

The aim of this study was to examine the process of creating stories for mixed realities, i.e., to investigate how creators of such stories use contextual information. We recruited seven writers through local screenwriters meetings and mailing lists. 3 writers were amateurs, 1 had a background in journalism and 3 writers were professional fiction writers with a background in writing movie screenplays. One of the fiction writers also had experience with writing stories for videogames.

The writers took part in 3 activities: a workshop, a period of writing a mixed reality story and a follow-up interview. The 7 writers were split into 3 groups to make it easier to organize dates for workshops. Inspired by the procedure of local screenwriters meetings, each workshop started with an introduction to the mixed reality story format, the aims of our study and a brief introduction of the writers' backgrounds. A general discussion on mixed reality games followed where the writers expressed their expectations from the experience of writing such stories. Each workshop concluded with a 20-minute writing exercise to draft a story synopsis.

Each writer had three weeks to develop a script for a MRS for runners, set on the campus of the University of Melbourne. For writers unfamiliar with the campus we organized a short walking tour at the end of the workshop.

Out of 7 participants, 3 writers completed their stories. The other writers dropped out of the study due to other commitments or without explanation. A follow-up interview was conducted with the writers who had finished their scripts to better understand the process of writing a story for mixed reality, the challenges that our writers had faced and the differences from their usual writing process.

All workshops and interviews were audio- and video-recorded and selectively transcribed. In our analysis we were looking for any pieces of interviews describing relationships between the physical world and the story world. Moreover, we analysed the scripts themselves to find examples of using (or not using) available contextual information. The following section describes findings that arose from interview transcripts and the scripts.

RELATING PHYSICAL AND VIRTUAL

We identified three ways in which writers dealt with contextual information to produce mixed reality stories: (1) they *blended* certain aspects of the story with contextual information; (2) they used *ambiguity* to allow for the lack of contextual information, and (3) in some instances they decided to write story elements that *contradicted* contextual information. These themes will now be discussed in detail.

Blending

As expected, all writers explored the opportunities to blend available contextual information with their stories. The main activity of the story was running, so all writers made the user character run in the story, and more importantly gave her a reason to run. In the first story the runner had to find coffee for a Baron that was in danger of falling into a deep sleep:

> *RAMONE (to the runner):*
> *Though I'd advise you hurry, the Baron cannot fall asleep too many times. He might fall into the deep sleep. And from that there is no waking". (Excerpt from the story "Coffee break")*

Here the author also implied the sense of urgency and importance to the run. In the second story, the runner has to run in order to summon winds, which would allow her to talk with local spirits. In the third story, the runner is chased by a monster in a horror story.

Two writers also used the university campus in their stories, as they knew that all runs would happen there. In the coffee story, all action lead to cafes on the campus and nearby places and mentioned nearby areas. The writer went beyond just mentioning familiar names and tried to make them feel natural to the story world. For instance, one character in the story used the name of a local area as an expression:

> *RAMONE*
> *BARON? Sweet Brunswick Tram! He's still verbal! ("Coffee break").*

Ambiguity

All participant writers toyed with the use of ambiguity as a way to tackle the lack of contextual information. For instance, writers knew that runs would be held on campus, yet they did not know the exact routes. During the workshops, it was mentioned that in the story expressions such as "a wooden door will be on your right" could be used as there are many wooden doors on campus and there is a high possibility that a runner would see one on her right.

With very few exceptions (discussed later on), writers were very reluctant to provide any specific details about the runner characters, as they felt that putting too much personality into the runners character can lead to alienation. One writer preferred to think of the runner's character as Gordon Freeman from the videogame *Half-Life* - a non-talkative person with no prominent background. Supporting this notion, another writer added that "no personality [for the runner character] whatsoever" felt like "a very instinctual thing to choose,

very safe". The assumption here was that the less participants know about their character the easier it would be to project their own personal traits into the character and thus feel more related and engaged.

The third writer had made a careful attempt to mention the character's age, assuming that most participants would be young university students. In his script, one of the spirits says to the runner:

> *ANNA*
> *You look young. Very young. I'm guessing...maybe early twenties? Oh, but It is so hard to tell with humans! (Excerpt from the story "Adam").*

The runners' gender was a particular aspect about which all the writers strongly felt to be ambiguous. Again, all three of the writers said that keeping the runner in their stories gender-neutral would make it easier for the player to relate to the character. For instance, the writer of the horror story had a runner sitting at the back of a car in the beginning of the story and at some point the characters at the front were about to refer to the runner. At this point the writer decided to put another character in the back of the car just so characters at the front could say "they" rather than "he" or "she":

> *MARY*
> *Hey, in the back. You two doing alright?*
>
> *JOHN*
> *They can't hear us.*
> *(Excerpt from the story "Horror Runner")*

Contradiction

Lastly, in several instances, the writers created story elements that contradicted the contextual information from the physical world. By definition, any fictional story contradicts "reality" in some way, however in regards to the aims of this study, we found it particularly interesting to understand why writers might be reluctant to use an opportunity to blend their story with the context of the physical world or an opportunity to be ambiguous when the contextual information is unavailable.

The writer of the horror story felt strongly that it is more important to get the atmosphere right rather than staying true to the surrounding environment. For instance, he specifically mentioned that the story is happening in the middle of the night, despite knowing that runners would be running during the daytime. He also wrote scenes in a car and in a cabin. While it is a possibility that some runs might occur in the night time, users who run with the mixed reality story will not use a car on campus, nor will they find a cabin that fits the story description. Moreover, although it is not mentioned in the script directly, it is assumed that all characters in the story, including the runner, are teenagers. The reason here is again to embrace the tropes and clichés of a horror story:

> *In fact [...] it's basically a B-movie, 80s horror movie. I chose that because it's got all the tropes you're familiar with. It's a bunch of teenagers going off and doing something really stupid. [And then a] Monster attacking. The main goal there is [to] run for your life. (The writer of "Horror Runner")*

Another interesting example came from the coffee story:

> *RAMONE*
> *Here? Here is where you want to search for it? With all of Lygon [this street in Melbourne is full of Italian cafes] riches behind you?*

It is implied, in this part, that the runner in the story had a choice of where to go for the coffee hunt, while the actual participant would have no such choice. Some runners might have thought that it is a shortcoming of MRS to make them look for coffee on campus while there is Lygon street nearby. In this excerpt author disputed the possible questions by making it clear that it is actually their own (or rather their character's) fault.

DISCUSSION

This study extends previous work on mixed reality projects that focussed on the technology design and users' experiences with mixed realities [e.g. 2, 4, 6, 7] by showing how creative writers utilise contextual information in order to create mixed reality stories. As expected, the writers sought to blend the physical and virtual worlds in their mixed reality stories by incorporating references to activities, locations and characters from the real world into the story. However, in some cases, the writers used ambiguous information in their stories, i.e., when it was difficult to anticipate contextual information like specific locations and gender in the story. Moreover, in various cases, the writers decided to contradict contextual information, i.e., they created fictional accounts that significantly differed from the experiences and the physical environment of the user.

While there is a long tradition of blending the physical and virtual in mixed reality applications, the focus on ambiguity and on breaking connections between physical and virtual through contradictions may be novel. Hence, these two themes will now be discussed in detail.

Exploring Ambiguity

This study showed how creative writers used ambiguity to manage contextual information that was difficult to anticipate. The notion of ambiguity is not new to creative writers [10]. Traditionally, writers create gaps in the stories for readers to fill in. Thus, a scene of a protagonist putting on running shoes at home can be followed by a scene in which the protagonist is running in a park; it is the role of the reader to assume that the protagonist somehow got herself to the park between the scenes.

Meanwhile, in the field of HCI it has been suggested that the lack of contextual information can actually be seen as a resource for design [9]. In their paper, Gaver, Beaver and Benford demonstrate how, in certain cases, intentional use of ambiguity leads to a closer personal engagement. Gaver and colleagues used the design of the game *Bystander* to illustrate how ambiguity can be used to create an interesting challenge for players, rather than be seen as a flaw. In the game, a player can only see a hint of the other player's location. They were not able to get the specifics due to the unreliability of used GPS tracker. Thus, players had to communicate in order to navigate in the game. Here, the use of ambiguity encouraged players to collaborate more closely.

In the study, we observed yet another interesting use of ambiguity. Our writers avoided referring to the runner's appearance or gender because they anticipated that the players would fill the gaps in their minds with their own personal details. In the case of MRS, the additional value of this approach is to make a player feel like she *is* the character in the story. By simply using ambiguity in their stories, writers allowed scalability of MRS. Now runners of different genders and ages can ideally feel like the story is specifically about them. It is also important to note that all that work in this case is done inside the stories and does not require changing the piece of technology that delivers the story to a runner.

Breaking Connections Between Virtual Real

This study showed that in some cases writers were not afraid to deliberately break the connection between physical and virtual worlds. The value in this case is not in the mere contradiction with "reality", yet in enhancing the story and allowing it to fit with the writer's intentions and the expectations of a particular genre. For instance, in writing a horror story a writer can decide that the story should be happening in the nighttime, even if he knows for sure that many runners will be running during the day.

Such a decision can potentially affect not only the quality of the story but also the runner's behavior. In an empirical study of *Zombies, Run!* [12], researchers found that if a runner is more engaged with the story, she would be more curious about finding out what will happen in the next mission and therefore more excited about the next run. Furthermore, if the connection between physical and virtual world is broken, runners might even take an extra step and try to restore the connection themselves. For instance, in the same study [12] one runner decided to run at nighttime to align the physical experience of his run with the fictional account of the zombie story.

While designers of mixed reality systems may go to great lengths to connect the physical and virtual, it seems that a deliberate break of such connections is still currently a somewhat unconventional approach. However, the findings reported in the study of *Zombies, Run!* [12] show how such a break can be potentially beneficial.

CONCLUSIONS

In this paper, we examined how creative writers use contextual information in the writing of mixed reality stories. While it may seem beneficial to use contextual information whenever possible to integrate physical and virtual worlds in mixed reality applications, this study showed that such integration was not always the choice of writers. The writers also used ambiguous information or deliberately contradicted information about the physical world in their stories to provide an enhanced experience for the users of the mixed reality story.

Further work is required to explore the experience of users of mixed reality stories. While the writers made assumptions of how certain story features would affect actual running, little is known about the real impact of contextual information integrated with the story, along with ambiguous and contradictory information. Empirical studies with actual runners are needed to evaluate the stories and the writers' assumptions about the integration of contextual information or the lack thereof. We hope that this work creates a foundation for future studies of that kind.

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APPENDIX III: STUDY 3

III.I PLAIN LANGUAGE STATEMENT

THE UNIVERSITY OF MELBOURNE
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

PROJECT TITLE:	**Understanding the Spatial Involvement In Mixed Reality Games**
INVESTIGATORS:	**Dr Martin Gibbs, Dr Bernd Ploderer, Aleksandr Kan**

The Project
Mixed reality games blend together digital technologies and physical environments. The purpose of this project is to explore the relationship between fictional narratives in these games and physical spaces. This study is a part of Aleksandr Kan's PhD research project.

Your Participation
If you agree to participate, you will be asked to run with a running application prototype. This application offers a story based on Zombies in the University of Melbourne Parkville Campus. Pieces of the story are divided into missions and appear in the headphones while you're running. A mission lasts about 20 minutes during which you are expected to walk, jog and/or run. We will ask you to have a run in University of Melbourne Parkville Campus. If you will want to continue with the prototype, we will ask you to use it again once or twice.

Prior to beginning the project, we will ask you to ensure that your health is of a standard that you can safely participate in a jogging program.

To better understand your experience an interview will be conducted, one after your run. The interview will last less than an hour. The interview will be audio recorded so the data can be used later in the project.

If you have a dependent relationship with any of the researchers that are involved in the project (for example: teacher/student or colleges from the department of Computing of Information Systems), your participation in this study, will not affect in any circumstance ongoing assessment/grades or management relations.

Your participation is voluntary. It will always be up to you whether you want to go for a run, record an audio or answer to a particular interview question. You are free to withdraw at any stage and also to withdraw any unprocessed data provided.

Why Should I Participate?
We hope that the prototype will improve your running experience by providing some additional motivation to exercise and diversifying your running routine. Your feedback on the prototype will help to better understand the role of narratives within mixed reality games. This will help designers create more engaging stories for mixed reality games.

HREC # 1340524

1

Potential Risks
Walking, jogging and running are physical activities that are undertaken outdoors and can involve health and injury risks. In taking part in this project you acknowledge those risk and take full responsible for any health and injury problems that develop, and undertake to always engage in these activities in a safe manner.

We will ask you to take all necessary breaks during and in-between the runs.

Privacy
We aim to protect your confidentiality within the limits of the law. All the information you supply will be anonymised. Your name and contact details will be stored separately from the data you provide in a password-protected computer file. If we chose to use any materials related to you in the reports and presentations, we will try to contact you before doing so. Only researchers listed above will have access to collected information. The data will only be used for the research purposes and will be kept securely for five years after the last publication arising from this study, before being destroyed.

Furthermore, you should consider that although we won't use your name in any findings arising from this study, there is still a chance that due to the small number of participants it will be possible to identify you by contextual information.

Further Information
If you have any questions please contact any of the researchers:

Aleksandr Kan	kana@student.unimelb.edu.au	(04) 2381 3059
Martin Gibbs	martin.gibbs@unimelb.edu.au	(03) 8344 1394
Bernd Ploderer	ploderer@unimelb.edu.au	(03) 8344 1511

This project has been approved by the Human Research Ethics, Committee The University of Melbourne (project number: 1340524). If you have any concerns regarding the conduct of this research please contact the Executive Officer, Human Research Ethics, The University of Melbourne, VIC 3010 ph: (03) 8344 2073 fax: (03) 9347 6739.

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III.II CONSENT FORM

THE UNIVERSITY OF MELBOURNE
DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

PROJECT TITLE:	**Understanding the Spatial Involvement In Mixed Reality Games**
INVESTIGATORS:	**Dr Martin Gibbs, Dr Bernd Ploderer, Aleksandr Kan**

1. I consent to participate in this project, the details of which have been explained to me, and I have been provided with a written plain language statement to keep.

2. I understand that after I sign and return this consent form it will be retained by the researcher.

3. I understand that my participation will involve one or two interviews and runs with a running application. I agree that the researchers may use the results as described in the plain language statement.

4. I acknowledge that:
   (a) the project is for the purpose of research.

   (b) I have been informed that the study is voluntary and that I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data I have provided.

   (c) I have been informed that my runs will be logged and that the interviews will be audio recorded for later analysis. The records will be stored at the University of Melbourne for five years after publication and destroyed afterwards.

   (d) I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements. I am aware that that due to the small number of participants in this research project, there is a possibility that individuals can be identified by contextual information;

   (e) I will be referred to by a pseudonym in any publications arising from the research.

   (f) I hereby certify that I am not aware of any medical condition that may increase the risk of illness or physical injury to me as a result of my participation. Participation in running exercises can involve a minor risk, and I acknowledge that I will not hold the University liable for any illness or injury incurred during this study.

If you wish to receive a copy of the project summary report at the conclusion of the project, please provide your email address: _____

Name (please print):

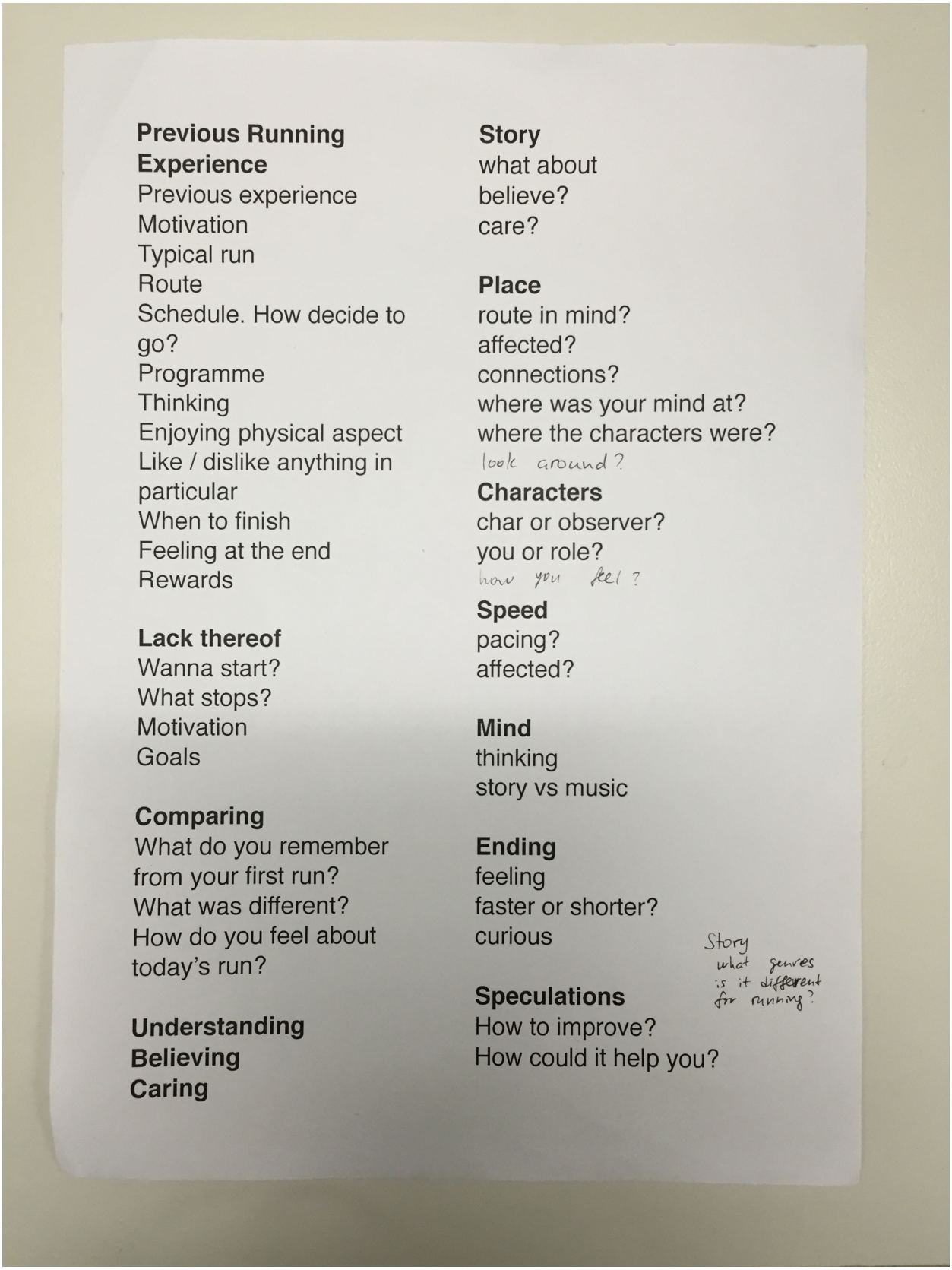
Signature: Date:

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HREC # 1340524

1

III.III INTERVIEW STRUCTURE



Previous Running Experience
Previous experience
Motivation
Typical run
Route
Schedule. How decide to go?
Programme
Thinking
Enjoying physical aspect
Like / dislike anything in particular
When to finish
Feeling at the end
Rewards

Lack thereof
Wanna start?
What stops?
Motivation
Goals

Comparing
What do you remember from your first run?
What was different?
How do you feel about today's run?

Understanding
Believing
Caring

Story
what about
believe?
care?

Place
route in mind?
affected?
connections?
where was your mind at?
where the characters were?
look around?

Characters
char or observer?
you or role?
how you feel?

Speed
pacing?
affected?

Mind
thinking
story vs music

Ending
feeling
faster or shorter?
curious

Story
what genres
is it different
for running?

Speculations
How to improve?
How could it help you?

III.IV QUESTIONNAIRE

Name _____

Age _____

Gender _____

Occupation _____

How familiar were you with the University Campus? not at all ○ ○ ○ ○ ○ ○ ○ very familiar

Running

Do you run regularly at the moment? _____

How long have you been running? _____

How often do you run? _____

How long is your typical run? Time: _____ Distance: _____

Do you listen to music while running? _____

Which apps or devices do you use while running? _____

Gaming

Do you consider yourself a gamer? _____

How often do you play games on a gaming console? almost never ○ ○ ○ ○ ○ ○ ○ very often

How often do you play games on a computer? ○ ○ ○ ○ ○ ○ ○

How often do you play games on a mobile device? ○ ○ ○ ○ ○ ○ ○

How often do you play physical games? ○ ○ ○ ○ ○ ○ ○

Which games or genres do you enjoy most? _____

Prototype

How much did you enjoy running with the app? not at all ○ ○ ○ ○ ○ ○ ○ very much

Would you enjoy the same story in form of a “simple” audiobook? _____

Would you run with another mission of the same story again? _____

Would you run with another story? _____

III.V ADVERTISEMENT

RUNNERS NEEDED

Try running with a mixed reality story on Melbourne University campus

Researchers at the University of Melbourne are looking for participants in a study of the user experience of running with mixed reality stories. We invite runners over 18 years old with any level of running experience, as long as they are fit and healthy to run.

In the study we use a prototype of a running application, which provides a mixed reality story. Runners listen to the story on the go through their headphones, while running on campus. Participants will be asked to have at least one run with the prototype. Interviews will be conducted in order to better understand runners' experience and a role of fictional elements. We will invite participants for a run with a different story, if they enjoyed the experience.

How Do I Agree to Participate?

If you are interested to participate or want to know more about the study please contact PhD Candidate Alexander Kan from the Department of Computing and Information Systems: kana@student.unimelb.edu.au

To find out more about the research please visit alexkan.com



This project has been approved by the Human Research Ethics, Committee The University of Melbourne (project number: 1340536). If you have any concerns regarding the conduct of this research please contact the Executive Officer, Human Research Ethics, The University of Melbourne, VIC 3010 ph: (03) 8344 2073 fax: (03) 9347 6739.