Evaluating the User Experience of Mobile Augmented Reality

The Case of WOORLD

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"The digital world will be soon enough be enmeshed with the physical world in such a way that our 'reality' will be the transparency mode that we choose."

~ Monika Bielskyte[1]

[1] https://medium.com/pandemonio/whats-vr-for-a-conversation-with-monika-bielskyte-d327ed0d23b5

Acronyms

2D – Two Dimensional

3D – Three Dimensional

AR - Augmented Reality

GPS – Global Positioning System

HMAR – Handheld Mobile Augmented Reality

HMD – Head-Mounted Displays

MAR - Mobile Augmented Reality

QR – Quick Response

UI – User Interface

UX - User Experience

VR – Virtual Reality

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Abstract

This study investigates the user experience of handheld mobile augmented reality (MAR). Smartphones are expected to drive the mass adoption of Augmented Reality. Still, the industry is lacking the 'killer application.' A good user experience (UX) is considered to be influential in the success of a product. However, little research efforts have been dedicated to this niche. Thus, the purpose of this study is to identify the types of experiences elicited by MAR, and how the system's components contribute to the experience. In order to research this topic, a qualitative case study approach is chosen. The application under investigation is WOORLD, an MAR sandbox game created by Funomena and built with the Google Tango technology. The study employs semi-structured interviews and direct observations during explorative in-situ game tests as main methods. Five participants agreed to partake in the sessions. The data analysis is guided by Thomas Olsson's framework for Desirable UX for MAR and the related Component Model (2013). Evidence is consolidated with insights from the application analysis. Finally, the study presents a set of positive and negative experiences elicited by WOORLD, associated with the different categories derived from the framework: instrumental, cognitive and epistemic, emotional, sensory, social and motivational and behavioural experiences. The experiences are linked to the relevant components of the application. Drawing from concepts of game design and game experience, the study proposes an adaptation of Olsson's framework and model to better fit the domain of MAR games. The findings from the case add to a body of knowledge aiming towards an improved understanding of the user experiences of mobile augmented reality and how it can be designed for. Further research is necessary to strengthen the validity of the case study.

Keywords: User Experience, User Experience Evaluation, Mobile Augmented Reality,

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Introduction

"Imagine taking 30 linear steps. You'd end up in the apartment across the street. Now imagine taking 30 exponential steps. Do you know how far you would go? 26 times around the world!"[2]

This is the impact enthusiasts anticipate the advent of digital realities and immersive media to have on our lives. One of these concepts is Augmented Reality (AR), the idea of imposing a layer on top of the real world which contains new information and experiences. The metaphor is emblematic for the heightened expectations people harbor about AR. Ever since Pokémon GO catapulted AR briefly into the realms of mainstream attention last year, people have been banking on the technology to gain momentum. The hype faded quickly, and AR has yet to offer proof that it is an essential item beyond filters and face swaps.

On the heels of excitement comes disappointment and arrested development. On the hype cycle, Gartner positions AR at the trough of disillusionment, a period of waning interest as implementations fail to meet the users' expectations (Panetta, 2017). The road to mass adoption is still long. The industry now looks expectantly at mobile AR, hoping it will bring the long wished-for breakthrough. For example, Facebook founder Mark Zuckerberg is an advocate of the phone being the "…consumer platform [where] a lot of these AR features first become mainstream, rather than a glasses form factor that people will wear on their face" (Facebook, Inc, 2016, p. 16). The numbers support this idea. Today, there are more mobile devices on this planet than people (Boren, 2014) and the barriers around hardware, software, and price are lower than ever. Since modern smart phones are equipped with powerful processors, high-resolution cameras, and sensors, many people already own potent AR hardware (Azuma, 2016).

There are two main ingredients missing: a hero device and a killer app. The former role could be taken by Apple, which is about to release a new iPhone featuring an ARKit that has gained a lot of attention over the course of the past months. Whereas

[2] (Michael Valdsgaard as quoted in Ulanoff, 2017)

the technology is not ground-breaking, Apple manages to combine "the convenience of your daily phone with the appeal of advanced AR," which could make all the difference (Savov, 2017). A harder quest is the search for the killer app. Studies confirm the impression that publicly available mobile AR applications show little practical or emotional value (Olsson, 2013).

As long as it is nothing more than a gimmick, AR will not catch on. People need applications that offer a long-term value beyond the excitement of novelty. Besides a convincing technical performance, a good user experience (UX) design is considered imperative for the adoption of AR. UX is an umbrella term for peoples' attitudes and feelings towards a product. The extent to which a system can elicit positive experiences can influence its commercial success (Law, 2010).

I argue that there is a need to gain a better understanding of what makes a good user experience in the context of mobile Augmented Reality (MAR) to be able to create novel and better systems. Most research endeavors within AR address technical obstacles and usability issues. Only a few are concerned with the experiental aspects of AR and there is even less literature on handheld MAR (De Sà & Churchill, 2013; Irshad & Rambli, 2014). Research of experiences can contribute to a body of knowledge, from which ultimately empirically grounded design guidelines can be derived. The purpose of this study is to explore the experiential aspects in the use of MAR. Therefore, the research questions read as follows:

(1) What types of experiences are elicited by MAR?
(2) How do the components of the system contribute to these experiences?

The study is delimited to visual MAR on smart phones. Furthermore, the focus is laid on consumer-level applications in the domain of games and entertainment. The application under study is the AR game WOORLD, which is played indoors. Therefore, the study is concerned with indoor augmentation. The research focusses on users expectations of and experiences with MAR, and tries to connect them to the aspects of the system.

The study is structured as follows:the first chapter conducts a compact review of literature on augmented reality and user experience. The review shows a gap of research and presents a framework for the evaluation of MAR. The subsequent chapter lays out data collection and data analysis methodology. This is followed by a presentation and analysis of the case, the application WOORLD built with Google's Tango technology. The next chapter provides an overview of the findings, which are subsequently analyzed and discussed in the context of existent research and literature. The thesis concludes with implications for theory, practice, and methodology and an outlook on further research.

Literature Review

This chapter conducts a summarized review of the literature on AR and UX respectively. Then, a framework for assessing MAR services is presented. The chapter concludes with a concise overview of UX studies of AR and MAR, indicating a research gap.

Augmented Reality

"Any sufficiently advanced technology
is indistinguishable from magic."
~ Clarke, 1973, p. 36

The first ever invented, fully functional AR system was the "Sword of Damocles". Created by Ivan Sutherland (1968) in the 1960s, the HMD technology allowed users to see computer-generated information mixed with physical objects. However, it was not until 1992, when Caudell and Mizell proposed overlaying digital information on the real world to facilitate aircraft assembly at Boeing, that the concept received its current name. Initially, AR required expensive custom hardware and software, leading to the development of bulky and invasive devices. Nowadays, the domain exhibits a variety of systems and equipment, ranging from stationary to mobile devices and wearables. Likewise, the applications of AR vary from individual services to industrial, military, medical, gaming, advertising, and educational contexts (Kourouthanassis, 2013).

The Reality-Virtuality Continuum

In scientific literature as well as in public discourse, augmented reality is connected to virtual reality (VR). This creates a fair amount of confusion about these two distinct terms. It is, therefore, reasonable to create a consensus of what constitutes AR and distinguish it from other related media and technology. A classification introduced by Milgram et al. (1994) establishes clarity on that matter. The scale of their Reality-Virtuality Continuum ranges between two extremes; from the entirely virtual to the entirely real. VR is situated as the virtual end of the scale, whereas AR is a subset of the mixed reality. It differs from VR in that it maintains the information of the user's environment and superimposes digital information (ibid). Effectively,

the physical surrounding serve as the backdrop for computer-generated annotations (Höllerer & Feiner, 2004).

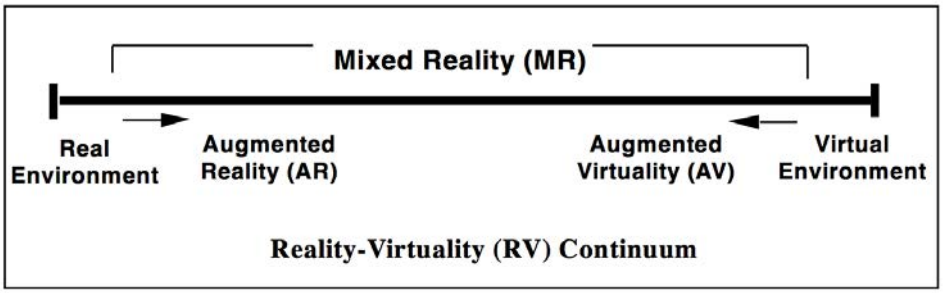

Figure 1: The Reality-Virtuality Continuum (Milgram et al., 1994, p. 283)

Examples of Augmented Reality

AR exhibits forms of acoustic, tactile, olfactory, gustatory and visual augmentation. In the following, I will briefly present examples for each sensation to illustrate the spectrum.

Acoustic Augmentation: The assistive navigation app Cydalion, directed at the blind and visually impaired, uses an array of sensors to examine areas in front of them, releasing sounds to communicate the location and distance of obstacles. (Cydalion.com, 2017)

Olfactory Augmentation: Scholars from the University of Tokyo created an application to trick the users' senses, transforming the taste of a plain 'meta cookie' to any of seven flavors. They use marker based visual AR to recognize the chosen cookie and manipulate the appearance of its texture through a visual overlay. Additionally, they use an air pump to release the corresponding smell so that users would have the impression to eat a flavored cookie instead of plain one. (Narumi et al., 2011)

Tactile Augmentation: The Disney research lab invented a tactile AR technology which manipulates the feeling of real objects using the principle of reverse electro-vibration. By injecting electrical signals on the user body, an oscillating electrical

field is created around their fingers. When sliding their fingers on an object, users perceive the object's texture differently. (Bau, O., Poupyrev, I. 2012)

Gustatory Augmentation: Scholars from the National University of Singapore explore options to simulate primary taste sensations through electrical and thermal stimulation of the human tongue. Using thermal changes and electrical stimulation, the researchers managed to induce sour, salty, bitter, minty, spicy, and sweet sensations. Currently, they are working on a lollipop-like tongue interface, to make the interaction with the device more natural. (Nimesha Ranasinghe et al., 2011)

Visual Augmentation: AR is most commonly associated with visual augmentation. Famous examples of visual AR include the mobile game Pokémon Go, which uses overlays to make Pokémon blend in with the environment of the player (Pokemongo.com, 2017), or social applications such as Snapchat, which allows users to manipulate their photo or video stream with filters which are mapped on their face (Snapchat.com, 2017)

Visual AR is the form of augmentation under study in this thesis. I will therefore move on to present its characteristics.

Characteristics and Challenges of Visual Augmented Reality

Ronald Azuma (1997) offers a widely cited definition of AR as a technology which seamlessly merges digital elements with the environment in real-time. The scholar also introduces the reader to three characteristics exhibited by AR: It must combine the real and the virtual, it must be interactive in real time and it must be registered in 3D (ibid). In the context of visual AR, this involves computer-generated graphics which are spatially registered with and overlaid on real objects in the physical world, using different display and tracking technologies (Höllerer & Feiner, 2004). Below, I will explain these characteristics in more detail.

Combining real and virtual objects involves the layering of computer generated content onto the physical world. Since the concept of AR determines that users know and feel they remain in the physical environment (Craig, 2013), the digital is not

occluding the physical completely. The visual fidelity of the augmentation significantly influences whether the user will accept them as matching the environment. Some of the greatest challenges in that regard are issues of tracking, occlusion, and illumination (Madsen, 2016).

Spatial and temporal registration is another key aspect of AR. Spatial registration demands that digital information embedded in the real world must be linked to a physical point and reliably stay at this location, regardless of where the user moves (Craig, 2013). Simple spatial registration technology makes use of fiducial markers, such as QR codes (Höllerer & Feiner, 2004). More advanced technologies interpret the environment using cameras or other sensors, such as GPS, accelerometers or gyroscopes, to determine a point of reference. Unlike fiducial tracking, these marker-less tracking systems can store environmental information (Barandiaran et al., 2010).
Temporal registration refers to the device detecting changes in the user's perspective to display the augmented objects accordingly. Every time the view changes, the data needs to be re-rendered. If users change their point of view too rapidly, problems of latency may occur, leading to visual distortions (Höllerer & Feiner, 2004).

Registration and tracking technologies work with varying precision. Depending on the field of application, the requirements hereof differ. A poster of a marketing campaign offering additional information through AR may require less accuracy as an AR game, which may need precise and stable tracking of the game objects to keep the player engaged. High precision is required, e.g., for surgical assistance applications (Madsen, 2016).

Azuma's (1997) last criterion defines AR as interactive real-time media. Interaction includes the manipulation of the object in space as well as the physical point of view (ibid). The condition of real-time means that the computations (image processing, user tracking, physical behavior, rendering, etc.) are ideally performed synchronously to the scene acquisition. This helps to achieve a fluidity and supports

the illusion of a natural scene (Valentini, 2012). By applying these criteria, media such as movies and projections are excluded from the scope.

In addition to the technical challenges mentioned above, Azuma (2016), quotes the lack of semantic understanding of the world as the most significant challenge of AR today: "[…] we have AR systems that can embed virtual 3D objects convincingly, putting them into the context of the reality, but those objects are not really connected to reality. The real world is just a background, and therefore the augmentation isn't particularly meaningful." (p. 235)

Having established a shared understanding of visual AR, I will now illuminate the specifics of mobile augmented reality.

Mobile Augmented Reality

Mobile augmented reality (MAR) refers to systems that provide AR capabilities mediated through a mobile device. This includes wearables such as HMDs and wrist-worn displays as well smartphones and tablets. Gjøsæter (2015) calls the latter handheld mobile augmented reality (HMAR). These standalone handhelds use sensors to register and track their position, overlay the world with 3D augmentations and provide an interface allowing the user to interact with them (ibid) Typical use cases for MAR fall into the categories of navigation, entertainment, information seeking or gaming (Craig, 2013).

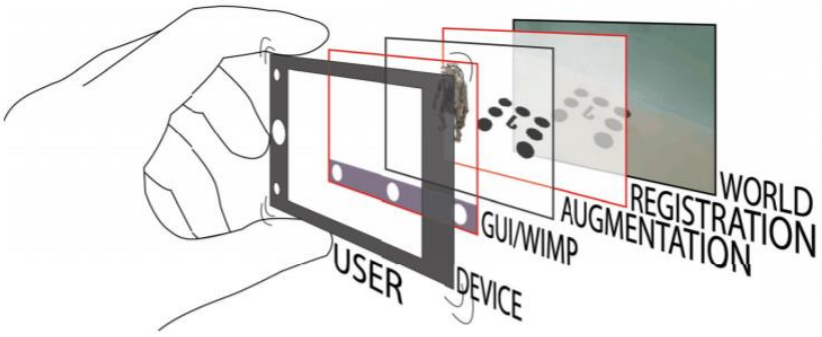

Figure 2: HMAR systems, according to Gjøsæter (2015), p. 75

The initial idea for handhelds as AR devices was brought up by Rekimoto (1996). He argued that HMDs isolate the users from the real world, whereas handhelds would

allow for a more natural interaction. The first ones develop and untethered HMAR system were Wagner and Schmalstieg (2003). One year later, Möhring et al. (2004), first brought AR to a cell phone. Since then, technology has advanced significantly. Owing to the emergence of smart phones with powerful processors, high-resolution cameras, and sensors, many people today already own potent AR hardware (Azuma, 2016).

Some scholars dismiss HMAR as inadequate to realize the full potential of AR (Rosenblum et al., 2012). Others consider it a good alternative to existing AR systems. They argue in favor of smartphones and tablets "because they are minimally intrusive, socially acceptable, readily available and highly mobile" (Brondi et al. (2008, (p. 114)) and because using an everyday device does not "remind you that you are doing something special in order to experience the augmented content" (Craig, 2013, p. 211).

The aspect of mobility brings unique design challenges for MAR applications concerning, e.g., real-time information retrieval, information visualization, object recognition and tracking and user interaction (Kourouthanassis et al., 2013; De Sá & Churchill, 2012). Other challenges concern the constraints that the respective devices are subject to, such as memory, battery life, computational capability, input and output options or screen real estate. In addition to these constraints, MAR applications are also challenged by the environmental conditions under which the user will experience the application, such as visual noise and lighting. (Craig, 2013)

User Experience

"Experience is difficult to define because it is reflexive and as ever-present as swimming in water is to a fish."

~ McCarthy & Wright, 2004, p. 15

Experience has been called a weasel word. Its notion is hard to grasp, and many definitions are characterized by vagueness and ambiguity (Lennon, 1960). Taking a pragmatist stance, McCarty and Wright (2004) relate experience to the "felt life" and its "emotional quality" (p. 12). A crucial aspect of experience is the process of sense-making, which takes place in the lights one's personal history and disposition (ibid) Thus, researchers need to consider the variety of "the liveness and feltness […], the ordinariness and enchantment, the organic rhythms and personal engagement" (ibid, p. 52). In the context of technology and product development, it is the experience of the using a product which is the pivot of interest.

Essential Characteristics of User Experience

Creating a captivating and positive user experience is a key goal in digital product and service design. Donald Norman states that "technology should bring more to peoples' lives than the improved performance of the tasks: it should add richness and enjoyment." (2004, p.111) Thus, good design seeks to induce positive emotions by taking account of the users' needs, wants, and expectations, and limit negative emotions such as frustration or boredom. (ibid) It has been agreed on that the success of, e.g., an application can be positively influenced by the extent to which they elicit positive experiences (Law, 2010) .

The term of UX is widely used, but lacks conceptual clarity. There are diverse perspectives on UX, each of them taken from different stances such as psychology, behavioral science or business. It is an umbrella term for designing and evaluation the experiences people have when using a product or service, involving their attitude, behavior, and emotions. (Roto et al., 2011) The International Organization for Standardization defines UX as "a person's perceptions and responses resulting from the use and anticipated use of a product, system or service" (ISO, org, 2017).

An exhaustive presentation and discussion of the different stances of UX would go beyond the scope of this paper. Instead, I will outline key characteristics and commonalities below.

First of all, there appears to be a consensus among many scholars that UX complements usability-centered approaches. Usability is concerned with the extent to which a user can achieve specific goals with the objects in question, whereas UX goes beyond functionality and to include aesthetics, hedonics, contextual and temporal aspects, shifting the focus from the product to the person and their context. (Forlizzi & Battarbee, 2004). Both, the functional and non-functional attributes, are of interest when evaluating the perceived quality of a product (Hassenzahl, 2010).

Secondly, there is an agreement that UX is holistic, meaning that it "emphasizes the totality of emotion, motivation, and action in a given physical and social context" (Wiklund-Engblom et al, 2009, p.666) There is a strong focus on the "felt experience," rather than the sole product attributes (ibid). In line with this, many scholars emphasize the importance of emotion, stating it is "at the heart of any human experience" (Forlizzi & Battarbee, 2004, p. 264). Emotions are known to affect decision making such as purchasing behaviour, the way people use and talk about technology (Beauregard and Corriveau 2007). Attributes such as fun, joy, and pleasure have been widely used by individuals to put their experiences in words, which implies that design should focus on these positive emotions. (Hassenzahl, 2010; Norman, 2004)

Thirdly, it is acknowledged that UX is subjective. How experience unfolds thus varies highly depending on peoples' individual differences, such as knowledge, experience, skills, personalities and physical attributes. (Beauregard and Corriveau 2007)

Lastly, it is widely agreed on that UX is dynamic and situated in place and time (Hassenzahl, 2010; McCarthy & Wright, 2004). This means that experiences vary regarding their temporal granularity and time span. One can distinguish between anticipated UX, monetary UX, episodic UX and cumulative UX. Anticipated UX entails a person's expectation before use. Momentary UX captures a distinct change of

emotion during usage. Episodic UX reflects on a usage episode in the past. Lastly, cumulative UX combines the various experiences one has had with the product over time. (Roto et. al, 2011)

I conclude this part with the remark that some of the scholars quotes above represent conflicting stances. The humanistic approach (e.g. McCarthy and Wright) is non-reductive, rejecting any attempts to operationalize experience and keeping to rich description of the unique situation instead. The approach is best suited when the experience is not yet well understood, but it does not permit any generalizations (Bardzell & Bardzell, 2015). Psychology-based approaches (e.g. Hassenzahl) on the other hand create models auf experience which are grounded in psychological research, breaking UX down into small units of analysis. Like any model, this constitutes a simplification of a complex matter, but it still contributes to an understanding and is particularly suitable in cases where experience is already well understood and accessible (ibid). In this study, the domain under examination is underexplored (AR), while other aspects are well-researched (mobile applications, games). Therefore, I lean towards a psychology-based approach.

User Experience in Games

Since the application under study is a game, it is necessary to give some considerations to the particularities of the domain as compared to other services. Pagulayan et al. (2008, pp. 884-888) articulate the differences between games and other services, which they refer to as productivity applications, by spelling out a set of principles in which they differ from one another. Four of them are outlined below.

Result vs. Process: The scholars consider productivity applications as tools which goal it is to make tasks easier, more efficient, less error-prone and to extend domains of work to a larger population. The focus of design endeavors is an improved product. Games, by contrast, are designed to stimulate pleasure and joy, with a sufficient level of challenge. The goal of the design for games is to create a pleasurable process. (ibid)

Remove Constraints vs. Impose Constraints: Another crucial difference between games and productivity applications is that games impose constraints, whereas productivity applications try to remove them. In productivity applications, constraints are usually a sign of unresolved design problems. In games, they are deliberately put to contribute to their enjoyment. Games are supposed to be challenging, which requires "a clear understanding of the difference between good challenges and frustrating usability problems." (ibid, p. 889) Also, the challenge level in a game should increase to keep the player interested and address different skill levels. (Pagulayan et al. ,2008)

Importing Goals vs. Defining Goals: In productivity applications, the goals of the users are usually defined by the external environment; setting up a deck of slides for a presentation, measuring the dimensions of a table or finding the way to the restaurant one booked a table for. Games, on the other hand, define their own goals, which are set completely in an artificial world. Communicating these goals to the players are usually achieved through progressive storytelling and in-game tutorials. The primary goal of most games is to acquire all the available rewards or knowledge inside of it. (ibid)

Function vs. Mood: Productivity applications use graphics and sounds to convey function, such as a feedback sound of a button. Games use them to create a whole environment and atmosphere. (ibid)

A positive game experience is attributed to its potential to immediately, consistently and meaningfully satisfy intrinsic needs. Games can provide the player with mechanism and opportunities to nurture needs of autonomy, competence, and relatedness. (Rigby & Ryan, 2011). The ultimate emotional state users expect from games is fun. Fun can lie, for instance, in a game's "ability to challenge, to bring people together or to simply experience unusual phenomena" (Pagulayan et al., 2008, p. 892). To create a fun game, designers need to empathize with their audience and carefully construct "an experience that causes them to think clever thoughts and feel profound emotions" (ibid, p. 891). A popular framework for game design is the elemental tetrad developed by Schell (2015). He proposes designers to approach

their craft through the lenses of Mechanics (procedures and rules behind the game, e.g. the goal and the game logic), Story (the sequence of events), Aesthetics (how the game looks, sounds, smells, tastes and feels) and Technology (the technology and material the game consists of).

The tetrad illustrates the different components in games which influence the overall user experience. However, a core concept of UX research in games is the “essential but elusive quality” that constitutes the gameplay experience (Ermi and Mäyrä, 2005, p. 2). It emerges as a result of the unique interaction between the player and the game and is defined as "an ensemble made of the player's sensations, thoughts, feelings, actions, and meaning-making in a gameplay setting" (ibid). Gameplay experience relates to the need of competence proposed by Rigby and Ryan (2011), and a body of research suggests it might be the most important factor contributing to the positive experience of games. (Uysal and Yildirim, 2016).

Gameplay quality is the result of the balancing act between the skills of the player and the challenges of the game (Ermi and Mäyrä, 2005). A particular successful balance between the players' abilities and the level of challenge can lead to a state of flow. Flow is a highly rewarding state of absorption in one's activity that is connected with a loss of sense of time (Csikszentmihalyi, 1990). Due to their challenges and immediate feedback, games qualify for flow-like experiences (Emri & Mäyra, 2005). Related concepts in the context of games are immersion and presence. The latter represents a psychological state of "the sense of being in an environment" (Steuer, 1992, p. 75) as well as the "subjective experience that a particular object exists in a user's environment” (Stevens and Jerrams-Smith 2001, p. 194). Similarly, the concept of immersion signifies as “the sensation of being surrounded by a completely other reality […] that takes over all of our attention” (Murray, 1997, p. 98). These concepts overlap and are often used interchangeably. Ermi and Mäyrä (2005) speak in favor of using the term of immersion in the context of games. Their gameplay experience reflects the spectrum of immersion. Sensory immersion is related to the audio-visual execution of the game. Impressive graphics and captivating sound design can make the player get lost in the game worlds stimuli. Challenge-based immersion refers to the balance of the game's challenges and the player's abilities described above. Motor skills or mental skills such as

problem-solving. Imaginative immersion relates to the game's world, its characters, and the story elements. (Emri & Märyaä, 2005)

All of these aspects are likely to play a role in the UX of the MAR game under examination and have to be taken into account during the research process.

User Experience Evaluation

Evaluation can be defined as the provision of empirically-driven feedback, the "systematic acquisition, and assessment of information that provides useful feedback about the service in question" (Olsson, 2013, p. 205 . Depending on the object under study and its purpose, there are different types of evaluations. A fundamental distinction is that between formative and summative evaluation. Formative evaluations aim at improving an object, examining its distinct features and their quality from the experiential standpoint. Summative evaluations assess the overall quality of the object, determining whether it can do what is was designed for (Roto et al., 2010). Since UX is holistic and highly subjective, each research problem requires careful consideration about what to measure, how to triangulate the data and how to evaluate and interpret it. This holds equally true for the evaluation of games. (Pagulayan et al., 2008)

Methodological considerations for UX evaluations as presented by Olsson (2013) may guide the research design. To start with, he postulated that UX measurements should be self-reported to cope with the subjective nature of UX (Law and Schaik, 2010). As experiences are mostly conscious and cognitively processed, they are hard capture through objective measures, such as eye-tracking or observations. It requires the user to process and reflect on their experience in order identify and verbalize the experience. (Olsson, 2013) Also, it is deemed valuable to allow the experience to take place in an authentic setting. In other words, field studies should be chosen in favor of lab studies (Fields et al., 2007). Olsson (2013) stresses the significance of this for AR applications, as their experience builds in the idea of mixing reality with the physical. Next, he urges triangulation of data to get broader insights and a greater coverage of UX phenomena, e.g., combining quantitative data with qualitative insights. Whereas quantitative data can give insights about, e.g., the

most satisfying and least satisfying feature or aspect of a service, qualitative insights may reveal issues which might be representative of the whole application area. In the context of game evaluations, Pagulayan et al. (2008) suggest collecting both, behavioral and attitudinal data. Behavioural data is observable data based on the performance of the participant. Attitudinal data refers to the participant's needs, feelings, opinions and views. Furthermore, Olsson (2013) elaborates on the issue of temporal granularity of UX. To cover UX holistically, researchers should aim to cover all the levels of temporal granularity of use.

There are several methods for UX evaluation, yet there are rarely any widely accepted standards methods. Additionally, they are limited in their ability to capture the experience in 'its totality, in all its richness' (Vermeeren et al. (2010, p. 4). A meta study on UX evaluation identified 96 different methods (ibid). These vary regarding the nature and sources of the data gathered, the period of the experience examined, the location in which the method is used, the development phase the data should be gathered in plus the different dimensions of UX covered. In conclusion, they postulate a need for validated methods for certain experiences and domains and a better understanding of UX in general.
On that note, Olsson (2013) criticised these methods to lack metrics to assess new domains, such as AR. He argues: "It is not the novelty of technology per se that requires specific measures but the activities and interaction it allows and the experiences that these create. It is the interaction and the experiences that matter and are explicit to human—not the underlying technology." (ibid, p. 207)

Thus, he proposes a framework which seeks to capture the experience of AR.

Olsson's UX Evaluation Framework for MAR

Following this reasoning, Olsson consolidated a UX evaluation framework specifically for mobile augmented reality, incorporating the findings of previous research of his about user's expectations of and early experiences with mobile AR (Olsson & Salo, 2011; . Olsson & Väänänen-Vainio-Mattila , 2011; Olsson et al., 2009; Olsson et al,. 2011; 2011; Olsson et al., 2012). The scenarios and use contexts examined were location-dependent information and advertising, navigation,

shopping, virtual makeovers, street art, and tourism. The framework is rooted in a psychological approach to UX. Using the generic model of product experience by Buccini and Padovani (2007) to frame them, he developed 6 classes and 16 characteristics of desirable experiences related to MAR. The categories of experience have been placed in the classes which they primarily belong to. Olsson notes that the classification is not exclusionary, as some experience categories might be related to other classes as well. Also, the experiences are not necessarily exclusive to MAR per se, but relevant to the user's expectations towards MAR services as a whole (Olsson, 2013). Some of the categories might be more applicable to some services than others; games, for example, have not been an object of study in his researches.

Olsson's framework does not raise claims to completeness. He admits to the challenge of capturing UX in its entity and to dissect in its components. Other aspects affecting UX not related to the product or service design itself, such as pricing, branding or social acceptance, have been deliberately excluded by the scholar.

CLASSES	CATEGORIES
Instrumental experiences Pragmatic experiences originating from utility, user's accomplishment, product performance, and support for the user's activities.	**1. Empowerment** relates to the feeling of being provided with novel possibilities, instruments and ways of accessing, creating, and utilizing information. **2. Efficiency** describes the feeling of being able to perform everyday tasks and activities with less effort, time and other resources. **3. Meaningfulness** relates to the AR service appearing personally meaningful, appropriate and relevant in the user's current context and the activity one is engaged in.
Cognitive and epistemic Experiences. Experiences related to thoughts, human information processing, and rationality. Stemming from the product's or service's semantic features and abilities to arouse curiosity and satisfy a desire for knowledge.	**4. Awareness** describes the increased insight into one's surroundings and the related digital elements. **5. Intuitiveness** relates to the feeling of naturalness and human-likeness in interacting with the AR information.

Table 1: Olsson's (2013, p. 213 ff.) Desirable UX for MAR framework,(continues on next page)

CLASSES	CATEGORIES
Emotional Experiences. Experiences related to the subjective emotional reactions originated from the use of a product: for example, pleasure, entertainment, evoking memories and facilitating positively valued feelings overall.	**6. Amazement** relates to the feeling of having experienced or achieved something extraordinary or novel, hence often represented as "wow"-effect. **7. Surprise** is due to receiving contextually relevant, extraordinary, and useful information, and surpassed expectations in general. **8. Playfulness** refers to feelings of joy, amusement, and playfulness. **9. Liveliness** relates to the feeling of continuous change and accumulation of the service.
Sensory Experiences Experiences related to instinctive, non-cognitive sense related experiences. These originate from a product's or service's ability to arouse sensory and physical pleasure. The categories here are sensory by origin but also contain cognitive aspects and can be conscious too.	**10. Captivation** describes the feeling of being immersed and engaged in the interaction with the environment enriched with AR content. It relates both to the user's sensory-perceptual impacts and the spatial engagement and enjoyment of the imaginary world created by the system. **11. Tangibility and transparency** describe the senses of concreteness and coherence of environment-related content and the resulted augmented environment.
Social Experiences Experiences related to and originate from human to human interactions that are intermediated by technology. These originate from features that allow building or communicating one's identity or status, provide a channel for self-expression, or otherwise support social user values.	**12. Collectivity and Connectedness** relate to the feelings of participating in a user community, having novel ways for social interaction and communication, and being aware of other people using the AR service. **13. Privacy** relates here both to the sense of privacy resulting from how much and what kind of information about the user is logged by the service and publicly available, and the sense of social awkwardness that results from the obtrusive way of interacting with mobile AR. .
Motivational and Behavioral Experiences Experiences that are created when the use or own a product or service causes a certain behavior in the users: for example, inspires or motivates them to do something or pursue a goal with the help of technology.	**14. Inspiration** relates to feelings of being cognitively stimulated, curious and eager to try new things or appropriate the AR services for new purposes. **15. Motivation** relates to the feeling of being encouraged and motivated to participate in the service community or to do tedious, mundane tasks with the help of information technology. **16. Creativity** represents self-expressive and artistic feelings in users creating AR content and in mixing the digital with the real world in previously unimaginable ways.

Table 2: Olsson's (2013, p. 213 ff.) Desirable UX for MAR framework (continued)

Additionally, Olsson presents a model which illustrates which components of MAR services contribute to the different experiences. The model is based on the theoretical foundations of Hassenzahl (2004), who declares content, functionalities, presentation, and interaction to be central features of a product. The interplay of these features makes up the products character, which, as a consequence, elicits certain desired or undesired emotional responses in the user. On this model, Olsson mapped the AR service components which he considers to, individually or jointly, play a role in eliciting said experiences. The components vary in how specific to AR they are; still, they affect the overall experience of MAR since "…the potential users' expectations of AR services are often directed to other technological layers than AR per se." (Olsson, 2013, p. 219).

COMPONENT	DESCRIPTION
Augmentation	Characteristics of augmented reality as the system output, that is, an egocentric view, 3D and realistic spatial alignment and rendering with appropriate occlusions, lighting, shadows and reflections, and visualizing digital interactivity affordances in the environment.
Interaction and control	The way of controlling and providing input to the service and required mobile devices, and interacting with the AR content.
Information embedding	Real-world objects and locations embedded with or linked to additional digital content that is accessed with AR and computer vision.
Community-created content	User-created content, crowd sourcing and collaboration in content authoring and the content being modifiable and increasable by the service users.
Context-sensitivity and proactivity	Service functionalities and content being determined by and adaptive to the user's context, such as location and social surroundings, and proactively initiating interaction with the user.
Mobility	The technology being usable in mobile contexts and activities, and allowing "anytime, anywhere" and "in situ" kind of interactions; mobile devices as interaction devices. This can be seen as an overarching component behind all of the others and thus partly contribute to all of the experiences.

Table 3: Olsson's (2013, p. 219 f.) component model

Lastly, Olsson (2013) provides instruments for evaluation in the form of sets of subjective statements related to the different categories of UX in MAR to evaluate the user's subjective insights. However, these items have not been used yet in any

studies; thus, they are not empirically validated. He encourages the research community to make use of them in the context of real cases for validation and refinement.

This study, however, refrains from testing the quantitative items. Instead, it draws inspiration from Olsson's framework and model to gain an understanding of the UX of an MAR game in a qualitative manner. Since this framework captures the particularities of MAR and is grounded in the psychological approach to UX, I deem it as an appropriate point of departure for this study.

Related Work

Several scholars have carried out analytic reviews of published papers in the field of AR, with a focus on papers presented at relevant conferences (Swan and Gabbard (2005), Zhou et al. (2008), Dünser et al. (2008)). They found the majority of the papers to be dedicated to technological development efforts. Challenges in tracking, lighting, and rendering persist and inspire a significant body of research. Zhou et al. (2008) observed that most AR applications being researched are prototypes and serve as a demonstration of technological capabilities. Swan and Gabbard (2005) note a shortage of user studies in the field of AR, which is confirmed by Dünser et al. (2008), who claim that only 10% of the screened papers include some user study. If the field of interested is narrowed down to MAR and HMAR, the results are even more scarce, as a more recent review by De Sà and Churchill (2013) attests. On a similar note, Irshad and Rambli (2014) reviewed the publications covering the topic of UX in MAR of digital databases and libraries such as ACM, IEE Xplorer, and Springer Link. They were able to identify 35 papers which had been published in the previous ten years, of which again only a fraction dealt with user studies or UX evaluations.

In the following, I will briefly present a few selected papers which have employed in-situ user studies to examine UX factors for high-fidelity prototypes or mature MAR applications.

You et al. (2008) conducted an extensive and multi-staged field study to evaluate the users' interaction with a treasure hunt MAR game. A range of data collection

methods and tools were used to assess the application, collecting quantitative data through logs and qualitative data through observations, contextual inquiry, interviews, and questionnaires. The paper reports on factors which have an impact on the experience of the game, including contextual issues, setup difficulties, and game mechanics.

Wetzel et al. (2012) developed a location-aware AR game for an ultra-mobile PC. They conducted a study with 60 players to explore the relationship between game design and the experience of presence. They let users play the game in Cologne and used a spatial presence questionnaire, video recordings, and open-ended interviews, connecting in-situ data with post-experience analysis. They conclude that visual realism is not necessary for an immersive experience, and can be bridged by characters, content and a compelling narrative.

Kourouthanassis et al. (2015) explored the adoption of an AR travel guide through their emotional impact. They recruited participants who were vacationing and let them use the app for the time of their stay, evaluating their experience with a questionnaire combining validated items from technology acceptance and consumer behavior theory. They found that application triggers feelings of pleasure and arousal, which has an impact on the behavioral intention of using it.

Albeit the interest in the topic of UX in MAR is increasing in recent years, it can still be considered a niche, which calls for further research endeavors. De Sà and Churchill (2013) dwell on the reasons for the scarcity of research and propose:

> "Assessment of the usability of the specific interface or interaction design features yield well to laboratory-based evaluation of static of minimally interactive mock-ups [...], but full-service ecosystem design, such as those imagined for mobile AR applications do not yield so well to such methods. To be able to offer effective feedback, users need to be able to experience MAR services and applications as they are intended to be experienced: "in the wild" with interactive experiences and data presented in real-time." (p. 142)

This study aims to address the niche and contribute to the knowledge of the domain by conducting a study of a mature MAR application in the field.

Methodology

The following chapter describes the methodology used to understand the UX of MAR. The research process can be summarized as follows:

1. Identification of the case, the game WOORLD by Funomena. Analysis of WOORLD's components through the lens of Olsson's (2013) and Schell's (2015) frameworks
2. Development and pre-test of research design. Recruitment of participants
3. Briefing of the participants through AR info sheet (see Appendix a)
4. Execution: Semi-structured interviews about previous experiences with and expectations of AR, using Critical Incident Technique. Observation of participants during an open test of the game in the field. Subsequently, semi-structured interview about the experience, using Critical Incident Technique and retrospective Think-Aloud. (see Appendix b for Interview/Session Guide)
5. Analysis of data

Research Philosophy

Ontological perspective

In line with the shared understanding among scholars, this study approaches UX from a subjective perspective. Through the users' individual views, it aims to identify the kind of experiences evoked by the application and the components influencing the experience. I take the stance that the reality I am researching is intersubjective and based on meaning and understanding. Individual perceptions of the experience are likely to vary, depending on factors such as individual predispositions, personal values and attitudes. It can be assumed that e.g. a person with an affinity for games will engage more in the application than a person with no such tendency. The subjective approach allows for a more complete picture of the elusive concept that is an experience.

Epistemological perspective

According to Creswell (2002), one criterion in deciding on a research approach is the nature of the topic. With a lot of previous research, developing propositions is easier and a deductive approach is standing to reason, whereas little previous research usually requires an inductive approach that develops new propositions. In this case, there exists ample literature on the topic of user experience and its evaluation, yet rather little in terms of mobile augmented reality. Therefore, I will involve both, inductive and deductive reasoning and use evidence both as "the genesis for" and "in support of" a conclusion (Snape & Spencer, 2003, p. 14).

In order to acknowledge the subjectivity and situatedness of UX, this study follows an interpretivist research philosophy. The paradigm considers "people, and their interpretations, perceptions, meanings and understandings, as the primary data source" (Mason, 2002, p. 56). It builds on the intellectual traditions of phenomenology and symbolic interactionism. As such, it advocates the importance of understanding the human being as a social actor, who make sense of their role and those of others based on their own individual set of meanings (Saunders et al., 2009). By adopting this perspective, I acknowledge the importance of subjective experiences, which relates to the participants of this study as much as it does to myself as a researcher. I am aware that I am subject to my own beliefs and values, which impact the interpretation of the data and outcome of the study (ibid).

Research Design

My research interest lies in the investigation of the UX of MAR, as well as in understanding the influence of the service components to the experience. I adopt a descriptive case study approach with Funomena's AR game WOORLD being the application under investigation. Yin (2009) offers the definition of a case study as an empirical inquiry into the investigation of "a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p. 18). Descriptive case studies are usually based on existing theoretical models. However, there can be reasons to deviate from the model, e.g. when the goal of the study is to document the

phenomenon as completely as possible, without restricting it to evidence that has been found in earlier studies. (Yin, 2009)

This study can be considered a summative evaluation of the application. Because UX is subjective and situated, it is the informants who play the lead in this research. Therefore, the overall methodology of this project is qualitative. Qualitative methods are appropriate in this context, since they focus on contextualizing, interpreting and understanding the user, rather than quantifying a concept. They allow the researcher to shed light on the "how" and "why" of a phenomenon (Flick, 2002). Especially when carried out in the field, qualitative methods have the potential to allow the researchers to gain access to the rich nature of experience. (Wright and McCarthy, 2010).

The study captures behavioral as well as attitudinal data. It combines interviews and observation of the participant playing the game, allowing insights from the latter to inform the former. The sessions consisting of pre-test interview, game test and observation, and post-test interview lasted between 90 and 160 minutes. The research mainly covers the episodic UX, relying on self-reported reflections on their first-time user experience right after trying the application. It is executed in the field, meaning I conducted the research within the participants' own four walls, which is the natural setting to play the game in. The analysis is anchored in Olsson's frameworks, which serves a guiding principle but still allows openness to other evidence or emerging themes. Thus, the analysis work in this study is both, inductive and deductive, as I moved back and forth between evidence and theory.

A convenient and purposive sampling approach was adopted for this study, with the goal of recruiting participants who illuminate the research interests best. (Creswell, 2002) I was not interested in extreme cases, but I was rather looking for a more homogenous and typical sample. Sampling was attached to the conditions that the participants must be owners and daily users of smartphones, be somewhat interested in technological development and be familiar with the concept of AR. I recruited 2 female and 3 male participants who met these conditions from my circle of acquaintances. The participants have been sent an information sheet on MAR before the research to ensure a common understanding of AR and avoid confusion with VR. *(see Appendix a)*

Methods

Semi-Structured Interviews

An interview can be defined as „a conversation with a purpose“ (Dexter, 1970, p. 136), with the purpose being to gather information about a phenomenon. It is a suitable method that researchers can use to explore concepts like experiences, which are difficult to observe, or hard to operationalize and quantify. McCarthy and Wright (2010) state that narratives and conversations are the primary tools for the researcher to understand and make sense of user experiences. It requires the participants to commit to reflect and construct their experiences, and for the researcher to establish an empathic mindset and co-construct the experience in dialogue. (ibid) The validity of interviews can suffer from inaccuracies due to poor recall, response bias and reflexivity on the participants' side. Researchers can introduce bias to interviews through poorly articulated questions. (Yin, 2009)

In this study, I conducted two semi-structured interviews respectively. The first interview was held before the participants tried the application. It included icebreaker questions about their background, as well as their affinity for technology and games. Then, I proceeded to ask the participants about previous experiences with MAR applications. Here, I drew upon the critical incident technique, which tries to gather most significant experiences during the usage of the respective application. Asking for single remarkable experiences reduces the cognitive load for users, as they are easier to remember (Gremler, 2004). I encouraged the participants to include as much context to their narrative as possible. Lastly, I asked the participants to imagine the best version of the application in question. The goal of this interview was to get an idea of the participants’ expectations of AR.

The second interview was conducted after the users had tested the application. The questions were primarily inspired by the observations from the test sessions. After getting some general impressions from the participants, I guided them through their experience by recalling specific situations that occurred during the test. This approach can be considered an adaption of the retrospective think aloud. In this case, the technique was adapted to elicit participants feeling and emotions during

the test (Petrie & Precious, 2010). Again, I made use of the critical incident technique to let users reflect on the most and least satisfying experience with the application.

Direct Observation

Direct observation of the participants using the application in the field is meant to cover relevant behavioral or environmental insights. Observational evidence can provide additional valuable information on the phenomenon under study. The challenge behind observations is that the presence of the researcher can influence the proceeding of the event itself, since the participants are aware of being watched. On a different note, the researcher might unconsciously manipulate the events. (Yin, 2009)

In this study, the participants were asked to use the application and play the game. It was an open use situation, meaning that almost no further instructions or goals were given, and that the test was taking place in the field, the participant's homes. The only instruction given was to save and load the game at one point. Otherwise, it was free exploration. If the users managed to finish the game, they could choose to try the sandbox mode of the game as well. In general, the sessions varied a lot in length, depending on the participants' motivation. The observation ended when the users finished the game or lost interest. The participants were encouraged to express themselves and share their thoughts during the experience. However, I did not remind them to do so during the actual test, since I did not want to pull the participants out of the experience. I shadowed them during the test and retained from interfering, not commenting or helping the participants. Only if they had been stuck for a while and reached out to me, I would give them a hint.

The initial technical setup for the observation had to be adapted due to limitations of the equipment and technical difficulties. At first, I casted the screen of the Lenovo Phab 2 Pro in my computer to create a screen recording. Unfortunately, the connection was not stable and the phone seemed to have issues running both at the same time. Furthermore, I had only one static camera to capture the movements of the participants. They would easily move out of the range of the camera or turn their backs, which made the recordings not very useful. Since I needed to take notes for the subsequent interviews, I could not carry the camera around. It would have required at least as second researcher to make this work. Another option would

have been to spread the test and the post-test interview on two separate days. In that case, I would have been able to follow the participant around with the camera, go through the material afterwards, take notes and set markers for important scenes which could have been showed to the participants during the interview to help them reflect on their experiences. However, since I had only limited access to the test device, I had to complete the test and the interviews within one week.Therefore, the observation notes rely on the notes taken in the moment plus some additional information from the recordings.

Application Analysis

Besides capturing the participants' view, I played the app myself and analyzed its characteristics through the lens of Olsson's (2013) component model. This allowed me to get an initial understanding of the object under study. A summary is part of the case presentation of WOORLD.

Data Analysis

After each observation session, I did a quick summary of the observation notes. Later, I went through the video recordings to add evidence I may have missed. The interviews were analyzed via affinity diagramming, using an online whiteboard tool. Affinity diagramming is a tool that identifies themes and patterns from raw qualitative data. This is achieved by organizing the data, such as statements, interjections, expressions or gestures, into related clusters, after which the clusters are labeled thematically. These clusters may be predetermined, or they may emerge during analysis (Sower, 2010, Kuniavsky, M. 2003). I am taking on a mixed approach for the data analysis. Olssons's frameworks are the guiding threads for the data management and analysis. Frameworks are often associated with purely deductive approaches to research, as they pre-define themes and codes based on previous findings or literature. However, Gale et al. (2013) stress that frameworks do not have per se an "allegiance to either inductive or deductive thematic analysis." They deem combined approach of inductive and deductive qualitative analysis as appropriate if the research project aims to explore specific issues but still wants to stay receptive to "unexpected aspects of the participants' experience or the way they assign meaning to phenomena." (ibid) Therefore, I applied both inductive and

deductive approach to the analysis, using the frameworks to guide theme development, but also to create new emerging themes. I analyzed the interviews and observations notes to find direct or indirect statements, negations or observations tracing to different experiences. For instance, "I felt kind of stupid. […] I was stuck quite often." was interpreted as a negative experience related to *Efficacy & Mastery*, even though it was not explicitly mentioned. The data was then consolidated in the discussion with my findings from the application analysis.

Methodological Critique

Validity

In qualitative research, the concept of validity means that the study "represents accurately those features of the phenomena that it is intended to describe, explain or theorize" (Hammersley, 1992, p. 69). In this research, this condition translates to the question of whether the framework, the choice of methods, the analysis, the recruiting of the participants and the overall execution satisfy the purpose of studying the UX of MAR. Based on the deliberations on the methods above, I believe that qualitative data in the form of retrospective self-reporting and observation is suitable to capture the experience. The triangulation of methods can strengthen the validity of the single case. Still, the validity of this study might be threatened. I will discuss this by referring to three different types if triangulation.

Data Triangulation is achieved when a study uses different sources of information to increase the validity (Saunders, 2009). My primary data source were the 5 participants, who had a homogenous background. Involving e.g. UX experts to evaluate the app would have been a way to triangulate the data.

Investigator triangulation relates to involving several researchers during the analysis process. Ideally, the identification and consolidation of themes would have been conducted by at least two people. It is assumed that if several researchers arrive at the same conclusion from the analysis process, then the validity of the findings is heightened. This is also known as inter-rater reliability. (Saunders, 2009) However, I executed this research alone. Also, from an interpretivist stance, I acknowledge my own bias and influence on the outcome.

Methodological Triangulation involves the combination of at least two methodological approaches. The idea is that if the data sets from different sources support one another and arrive at the same conclusion, validity is established. (ibid) In this study, I make use of interviews and observations to nurture the evidence. Due to the challenges cited before, the data generated from the observations is not as thick as planned, and it was to a large extent used to inform the following interviews. Still, the data could support the points being made in the interview, e.g. in the case of immersion or a sense of presence.I considered triangulation via quantitative methods but ultimately dismissed this for various reasons. First of all, the survey items proposed by Olsson (2013) are not validated and would need further testing and refinement before use, which I would not have been able to deliver in the time given. Before the actual study, I tested the research design with two persons, including an adapted set of the survey items. The responses were discussed in the post-test-interview. In this context, I also asked the participants to explain to me how they understood the different terms and items. The results confirmed that the items are ambiguous, as the two participants had very different interpretation of them. Secondly, the application under study is not well known. It is only available on the Lenovo Phab 2 Pro and the Google Tango Device Kit only. WOORLD has been downloaded between 5.000–10.000 times thus far (Play.Google.com, 2017b), compared to, e.g., Pokémon GO, which registers between 100.000.000–500.000.000 installations on the Android Store alone (Play.Google.com, 2017b). It seems improbable that I would have found a statistically significant amount of people to participate in a survey.

Generalizability

Generalizability refers to the likelihood of the findings in one setting applying to another setting. Yin (2009) suggests that the results of a case study research can be transferable, which means they are applicable or relevant in a similar context. However, as opposed to multiple case studies, single case studies usually do not provide sufficient evidence to extrapolate the findings. However, it has not been this study's goal to generate results that are generalizable to other contexts or populations, but rather, to contribute to the understanding of UX and MAR in the context of games.

The Case

Having decided on the methodology, this section now sets out to introduce the case under study. It introduces the technology as well as the application in order to give context to the research an allow readers to compare the results to other academic work.

Google's Tango Project

Tango is an AR platform developed and authored by Google. It allows standalone mobile devices to understand their orientation and position relative to the world around them. Tango-enabled devices feature two cameras, sensor timestamping, and a software stack enabling motion tracking, area learning, and depth sensing. (Developers.Google.com, 2017a) Below, I briefly outline the core concepts of Google Tango.

Motion tracking: Tango gives a device the ability to detect its position as it moves in the environment. It can detect where it is and where it is facing, using visual features of an area in combination with visual-inertial odometry. Still, there are notable limitations to the tracking abilities. For instance, the device is not able to 'remember' previous trackings but starts over every time one initiates a session. Also, an accumulation of small errors over a longer period can lead to digital objects to drift and to look out of place. (Developers.Google.com, 2017b)

Area learning: Area learning allows it to store and reuse the information of the environment which is acquired through motion tracking. By recognizing key features, such as corners and edges, the device can locate itself within a previously learned space. Area learning can also improve drift corrections and increase the accuracy of the trajectory. *(*Developers.Google.com, 2017c*)*

Depth perception: Depth perception allows a device to determine the distance to objects in the physical world. For example, it enables the user to detect when a user is approaching a wall. Depth technologies implemented in Tango-enabled devices comprise Structured Light and Time of Flight, which make use of infrared sensors, as well as Stereo. (Developers.Google.com, 2017d)

Google Tango's AR capabilities are ahead of other commercially available product in the market place due to the functionalities outlined above, which is why I chose an app running on the Lenovo Phab 2 Pro (Lenovo.com, 2017) for this study.

WOORLD by Funomena

WOORLD[3] is an experimental game developed by the game studio Funomena in cooperation with Google, with the goal to demonstrate the AR capabilities of the Google Tango project. WOORLD transform the user's space into a virtual playground which they can interact with through the touch interface of their device. The game is advertised as a "unique and friendly augmented reality experience," which "lets you decorate your space with fantastical objects and then see how they interact in silly, playful ways" (Funomena.com, 2017). The game starts out with the player scanning the walls, floor and ceiling of the room. The player is then tasked with discovering and placing digital objects on walls, ceilings, and other surfaces, figuring out how to interact with them and collecting certain game objects to achieve the game's goal, after which a sandbox mode is unlocked.

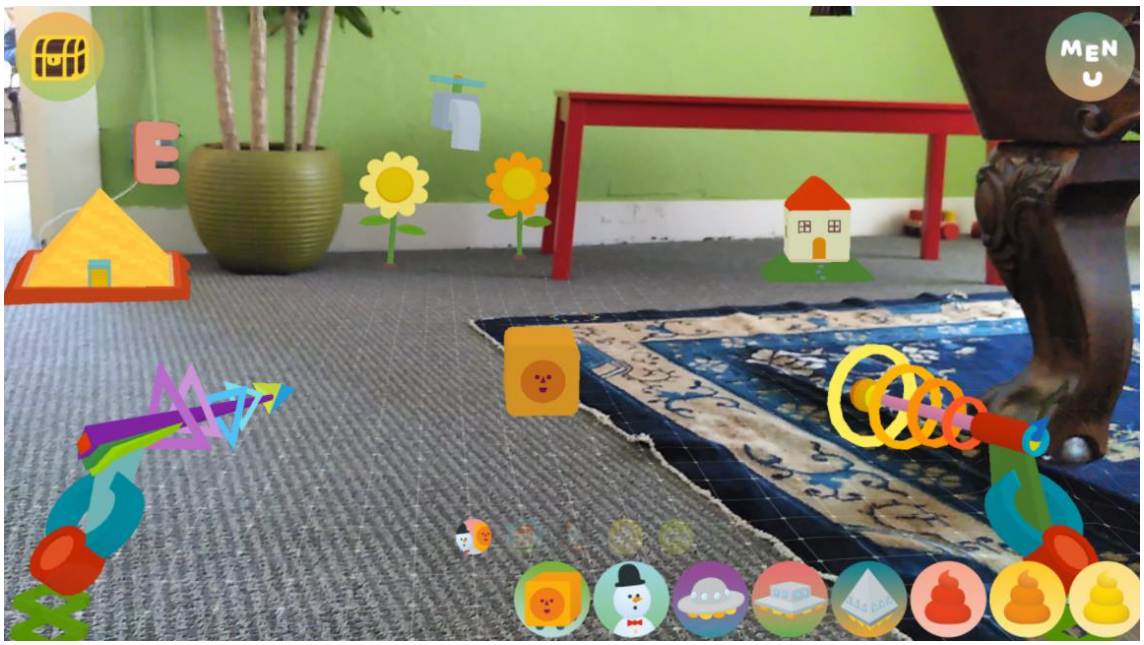

Figure 3 WOORLD screenshot.[4]

[3] See the video "Introducing WOORLD" on YouTube: www.youtube.com/watch?v=AgSYwL-PjfE
[4] Retrieved from https://play.google.com/store/apps/details?id=com.Funomena.TangoWoorld

The reason I chose this application for this thesis is two-fold. First of all, it is developed for Google Tango, thus making use of state-of-the-art mobile AR technology, showcasing what current AR is capable of. Secondly, WOORLD also allows for more exploration than other apps. The other applications available for the Lenovo Phab 2 Pro would let the user perform one specific task only or let them simply place AR objects in the room with little to no way of interacting with them. With its state-of-the-art technology and general openness, WOORLD makes for an interesting case to investigate.

In the following, I present a concise analysis of the game's characteristics through the lens of Schell's (2015) elemental tetrad developed by and Olsson's (2013) component.

Aspects of Game Design

Mechanics

WOORLD is defined by simple and repetitive mechanics. The game offers two different modes. In sandbox mode, players can freely place digital objects in their environment. This mode is unlocked after the story mode has been completed. The story mode offers a more guided experience of the game. The principles are taught to the player through a staged tutorial. The central aspect of the game is to discover new objects, which appear in the environment or through interaction with the games' characters or objects. A new object appears as a spinning token. If the player taps on it, it will move into his inventory. From there, the player can place the object in the environment using a gripper arm button and freely drag and drop them around. Most objects can be arranged freely, whereas some, such as the sun, the moon and clouds need to be placed on the ceiling. Tapping on an object will open a 2D menu which shows icons, indicating the interaction possibilities. Clicking on the icon will start the interaction if all the game objects necessary are placed in the scene. Successful interactions usually trigger an event that moves the game forward. Even though there is room for free play and exploration, I would argue that it is still a rather linear experience. The ultimate goal of the game is to collect four different kinds of rockets. If the player succeeds to do so, the main character will ride the rockets and 'break' through the ceiling, and the game is finished.

Aesthetics

The game's aesthetics are strongly influenced by the style of its designer, Keita Takahashi. The game objects are abstract and colorful, and they appear to be out of a cartoon world. The music and sound effects can be described as playful and cherish. The aesthetics make it easy to accept the fantastic elements of the game, but they could potentially also create a break from the environment.

Story

The game does not focus on narratives but rather in the sandbox-experience. Even the narrative driving the story mode appears to be subtle and is told implicitly. It comprises the quest of finding the rockets and helping the main character to get home.

Aspects of Augmentation

The game offers an egocentric view of the world. In the beginning, the player is asked to scan the room. After the scan is finished and the app has detected walls, the floor, and the ceiling, the game starts. Throughout the game, the app performs constant dynamic mashing, so that the player can expand the space during play (Ha, 2017). The app can detect obstacles such as chairs and tables, but the simpler the environment, the less error prone the augmentation. It works properly in well-lit environments but has difficulties with darker rooms, glass walls or windows.

Depending on how well the area has been mapped, the app shows sophisticated behavior regarding occlusion. One can see the characters disappear under the furniture, but it does not work with the limbs of the human body. To ensure the player will not forget about game objects which are occluded by physical objects in the real world, the app shows the silhouettes of the game object. Lighting and shadows are one of the biggest challenges in AR, but these are largely ignored in the context of the cartoonish style. Apart from placing objects in the environment, the application also plays with environment subtraction, e.g. simulating a hole in the ceiling. In particular interactions, the camera feed is manipulated, tinting the image on the phone. For example, interacting with the ‘moon' game will ‘darken' the environment.

Most of the objects defer any logic from the physical world, meaning they can be placed anywhere, grown out of proportion and behave in strange manners. Some have been equipped with physical characteristics. This applies to the game objects ‘moon', ‘cloud' and ‘sun,' which, if correctly placed, hang from the ceiling on a spiral cable. When pulling the object, one can feel the drag. Letting go of the object will make it bounce back and dangle. Also, the game has a collider attached to the camera, which pushes away any objects which are in the way. Respectively, the player can ‘feel' a bump.

The game makes use of direct and indirect affordances to guide the player's attention. The on screen 2D UI features the inventory, the game menu, the objects menus and hints. The game also provides visual and acoustic feedback if something is missing to perform a certain action. Furthermore, the game makes use of visual metaphors to indicate points of interest. Any object the player has not interacted with yet will display moving question marks.
Guiding the player's attention is challenging in AR, as they have full control over the camera and view. Most of the time, the location of the camera is tracked, and game objects will appear in the sight field. Other times, the camera is attached to the game character or an object. Some game objects use VFX trails to guide the player's attention to a specific spot on the ground. (Ha, 2017).

To save the progress and reload the game, the app needs to remember where the player placed the objects. It does so by determining a fixed spot and calculating the difference in relation to that (Ha, 2017). To save, the player takes a picture of a ‘memorable spot' in their room. The camera detects the edges of the physical objects and saves an image of its silhouettes and the positions of the objects in relation to that. To reload the game, the player must align the saved silhouette with the objects of the real world.

The AR technology has no semantic abilities. Thus, it does not understand whether the game is placed in a living room, bath room or kitchen.

Aspects of Interaction and Control

The player controls the app by manipulating the position of the smartphone. Tilting, shifting and moving influences the camera feed and in a few cases, also the game. In the beginning, e.g., the game object ‘house' will open its door when the player moves closer. Otherwise, control is exerted over the smartphone's touchscreen, making use of interaction patterns which people are probably familiar with. Tapping objects will change their state or open a context menu. This menu helps the player discovering new abilities and behaviors. Moving and placing objects is achieved through touch and drag. Items in the inventory can be skimmed through by swiping. They are selected through tapping. The interaction items ‘grow and shrink rays' are attached as big 2D pictures at bottom sides of the screen, are also fired by tapping. The game provides surface feedback through a 3D cursor.

Objects the player is putting into the scene will make use of relative placement to the camera. This means the objects are raycasted from the camera to a nearby location so that the player can see the outcome. If the placing of this object triggers the appearance of another one or an event, this will happen in relative placement to the recently dropped object, to ensure the player does not miss out on them (Ha, 2017).

Aspects of Mobility

The game is designed for smartphones or tablets with touchscreens. I can be played anywhere, with the constraint that it needs to be closed environment, meaning a room with walls, floors, and ceilings. Through the continuous mapping, players are free to move around the room and place objects anywhere. The game works with both orientations, horizontal and vertical.

The app uses low poly shaders and materials and only renders the objects which are currently in view. This to address the performance limitations of mobile phones and to limit heat generation and battery drainage. This is also influenced by the design of the mesh and tracking algorithms (Ha, 2017).

Presentation of Data and Findings

In the following, the findings of this study are set forth. The section starts out with an overview of the participants and the sessions. Afterwards, findings from the interviews and observations are presented. The findings are structured based on Olsson's (2013) framework for Desirable UX for MAR, including new categories which emerged and which are relevant to the domain of games. Insights and methodology are then reflected in the context of existing literature, leading to implications for theory, practice and further research.

Participant Information

The table below gives an overview of the recruited participants. Of those, IT and OE managed to finish the game. IT, KL and OE also got to use the sandbox mode.

	Age	Sex	From	Education	Profession	Game Affinity	Setting
MR	27	f	Norway	MSc Design & Innovation	Graduate Project Manager Civil Engineering	yes	Kitchen
AO	30	f	Denmark	MSc E-Business	Associate Project Manager Communications	no	Living Room
IT	26	m	Netherlands	MSc Design & Innovation	Student	yes	Living room with open kitchen
KL	28	m	Germany	MSc E-Business	Student / Software Developer	no	Common room / kitchen in dorm
OE	26	m	Germany	MSc Design & Innovation	3D Printing Engineer	no	Living Room

Table 4: Participants

Results from Pre-Test-Interviews

In the following, I will present an abstract of the finding related to previous experiences and expectations. The tokens used in the presentation (MR, AO, IT, KL, OE) refer to the individuals who made the statements *(see Appendix d for Affinity Diagrams).*

Most participants were familiar with the applications Pokémon Go and Snapchat. Other reported experiences with tracker-based furniture preview apps, a hologram cube, an AR yearbook and an AR TV quiz.

Positive experiences were related to a feeling of amazement. In the same breath, participants added that this feeling was evanescent, tying it to the novelty of the experience. MR said about Pokémon Go for example: “Seeing the Pokémon live didn’t do that much for me… I actually turned that off. […] But in the beginning, it was funny. ‘OMG, there is a Pokémon on the table!'" (MR) One participant felt that their amazement of Snapchat was brought down by others: "I was pretty impressed by the filters and how they stick to the face, the facial recognition. But then my boyfriend said it is actually not that high-tech, and I thought it was." (AO)

Other positive experiences were related to playfulness, which showed in the creative use of a marker-based furniture preview application: “The fun part was you could lift that sheet of paper and pretend you lift like a huge shelf and make funny pictures with it.” (OE)

Participants also valued applications which provided relevant content, such as Snapchat offering filters based on locations and happenings: “I think it’s more relevant and more fun. Because it is more related to what is happening and then, for example Game of Thrones, and you can send them to your friend.” (MR)

Participants also highlighted social aspects of experiences: "Pokémon Go is also a social thing. In my home town, we went on these raids at night, just a group of guys walking around the city." (IT) – "I really like the simplicity of the face swap. I could spend hours with this! At parties and stuff, it's really fun." (MR about Snapchat)

On the negative side, participants complained about a detachment from the physical world and impairment of social interactions: "[…] But it also really disconnects you from reality. […] I just don't like that you're holding a phone and having an extra layer between you and the world, for me, it feels weird." (IT) – "My sister spent like half the Christmas taking selfies and doing face swaps on Snapchat, and my grandma was just like: ‘Can't you put it down?' Yeah. I rather wish it was for something useful" (OE) The same person recounted his experience of playing Pokémon Go as follows: "I tried to get in touch with people, but they were mostly in touch with their phone. Even though you have your opponent right over there, they would not interact. I think that's kind of awkward." (OE) Some were even embarrassed to admit to

playing the game itself: "I was always trying to hide it because I didn't want anyone to see that I am playing Pokémon Go. I was ashamed of it." (IT)

One participant recounted a bad first-time user experience, where she couldn't figure out how to use Snapchat: "I couldn't figure out how to use the stickers, it was kind of not intuitive. […] It made me feel old when I couldn't use it, and I thought it was more high tech than it actually is." (AO)

Another topic was the disappointment of the performance of the technology, which is related to the participants' expectations: "I think I downloaded the IKEA app a long time ago, but it was really shit. 'Cause you could like place the furniture in the room and it was like hacked, the furniture was like floating in the air, none of the shadows looked correctly. I might just as easily cropped out a picture and held it and 'Oh, that looks nice!" (OE) – "There was like a block of text, and then it would translate only 75%. There were some blocks of text that were missing, and then out of context, it doesn't get the translation right. That's always a bit disappointing." (KL about Google Translate).

Concerning their expectations of a perfect AR system, two of the participants stated they would prefer not having a handheld device, but rather AR wearables. Others were wondering about use cases for tourism or cultural institutions, some were concerned with technological improvements. One participant summed up their expectation for MAR games as follows: "In a perfect world, it would be like having toys that you don't own." (MR)

Results from the Observations and Post-Test Interviews

This section starts out with a brief summary of the individual sessions, pointing out highlights and giving an indication of the overall experience as reported by the participants.

Figure 4: Participants playing WOORLD

MR considers herself a gamer and was particularly thrilled to try out the game. The space in the kitchen and her options to move were relatively limited. MR expressed strong reactions to the game's happenings, releasing cries of surprise, talking to the game characters, singing along to the background music and mocking the apps sounds. She summed up her experience as follows: “It felt like a weird dream. I would have loved it as a kid. I still liked it.”

AO was the least game affine of the participants seemed to quickly get bored by the game. She almost immediately asked for hints and was also the one who asked to quit the game the earliest. Even though her room was the most spacious of all, she quickly felt that it was getting "too small" for the game. Overall, she thought of the game as "cute, a bit odd […], but maybe I’m not that much of a gaming person, I was very quickly like: ‘Yeah, okay. Enough now.”

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Figure 5: The setting of AO

IT was highly motivated and so absorbed in the game, that he ran into walls and bumped his head several times. He was the first one to finish the game and unlock the sandbox mode. It was the second longest session of the test. A part of the game, in which the room is "flooded" was very buggy as the phone could not readily register his environments in dark corners, which made him, along with the clutter of the objects at that moment, uncomfortable. All in all, he was very excited about the game: "This is sooo good. It's so cool. I think I'm an easy target for this… what a great game." (IT)

Figure 6: The setting of IT

KL played the game in the common room of his dorm, which is situated on the ground floor of the building and has a large window front. He played the game in the presence of two of his roommates, which sparked some curiosity and interaction. At one point during the test, he left the room with the phone to talk with one of the roommates, during which the phone lost the tracking. When he came back, all the objects were messed with and suddenly “outside” behind the glass wall. This required him to re-start the game and play it completely from the beginning. His session was the buggiest, and since KL describes himself as very interested in technology, he got quickly annoyed by the game: “In the beginning it was very enticing. [...] As someone who is a bit of a techy guy, it was cool to get the latest project from Google. But the game itself was pretty disappointing. It's not really fun, there's no real game play going on, and it's also limited by the recognition abilities. Maybe it works better in different kind of rooms. With little objects, a lot of space. Like a jail, for example.“

Figure 7: The setting of KL

The session with OE was the longest of all. He seemed absorbed in the game from the beginning, which showed several times when he did not even notice his girlfriend walking in and out of the room and taking a glance on the screen. OE was the second one to finish the game, and he spent a lot of time in the sandbox mode after that, garnishing the room with objects and playing with the environment; such as the "Beer Pong." Even though he engaged extensively in the game, he concluded: "Fun, but disturbing. I would like to use it more for useful stuff, getting information

about your surrounding, maybe in a new place. I mean it's fun, but it doesn't help me much developing my interest for AR." (OE)

Figure 8: The setting of OE

Hereafter, I present evidence from the interviews and observations. The findings are structured based on Olsson's experience classes and categories, including new categories which emerged during the analysis. Olsson's categories represent positive experiences, which he considers desirable for UX of MAR. I will also cover negative experiences, interpret them as a failed design goal and relate them to the relevant positive categories. For example, the experience of feeling limited in ones' exploration is considered a failure in designing for *Empowerment & Autonomy;* feeling overwhelmed by the visual clutter is presented as a negative side of *Liveliness*, and the feeling of claustrophobia is related to *Tangibility & Transparency*. The experiences described do not necessarily refer to AR per se, but they reflect the overall experience which was evoked by the game.

Instrumental Experiences

Several experiences have been related to the instrumental aspects of the application. These experiences originate from "utility, user's accomplishment, product performance, and support for user's activity" (Olsson, 2013, p. 213). In this context, accomplishment is related to one's progress in the game. An explanation of the categories introduced in this section is part of the discussion further down.

Empowerment & Autonomy

The participants almost unanimously described WOORLD as an open-ended game with many options which allowed for free exploration: "It feels like an open, easy game. Just exploring, things are happening, and the block guy is guiding you through everything." (IT) Not all of the participants were comfortable with this openness and comment on its downside: "Usually when I play games, there are certain rules. […] It was so free everything, it was almost like too much, it became quite chaotic. […] So maybe because it's such a free play kind of game, it opens up for more chaotic situations." (MR) Other participants had a converse experience, who felt that lack of options in the game would impair their motivation to play the game in the future: "I only felt like… I don't know how it is if you play longer, but it is quite linear in the beginning." (AO) One participant felt that his experience was impaired due to technological limitations: "That limited me from exploring, because even though there was more space. I kept to one spot because I thought: 'Ehhhh, if I go there, it will probably behave buggy.' And that really inhibited my desire to explore. I had an idea, it works on the couch, but it doesn't work well under the table. That was limiting." (KL)

Efficacy & Mastery

In general, the game did not evoke strong or positive experiences of mastery. The participants perceived their progress in the game mostly as an experience of trial and error, while not knowing what they are doing: "I felt kind of stupid. It's very basic and still very confusing. […] I was stuck quite often. And then I just pressed the button five more times again and then, yeah… Then I move on. I can't really figure it out because there's tons of other stuff to push and try. […] When something new appeared, you felt like: 'Oh, I did something correct!'" (MR) Their progress did not involve a feeling of mastery: "I felt like I managed to do what I had to do […] I didn't think that I ever did anything great." (MR) – "I could solve the riddles. But they were fairly easy. So you don't feel exactly super proud." (KL) – "Every little thing you accomplish in the world is a moment of joy, but I mean, it's also… Not really worth talking about. I wouldn't tell my friends: 'Oh, yesterday I unlocked the whole game of WOORLD, or found a new poop…" (OE)

Many participants lacked a sense of accomplishment while playing the game and openly wondered whether they were playing the game right. OE was wondering about his performance compared to others: "I was thinking about some of my friends who would probably perform amazing compared to me, they would have probably finished it in 15 minutes. But I felt comfortable and okay with my performance in the game, but I also think that I'm not very good at it." IT was missing a competitive component he could compare himself to: "In the beginning, I was a bit worried because you were here and I thought: 'Do I play it fast enough?' […] You don't know how well you are compared to others. I'm a really competitive guy; I really want that competition at some point to keep me playing." AO got regularly stuck in the game and asked for hints to progress, which demotivated her: "Just that I couldn't get it to really get further. And I was feeling a bit frustrated about the sprouts. I don't want more sprouts!"

Meaningfulness

The game did not evoke a sense of meaningful play within the participants. It did not appear to be clear, how the actions in the game would influence its progress: "…what's the point? You don't really know what you're doing. […] That's okay, but maybe not for the long term." (MR) The uncertainty about one's progress left participants uneasy: "I got a bit restless, and then okay, whatever, next." (MR)

Another level of meaningfulness relates to the semantic abilities of the application; or rather the lack thereof: "I got the feeling that it does not really interact with the environment, but it just maps it. It uses the room where you are as a basis, but after that, there is nothing else except for placing stuff. […] It didn't matter what kind of room I was in. Like if I were in a kind of weird room, it wouldn't have been any different. Which would have been interesting, like if you had something growing out of every power socket or something, that would urge you to find some crazy rooms with a lot of angles." (IT)

Cognitive and Epistemic Experiences

Intuitiveness

All of the participants found the interaction within WOORLD intuitive, which they largely attributed to the well-known interactions of a mobile touchscreen: "It was

very drag and click and double-click, a lot of moves you were used from your phone. So that was pretty natural." (MR) This was supported by the staged in-game tutorial: "It's quite intuitive eventually, of course, in the beginning, it's weird, and you have to try a few things, but it taught you how to play the game without having to read the rules." (MR) Another aspect of it was how close the interaction resembled the interaction in the real world: "The 3D objects are just objects. So you can grab them, put them somewhere, just like in the real world, it's the same. It's super simple. […] Even my mother and father could play it." (IT)

From the observations, I noted that even participants who struggled quite a bit with the interactions would in the end still say how easy and intuitive it had been. Only KL mentioned: "It was more like picking things up, and I picked something else up, I was missing things... That was a bit tricky."

Awareness

Some participants found novel aspects in their familiar surroundings: "It made me see my surroundings that I am used to in a new light […]. Because it makes me interact with the objects in the environment that I usually take for granted as being there. The table is there. It serves me a function when I need it. But this game made me rethink it." (KL) This feeling was especially supported when the physical and digital world truly merged, for instance, when the 'rocket' burst through the ceiling left a 'hole' in it. Apart from that, the lack of interacting with the real world seems to limit experiences of awareness.

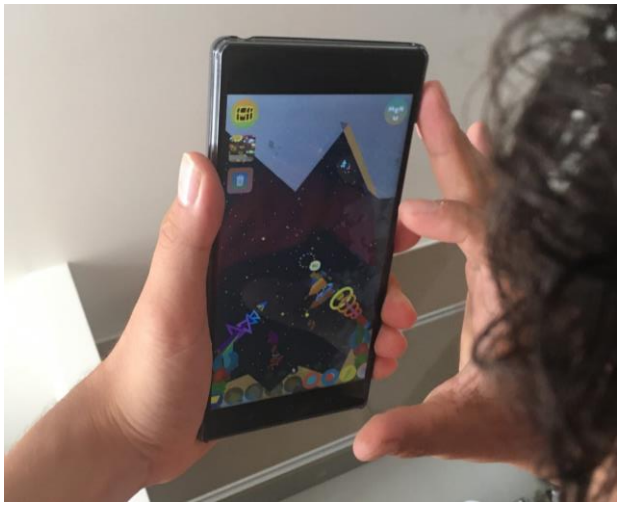

Figure 9: AR Subtraction: A "hole" in the ceiling

Emotional Experiences

Amazement

The experience of amazement partly reflects what the participants have said about other AR services before. Using the app has created experiences of amazement for most of the participants. Among the recalls of their most satisfying experiences, everyone mentioned the first times attaching clouds, the sun and the moon on the ceiling, as well as the tinting of the screen the moon does. Most were specifically impressed by how well the scanning of the room and the tracking worked, and that it could differentiate between walls, floors and the ceiling: "It worked really well, all the objects were always where you put them. That's what really amazed me. The house, it was just always in the same spot, as if it were in the room." (IT) – "It worked impressively good, also compared to my AR experiences couple of years ago, and pretty much 360° all around." (OE) The amazement could largely be held up for the technology only: "Impressive technology, but I'm not that engaged in the game." (AO) Those who encountered more bugs or technical issues related to AR were deprived of this experience to some extent: "I am very aware that is an app with a lot of limitations. It's fun to play through it, but it's nothing mind-blowingly amazing." (OE) Citing specific issues, the participant still claims that the challenges experienced did not impair the overall fun: "When it lost track, and suddenly the AR room was turned for like 90 degrees or whatever. Or sometimes some parts would disappear behind stuff. It was quite annoying or confusing. It's not a big problem; it does not interfere with the fun of the game and stuff... I'm still excited though; I focus more on the parts that work!" (OE)

Many participants recounted their excitement was fading: "It had a real WOW effect, but you get used to it, so quickly... that's why the game needs to be really interesting to keep on playing it." (IT) Also, the simplicity of the gameplay led to this perception: "Pretty boring, very repetitive. It was fun the first time: 'Oh hey, I can interact with the ceiling.' But the magic quickly evaporated." (KL) The same participant concluded the experience of playing WOORLD as being "nothing out of the ordinary." Metaphorically, KL described his experience of playing the game to moving to discovering one's environment in a new place: "So the way home, driving down Nørre Allé, this long stretch... in the beginning it was like oh wow, looking left, right,

skate park and so on and then you start to filter out. With this game, it was kind of the joy of getting to know your surroundings for the first time was brought back. But then it felt like Nørre Allé again."

Surprise

Positive experiences of surprise were related to the AR technology exceeding the expectations of the participants: "It's getting much better, I was surprised how much I got a sense of that the floor was actually there, which I hadn't had before." (AO) Participants also experienced moments of surprise when new objects appeared in the room: "I didn't expect that things would be growing from the walls. Also, the mushrooms on the door. That was funny. It was a lot of unexpected elements that came in." (MR) This could also be observed during the tests when participants were reacting loudly to a new object or were laughing and giggling. This was supported by the game design: "It's not only the novelty, but it was also the sounds and the clicking and the interface." (MR) The way of saving and loading a game was the source of other moments of surprise: "Also when I reloaded it and there was a little sketch of the room and then everything was exactly where I had put it before, that was very impressive to me. I wouldn't have expected that I had no idea how it was supposed to work." (OE) However, a surprise was always coupled with the participant's experience. Consequentially, KL, the more technically inclined participant noted: "I have seen a demonstration of Tango before. So my expectations were low and they were met regarding the technology as such […]. On some level, I was surprised that it would map the sofa correctly, and that I could put it on the sofa, but then things would vanish behind the chairs and stuff like that." (KL)

Playfulness

Positive experiences of playfulness were related to the novel ways of interacting with AR. "It was new; I had never interacted with my environment in that way, it was quite playful. […] It was fun to attach a cloud to the ceiling and then water a plant and watch it grow." (KL) One play found particular joy interacting with the shrink and grow ray guns: "I really enjoyed that, probably more than the actual quest. It took a couple of minutes to figure out how these weapons finally work. And when I did... then you have a direct response and you don't have to solve a quest or

anything, you can just change stuff in the world, make it big or small. I don't know; it was probably the fun part about it." The visual and auditory style of the game seemed to contribute to these moments of joy as well. Observing the participants, I could see many of them laughing, giggling, mocking the sounds within the game, or talking to the game characters and objects: "It's also a lot of the sounds and the music, it's very joyful and easy." (MR) The style of the game, however, did not resonate with all of the participants: "It just becomes ridiculous with all this stuff. It doesn't make sense." (OE) – "This weird companion and stuff, it didn't really resonate with me" (KL)

Liveliness

All of the participants would recall experiences of liveliness, positively or negatively. "All the colorful things that move around […] It was so exciting and something was happening right from the beginning. Just trying more and more and out stuff out and you have a lot of stuff everywhere." (OE) – "It was so playful and bursting with things." (IT) Liveliness was supported by the game's aesthetics: "Design, sounds, animations, the music, the little sparkling things when something new happens. It was never still in the game." (MR) – "It was super lively and the cute little sounds they were making, and talking to you…" (AO).

However, the amount of activity in the game and on the screen led to the participants being overwhelmed. MR noted during her session: “My eyes are getting tired of all the popping [up of things].” Everyone noted how "messy" the surrounding became, or how they were having a hard time finding an object: "It was too much stuff sometimes for me. I spent at least as much time tidying everything up as I spent time putting the objects out there. It was a bit messy for me." (OE) IT was more outspoken about this negative experience: "I got kind of frustrated because it was a mess at some point. It's also funny because it's fake anyway. But I was like: 'Everything is flooded!' and I really hated it." A particularly bad experience was recounted by KL: “There were a lot of objects hanging from the ceiling, it was super crowded but also I didn't want to move that much because there was not too much space for moving around. It made me feel like I want to get out of here."

Sensory Experiences

Captivation

The participants described different levels of captivation. Captivation can relate to the AR, to the game or the app as a whole. Most participants described a feeling of captivation to a lesser or stronger extent. They recall getting pulled out of the state of captivation by technical issues, repetitive gameplay or visual clutter.

AO for instance, who has no affinity for games in general, found the AR to be “just as immersive as virtual reality. Even though it was a cartoon.” However, she did not get hooked by the game itself: “I wasn’t excited enough about it to keep going. I just wanted to stop. [..] I feel like it’s more a personality thing. Even with board games and card games I’m like: ‘Eh, do we have to do that?’”

Also, KL described being intrigued and captivated in the beginning, but the game seemed not to stimulate him enough to keep him hooked.: "I felt captivated at first, but the sheer boredom of the game pulled me out of the experience." He also mentioned the game's interface to interfere with his experiences, such as the menu character and 2D notifications: “I felt so annoyed by them because everything felt so natural, but they really felt unnatural. I actually intentionally started ignoring those messages, because I found them distracting. They felt so off." He also found the technical issues problematic: "…you kind of get sucked into the experience. I was opening up to it fully. But then the glitches were a little bit frustrating, and that made you conscious that you were in a simulation. If it wasn't for that, I think you can get into a state where you really get lost." During his session, I observed many instances of KL impatiently rushing through the game, as he just wanted to finish it. He showed little interest in the game’s events, moving on to new activities before animations had ended. The lack of interest also showed when KL had to restart the game and start from scratch. He did not immediately remember how to solve the puzzles, even though he had solved them just before.

OE did get into that state, as he recounts: "You really get into the flow, that was from the second one, once you put the first thing on the floor, for me at least, you wanna try it out, what does it ." He describes a disconnect from the real world: "I don't feel like I am a part of the real world when I'm doing this game. It's not a parallel universe, but at least I disconnect from the real world and I focus on the AR world on the screen." This could be observed during the test, as OE did not even notice his

girlfriend walking in and out of the room, getting closer to him to take a look at the screen.

IT was also drawn into the game. Repeatedly, he ran into walls, bumped his head or collided with me. He also needed a longer break after playing the game before we continued with the interview. He finished the session claiming: “I’m done. I’m a wreck”, describing the experience as “super intense and exhausting.” He also mentions a loss of sense of time: "I don't know how long I have played it.' I don't know anymore; I was so in the thing." He partly attributes this to his competitive personality: "I just wanted to complete it. The whole motivation for playing this game is because you know there's more happening. You can't stop before everything is done, that's how I am! I didn't know how much I had to do and how long it would take, I just wanted to see as much as possible in the time frame that we had." (IT)

MR also felt captivated due to the novelty and simplicity: "I felt very focused in the game. This is very intense, you kind of lose yourself in it a little bit. […] It's also the simplicity of it. You can just try around what to do, without sitting through a 5-minute intro." She also described the experience as "intense" and "draining": "It takes a lot of energy to move around and hold the phone and look up and down. It's not as comfortable as sitting on the couch, having a controller." MR felt very aware being "in a kitchen and holding a device. […] That shut's it down a little bit. Because you're looking through it all the time." MR got pulled out of the experience when "too much" was happening on the screen, and by technical issues: "It definitely breaks the barrier." Even though the game was working well for her mostly, there was a moment when the app lost track and suddenly, all the game objects appeared to be in a kitchen closet. "Everything got shuffled. That's weird. Imagine you're a kid and it builds this really nice thing, and when you log in again and everything is moved. Because that's what happened, all these flowers and mushrooms I placed were stuffed in this really big lump in the closet." She names that do be a downside, especially in the long run: "With other games, I tend to get very invested. You kind of make it your little home and everything has to be in one way. And it feels like I wouldn't be able to do that in AR because it still feels so non-stable."

The participants IT and OE, who both finished the game, however, both stated they would not play it again, unless, for IT at least, there would be new levels.

Tangibility and Transparency

Many participants displayed behavior which indicated they felt the presence of the objects around them. I could observe them moving around the room, reacting to the game events by squeezing themselves into a corner of the room or trying not to step on the garden of digital flowers they had built. A few times, I caught participants were looking up from the screen to look for the game objects in the room: "It just felt like they are all in the room […]. One time I looked up from the screen to look for the moon." (AO) – "You give some sort of meaning to places. So that corner was the sun… You expected it to kind of be there for a second when you look. […] You get a feeling that something is there, even though it isn't. Because I place it there and it looks normally, And I think my mind just settles that something is there. Like me not trying to step on the flowers." (MR) MR also had a moment where she tried to move the real objects on the kitchen table through the device.

In general, participants found that the digital objects blended in well with their surroundings: "…most of it was very natural, the way it clicked with the environment, like the moon and the sun and the clouds… It looked like it was one with the kitchen. It blends in naturally." The feedback they got from the interaction with the objects added to this experience: "It feels the same. It respects the laws of physics." (KL) - "When you drag the cloud, it would kind of move up and bounce back. […] And you could feel that the objects were lashed on and you could tell that things were stuck to the floor, they were not hovering. " (AO)

It was visible to me and confirmed by the participants, how the game altered the perception of space: “The space got small quickly because there was so much happening, which was cool, but it was good that I could easily move around.” (AO) The feeling of the presence of the objects also had a downside: “It was really messy. And I also didn’t remove any of the objects, because I didn’t know if I would need it later on. It became very cluttered and crowded. It made me feel a bit claustrophobic.” (KL)

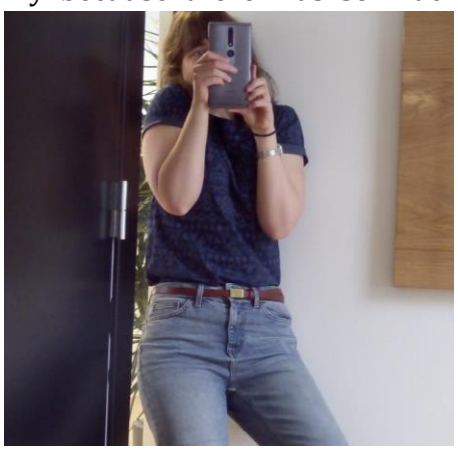

Figure 10: Participant forced into a corner (during pre-test of research design)

OE did not feel the presence of the game objects at all, which he accredits to the mobile device: "On the screen it kind of fits in organically, it's kind of life and moving around and using the surfaces as they are with our sense of gravity and stuff, so that feels kind of natural, but not in the sense that you could feel it or something. I didn't feel the presence of the clouds above me. I think it has a lot to do with the handheld device." He also gives a second explanation: "You're also not a part of it yourself. You can't do anything with your hand or your feet or something." In fact, many participants to tried to touch or kick the objects. That kind of advanced feedback from and interaction with the environment was something IT is hoping for in future AR games: "…or the flowers on the floor, what about if you could use your hands instead of your screen? It would feel more natural."

Social Experiences

Connectedness

The participants did not report experiences related to connectedness. Quite the opposite, as they were focussed, they did not feel any connection to the real world. This was well to be observed in the case of OE, who did not notice his girlfriend walking in. KL was playing the game in the common room of his dorm and attracted a bit of attention doing so. He showed the app to the other people present, who were curious, but no greater meaningful interaction spawned from this. The participants did not see the app as a social game: "I don't think I would play this game with my boyfriend. I don't know how two people would play this together. You're kind of just glued to the screen." (MR)

Privacy

The participants did not have any negative experiences related to issues of privacy. This was attributed to the fact that they are playing the game at home in a familiar environment without any witnesses. The thought of playing the game somewhere else than the home was received critically: "I think you have to be in an environment where you can let loose and be stupid. Because it is really kind of childish the whole game. " (MR) - "There's nothing wrong with the app, no offense to the guy who made it, but it's just stupid. Why would I change my surrounding with this stupid stuff? I

don't see any reason to do this in another place than here [...] I would probably be embarrassed by looking at someone playing this." (OE)

When KL was playing in the dorm, his fellow residents were watching him running around with the phone directed towards the ceiling looking rather confused, until he enlightened them saying: “It’s nothing narcissist. I’m playing a game.” The participant did not bother about the company: “In that department, I am also a bit less sensitive. I don't really mind. I was in my world, not in the real world, I felt like a little bit detached. And in my world, I don't feel embarrassed of what I do. I think I am quite aware, but I don't care too much. I also tend to make a point of making a fool of myself.” (KL)

Motivational or Behavioral Experiences

Creativity

OE did engage exhaustively in the sandbox mode of the game after he had finished the story mode. He put many objects on the tables, playing with the grow rays, trying them out on real objects. He particularly enjoyed playing "beer pong," trying to 'throw' a digital, bouncy object into a plastic cup which happened to be placed on the table in the living room: "All the things that happen on the screen are so imaginative. You can get super creative and try a lot of things, even though they're similar somewhat. [...] It's exciting to figure everything out and try out new things. Like the beer pong! I felt very stimulated to be creative. In the beginning, it was a "mistake" to put the house on the floor, but then, in the end, it was like: Oh shit, I can put the sun on the floor and the house on the ceiling, that's amazing." (OE).

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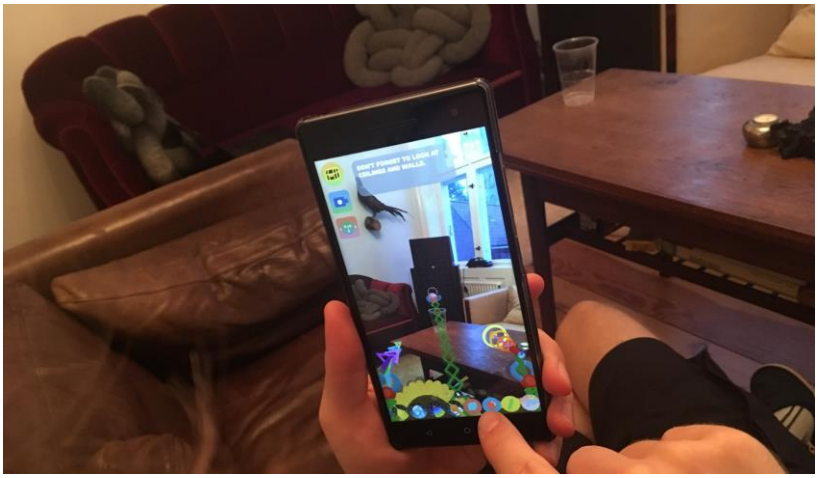

Figure 11: OE playing "beer pong"

Discussion

The table below summarizes negative and positive experiences the participants have had with MAR applications in the past. This information is helpful to get an idea of people's expectations towards MAR in general, since expectations are, amongst other, based on previous experiences. The table is a simplified representation of the findings presented before. It lacks the context and details provided in the data presentation but instead gives an overview of the findings for quick reference.

Instrumental Experiences			**Contributing components**
Efficacy and Mastery	☹	- Levelling of PKG did not make sense	Game Mechanics
Meaningfulness	☺	- Relevancy: Content adapts to location or latest movies	Context-Sensitivity & Proactivity
Cognitive and Epistemic Experiences			**Contributing components**
Intuitiveness	☹	- feeling old because of not being able to figure the app out - cumbersome setups	Interaction
Awareness	☺	- Exploring of the environment	AR
Emotional Experiences			**Contributing components**
Amazement	☺	- Novelty, first-time experiences	AR, Interaction
	☹	- Technical performance of application underdelivers expectations - Bugs, latency, recognition errors - WOW effect fades	AR
Playfulness	☺	- Joking around, "lifting" furniture - Embellishing pictures and videos	AR AR
Sensory XP			**Contributing components**
Captivation	☺	- Being hooked, feeling like "being there yourself" (TV Quiz)	AR
	☹	- Detachment from the real world - Feeling too aware of the device	Mobility
Social Experiences			**Contributing components**
Connectedness	☺	- Fun of face swaps at parties - Going on Pokémon raids with your friends - Tying game logic more to people	AR Game Mechanics Game Mechanics
	☹	- Detachment from people, glued to the phone, not interacting	
Privacy	☹	- Embarrassment of playing in public, being afraid to be seen	

Table 5: Previous experiences with MAR

Learning about users' expectations gives some context to the experiences elicited by WOORLD. The most technical person, for example, was also the most critical of the applications' performance, which other users were more forgiving of. Most of the participants previous AR experience was based on marker-based augmentations or facial recognition, so the expectations regarding AR itself were easily exceeded.

Other expectations and experiences referred to aspects not exclusive to MAR, but mirrored reservations towards an excess use of technology in general.

A similar simplified overview has been created of the positive and negative experiences related to WOORLD. The table reflects the variety of experiences that the different participants had.

Instrumental Experiences			**Contributing components**
Empowerment & Autonomy	☺	- Openness and exploration	Game Mechanics
	☹	- Chaos, "too much freedom" - Bored by linearity of the game - Feeling limited in one's exploration	Game Mechanics Game Mechanics AR / Recognition
Efficacy and Mastery	☺	- Being in control, the objects behaving the way you want - Quickly mastering the basics	Interaction & Control Interaction & Control
	☹	- Feeling confused and stupid - Not knowing what you're doing - Lack of feeling of mastery - Lack of feeling of accomplishment - Insecurity about performance - Lack of competition/comparison - Feeling stuck and demotivated	Game Mechanics Game Mechanics Game Mechanics Game Mechanics Game Mechanics Game Mechanics Game Mechanics
Meaningfulness	☹	- Pointlessness - Missing a more advanced interaction between the physical and the digital world	Game Mechanics AR / Semantics
Cognitive and Epistemic Experiences			**Contributing components**
Intuitiveness	☺	- growing knowledge while playing game / tutorial - picking up the interactions quickly - drawing on knowledge from mobile phones	Game Mechanics Interaction & Control Interaction & Control Mobility
	☹	- Mis-clicking or mis-placing	Interaction & Control
Awareness	☺	- Re-thinking and discovering the environment	AR
Emotional Experiences			**Contributing components**
Amazement	☺	- Impressed by placing objects, tracking, tinting of camera feed, object interaction - WOW effect - Doing something special with your phone	AR Interaction & Control AR, Interaction & Control Mobility
	☹	- Amazement due to novelty faded quickly - Annoyed and disappointed by technical issues - Bored due to repetitiveness of gameplay	AR AR / Recognition, Tracking, Rendering Game Mechanics
Surprise	☺	- Exceeded expectations in technical performance - by game objects growing in the room - increased by sounds and music	AR / Recognition, Tracking, Rendreing AR / Recognition, Tracking Game Aesthetics
	☹	- Low expectations were met, but somewhat subverted by technical issues	AR / Recognition, Tracking, Occlusion

Playfulness	☺	- Novel ways of interacting with the environment - Experimenting with object manipulation with grow and shrink rays - Talking with game characters, singing along, mocking sounds etc.	AR, Interaction & Control AR, Interaction & Control Game Aesthetics
	☹	- Repelled by "childish" style	Game Aesthetics
Liveliness	☺	- Excitement and stimulation since "it was never still in the game" - "Feedback" from objects and characters	Game Mechanics Game Aesthetics Interaction
	☹	- visual clutter - feeling overwhelmed by the happenings on the screen	AR Game Mechanics Game Aesthetics
Sensory Experiences			**Contributing components**
Captivation	☺	- Feeling immersed in the world, forgetting about time, not noticing the presence of other people	AR Game Mechanics
	☹	- Loss of interest and motivation, feeling bored by the game - Dissonance between real and digital elements - Technical issued and clutter pull you out of the game - "Super intense and exhausting" - Physically energy draining	Game Mechanics AR Mobility AR Mobility
Tangibility & Transparency	☺	- Feeling the presence of game objects in the physical space - Realistic interaction with objects, feedback - altered perception of space	AR Interaction & Control AR
	☹	- feeling boxed in, claustrophobia - no feeling of presence - dissonance between the self and the digital world	AR Mobility / Mediation AR / Interaction & Control
Social Experiences			**Contributing components**
Relatedness	☹	- Feeling disconnected or no connection to the real world and people	Game Mechanics
Privacy	☹	- Embarrassment, if the game was to be played outside the home	Game Design
Motivational or Behavioral Experiences			**Contributing components**
Creativity	☺	- feeling stimulated to manipulate the environment with the digital objects and to try new things	- AR, Interaction & Control - Game Mechanics (Sandbox)

Table 6: Experiences with WOORLD

The table summarizes the types of positive and negative experiences the participants reported, and links them to components of the application. Of course, experiences arise as result of an interplay between different factors and attributing them to a single component may fall short. Therefore, this link should be understood

as an indication of which component was primarily associated with the experience, from the user's point of view.

Olsson (2013) assumed the component of Augmentation to be the primary contributor to experiences of amazement, captivation and tangibility. This assumption was confirmed in the case for WOORLD. Positive experiences in these categories were often linked to aspects of augmentation. For instance, the fact that the app could detect walls, floors and ceilings elicited amazement in the participants. The novelty and quality of the augmentation also nurtured immersive and captivating experience, which is what Emri & Mäyrä (2005) referred to as sensory immersion. Experiences related to tangibility were facilitated by the way game objects merged seamlessly with the environment, which tricked the participants' minds into the feeling the presence of the digital objects in the environment.
Aspects of augmentation were also related to negative experiences. These were mainly concerned with technical issues and the disappointment related to them. Another example of negative experiences was the claustrophobic feeling that was created through the intense feeling of object presence.

Olsson (ibid) suggested the component of Interaction & Control to be an important contributor to e.g., creativity, playfulness and captivation, which was partly confirmed in this study. In WOORLD, the component was related to experiences of playfulness, creativity, tangibility, and amazement. An experience shared by many was the impression of the app being intuitive. Familiar interactions of dragging and dropping, as well as the visual and acoustic feedback the WOORLD was giving cemented this impression. On the downside, the classic on-screen interaction deprived some participants from an immersive experience, reminding them they are just playing a game on a phone.

Olsson considers Mobility to be an overarching component contributing to all of the experiences. The topic has not been dominating the interviews. One participant was amazed that she could "something special" on her phone. The same person later mentioned how exhausting and physically draining it is to move around with the

phone constantly. Most comments were related to technical issues or usability, such as the screen size or the phone developing heat, which is out of this thesis' scope.

A big part of the conversations involved the gameplay. The topics that were brought up in the interview inspired a re-contextualization of the instrumental experience categories (see Theoretical Implications for further explanation). These categories of Empowerment & Autonomy, Efficacy & Mastery and Meaningfulness, were related to the mechanics of the game. Many of the experiences resulting from the mechanics were negative, e.g., participants lacking a sense of accomplishment, feeling insecure about their performance or being stuck and frustrated. This can be traced back to simple riddles, random and repetitive tasks and the absence of any performance feedback.

The literature review established that immersion is a central aspect in UX in games. This concept is reflected as captivation in the Olsson's framework. WOORLD got the participants hooked due to its novelty and its solid technical performance; however, the simple gameplay compromised the experience to a certain extent. The game was lacking challenge-based immersion (Emri & Mäyrä, 2005) and had an overall poor gameplay experience, which is a substantial flaw for any game app.

However, one needs to take the context of this application into account. WOORLD has been developed in a partnership between Funomena and Google to essentially exhibit Tango's abilities. The app can be understood as a mature experiment of MAR, which is deliberately negligent of a sophisticated gameplay in favor of flamboyant augmentations.

Implications for Theory

Olsson's framework of Olsson's framework of Desirable UX is meant to reflect a variety of experiences specific to MAR, but it is generic in terms of the type of application domain under investigation. In the light of, e.g., the considerations of Pagulayan et al. (2008), as outlined in the section User Experience in Games, and the evidence from the case study, I suggest an adjustment of the framework to the context of games. Particularly the class of "Instrumental Experiences" seems to be

more relevant to productivity applications than to games, as it focusses on the application's utility and performance. By referring to acknowledged concepts of game design mentioned before, I propose to re-contextualize the categories to reflect the user's accomplishment in the game.

Rigby and Ryans (2011) introduced the idea of games to fulfill the needs of autonomy and competence. They suggest that players can experience empowerment when the game involves interesting options to advance in the game. Even if the freedom of the player is constrained, they can still feel empowered in their autonomy if they personally endorse and willingly engage in the linear path they are on. Competence needs can be satisfied by the gameplay design (Ermi and Mäyrä, 2005). By leveling the players' skills with the games' challenges, and giving feedback regarding the performance, games can lead to a feeling of efficacy and mastery (Rigby and Ryan, 2011). If the game establishes discernible links between the player's actions, the consequences in the game and rewards, players can get a sense of mission and purpose and engage in what Salen and Zimmerman (2004) call meaningful play.

Building on the above, I suggest to re-contextualize the instrumental experience categories as follows:

CLASSES	CATEGORIES
Instrumental experiences	**Empowerment & Autonomy** relates to the feeling of being provided with novel possibilities, different options in the game and/or volitional engagement. **Efficacy & Mastery** describes the sense of progress and personal accomplishment elicited by the game. **Meaningfulness** relates to the game having a discernable and integrated relationship between the players actions and the game's outcomes.

Table 7: Re-contextualised experience categories, based on Olsson (2013), Rigby and Ryan (2011), Salen and Zimmerman (2004).

Like the existent categories, the newly introduced ones are rather broad in their meaning. For example, Efficacy & Mastery comprises experiences relates to challenge, competiton, completi During the interviews, it emerged that the game's characteristics such as the aesthetics and logic are central to the experiences presented above, as well as to the overall experience. The Game Design was an important factor discussed and therefore found its way into the analysis. Olsson's (2013) model could be expanded with this component to better reflect the domain. Games differ from many other systems in the sense that they, e.g., create obstacles to create positive experiences and use sensory aesthetics to create an immersive environment (Pagulayan et al., 2008). Therefore, it seems reasonable to consider this category in any analysis.

I anchored the component Game Design in the elemental tetrad proposed by Schell (2015), including Mechanics, Aesthetics and Story. As aspects of "Technology" are already sufficiently reflected in the existing model, that element was excluded.

Game Design	The mechanics of the game, such as the rules and constraints, the narrative of the game as well as its aesthetics, including e.g. visual style, character design, music and sound design.

Table 8: Additional component for the component model, based on Schell (2015)

To conclude this section, I acknowledge that all of the suggestions require further testing and validation.

Implications for Practice

A survey conducted among UX researchers and practitioners showed a strong agreement to the statement: "We cannot design UX, but we can design for UX" (Law et al., 2009, p.722). Designing for UX requires knowledge about users, use contexts and tactics of how to design for specific experiences. Case studies can be a point of departure towards a better understanding, showcasing pitfalls or best practices, and establishing a link between a system's component and the experiences. In that sense, this study could be seen as a step in that direction. However, insights from a single

case study cannot be extrapolated. It would require further studies to be able to compare the insights and identify patterns.

On a general level, this study feeds the argument made in the introduction that a positive experience cannot be solely derived from the augmentation. What the industry needs as a killer app is an application that uses AR in a meaningful way. The fascination cannot hold up when something as crucial as the gameplay is not properly designed. Even more, the study indicated that users have a certain tolerance for technical issues. As long as the overall experience is good, participants are somewhat forgiving towards smaller glitches. It is more important to identify meaningful opportunities for MAR and design for experience with the user in mind.

Methodological Limitations

The study is subject to several limitations. The main limitation is the focus on only a few data sources, making the case rest on unsound footing. To strengthen its validity, the case would benefit from being nurtured with more primary and secondary data. Options include, e.g., to involve UX experts for experiental heuristic evaluations; to recruit a statistically relevant sample of users for a survey; or to test the application with different groups of people.

Another limitation is the focus on episodic UX. In order to holistically capture the experience, researchers need to consider the change of experience over time. To a limited extent, the study approached anticipated UX on a general level, by enquiring about previous experiences and general expectations. But constraints of time and accessibility made me exclude the aspects of long-term experience, and made me focus on the first-time, episodic user experience instead.

Furthermore, my abilities as a researcher impact the quality of the data. Conducting good interviews is an art that requires mastering. Crafting revelatory and non-leading questions from the observation notes in a short time frame was definitely challenging. Sometimes, it was difficult to make participants share narratives instead of their opinions. This experience also showed me how much qualitative research is putting a cognitive burden on the participants. This is another aspect of how the study could benefit from quantitative data, as the hurdle and the effort to participate in e.g., a survey is a lot lower.

Also, one cannot rule out the possibility that the replies were subject to a participant bias. All of them were very eager to help me, but sometimes, I had the impression that they were telling me what they thought I might want to hear, or what might be helpful for the thesis.

The project was also limited by the fact that I was working by myself and with limited technical resources. The issues I had with the setup for the observations, as described in the section *Methods*, could have been easily mitigated if there would have been a second researcher. Especially in the case of the observations, this would have probably resulted in richer data and detailed observations. Another downside of this setup was that I needed to stay close to the participants to be able to observe them while seeing what is happening on the screen. One participant told me: "In the beginning, I was a bit worried because you were here and I thought: 'Do I play it fast enough?'" (IT) People feel uncomfortable and behave differently when they know they are being watched, and my presence may have pulled its weight.

Having participants test the app in the field was interesting. In controlled lab settings, researchers usually take care of potentially disturbing aspect, e.g., making sure that the light is good and that the surfaces are suitable for the recognition system. Since I wanted to explore the experience of MAR in general, I did not want to limit myself to an artificial setting. Furthermore, I believe that the insights generated in the field will be different from the ones generated in the lab. Participants seemed comfortable being in their own home, and it felt quite easy to warm up to them. Also, the in-situ test allowed for situations which would not have happened in a lab, such as the interactions with other people or the discovery of "beer pong." Not being in control of the settings, can also lead to extreme situations, as in the case of KL, where the application struggled with the tracking and the big windows. In short, studies in the field can potentially add richness to insights, but also a lot of chaos.

The analysis does not enable us to generalize the findings, as the research has been situated and focussed on the specific context of this application.

Conclusion

Positive user experiences are the imperatives for the mainstream adoption of Augmented Reality. The omens are favourable, as companies bring mobile applications to the market, which feature powerful AR abilities as a part of der hardware and software.

This research project set out to investigate the user experience of mobile augmented reality. It was driven by the desire to explore (1) what kind of experiences are elicited by MAR, and (2) how the different components of the MAR application contribute to these experiences.

A qualitative case study of the MAR game WOORLD was chosen as an approach to answer these questions. WOORLD is a MAR game, which is built with Google Tango and therefore deemed representative for the state-of-the-art technology. A UX evaluation was performed through the perspective of five participants. The study, which was conducted in the field, consisted of qualitative methods. This is one of the few user studies, to my knowledge, to examine a mature MAR application in the field. The data analysis was anchored in Olsson's framework for Desirable UX for MAR as well as theories from game design.

The results showed that aspects of *Augmentation* could contribute to positive experiences of *Playfulness, Tangibility and Sensory Immersion*. For example, a good ability of the technology to register, render and track the digital objects, translates in the use context to a seamless integration of the digital and the physical world.
In the case of WOORLD, aspects of *Interaction & Control* were, e.g., related to positive feelings of *Intuitiveness* due to the well-known interaction with the touch screen. Positive experiences of *Mobility* were related to the sensation to be able to do 'something special' with a common device. All of the components above did also facilitate negative experiences, such as feelings of claustrophobia, exhaustion or frustration. Components of *Game Design* impacted experiences of *Captivation*, *Empowerment & Autonomy or Efficacy & Mastery*. Due to the simplicity of the game mechanics in WOORLD, the influence exerted appeared to be rather negative.

The study contributes to the body of knowledge of UX of MAR, and how to design for it. However, the findings are not generalizable to other contexts. More in-depth research would be necessary for this purpose. First of all, future research could underpin this case study with more qualitative and quantitative data to strengthen its validity. Secondly, long-term studies need to be realized to capture UX holistically, Thirdly, more case studies of similar applications should be conducted. Then, the different cases could be cross-analyzed. Identified patterns could be turned into empirically grounded design principles, to guide the future development of compelling MAR systems.

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Appendices

a) Info Sheet

b) Interview & Session Guide

c) Observation Notes

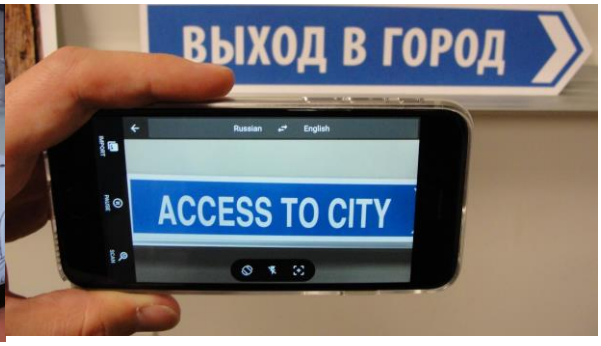
d) Affinity Diagrams – Pre-Test Interviews

e) Affinity Diagrams – Post-Test Interviews

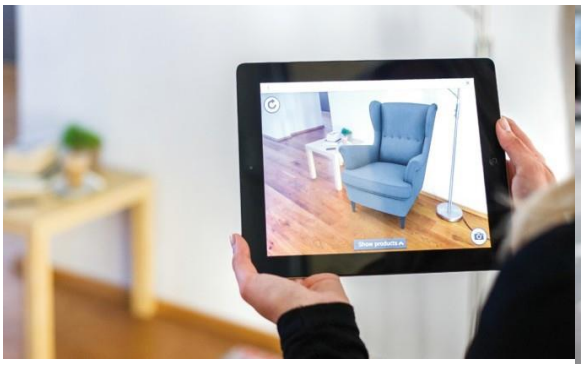
a) Info Sheet

"Augmented Reality (AR) is all about enhancing the real-world view of your surroundings with computer graphics or virtual objects. It is different from Virtual Reality, where your entire field of view is replaced. You can experience AR on a smartphone. There are many apps that use the phones camera and sensors to overlay information on a real-world view."[1]

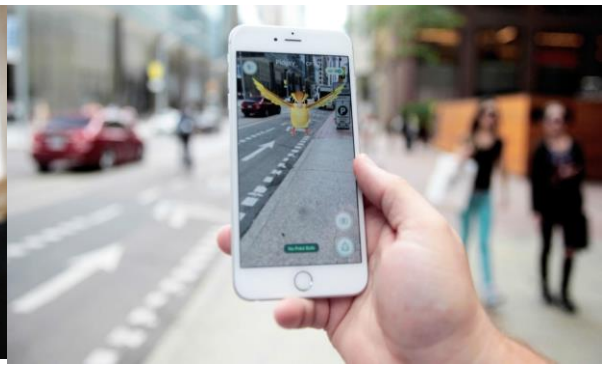
Augmented Reality Coloring Book[2]



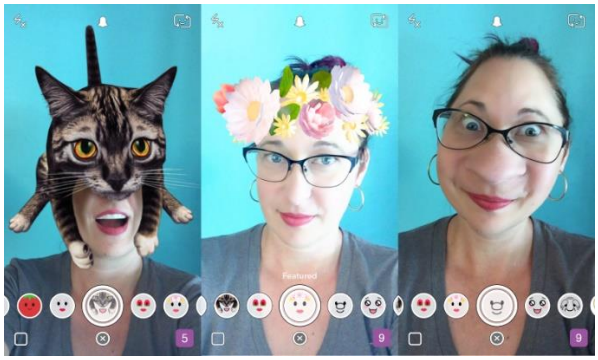
Google Translate[3]



IKEA AR app[4]



Pokemon GO[5]



Snapchat Filters[6]

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[1] http://www.bbc.com/news/av/technology-36799788/technology-explained-what- is-augmented-reality

[2] http://www.affinityvr.com/wp-content/uploads/2016/06/arcolor.png

[3] https://i.ytimg.com/vi/5OK2xxjI5MY/maxresdefault.jpg

[4] https://freshideen.com/wp-content/uploads/2017/02/erweiterte-realit%C3%A4t-ar-augmented-reality-app-ikea-katalog.jpg

[5] http://data1.ibtimes.co.in/cache-img-0-450/en/full/613455/imgpokemon-go-alternatives-best-ar-based-games-that-can-fill-void.jpg

[6] http://thisfairytalelife.com/wp-content/uploads/2016/04/snapchat-basics-filters-2.png

b) Interview & Session Guide

Prepare:

- Send out info sheet to participants.
- Charge Google phone, camera and phone.
- Bring: Phones, camera, notebook, pen, info sheet (just in case)

Welcome/Introduction

First of all, thank you so much for taking your time and for letting me come to you space. Your input will be super helpful for my thesis, so thanks again!
I am Nora, and I will lead you through this session today, which will take approximately two hours. The session consists of three parts.

> (1) First, we will have a conversation about you and your experiences with Augmented Reality.
> (2) Then, I will ask you to try out an application. It is an augmented reality game which you can freely explore. I will observe you while you're doing this and take some notes.
> (3) And afterwards, we will talk a bit about the game and your experiences with it.

What I would like to make clear is that, I am evaluating the app, and not you. You can't do or say anything wrong there. Also, don't worry to hurt my feelings, I have not been involved in the development of this game and won't take any offense ;)
I will be recording the interviews on tape, and I will record a video of you testing the application. Any audio and video is for internal use only, and purely for analysis of the session. Would this be okay with you?

If for some reason, you don't want to continue the session or if you need a break, just let me know and we can stop. You can ask questions anytime. Everything recorded in this session is confidential and will be anonymized in the thesis.

Do you have any questions so far?

Pre-Test Interview

- Can you tell me a bit about yourself?
- What do you do for a living? / What do you study?
- What excites you about your job/studies?
- Do you keep up to date with latest technological advancements? How?
- Are you interested in games? What are your favorite games?
- Have you used mobile AR apps before? Do you have any on your phone?
- Can you share an experience about trying them for the first time?
- What's the most satisfied you've felt using the app?
- What's the most frustrated you've felt using the app?
- In an ideal world, how would that app work to give you an overall satisfying experience?

Great! That's the end of the first part. We can take a short break if you'd like to. Otherwise, we proceed to the second part.

Game Test

The game you will be playing is called WOORLD. I would like to ask you to start a game and just explore. I don't have any instructions for you. Just do what you want to do. As I said, I will videotape this session and shadow you. I'd also like to encourage you to share your thoughts or feeling with me that may come up during the test.

[Test] – ask to save & load

Thank you so much! I'm going through my notes now, so you can take a little break.

Post-Test-Interview

- If you were to tell your boyfriend/girlfriend/roommate tonight about this game, what would you tell them?
- You said before, you had tried the app … before. How did it compare to this?

- What are your thoughts on…
- How do you feel about…
- Can you recall a specific moment, when…
- There were some moments of…
- I also noticed you did…

- What was it about…
- You said at some point…
- Do you remember the moment when you did … . Could you talk a bit about that?
- How did that make you feel…?
- What was it about the app that made you feel this way?

- What's the most satisfied you've felt using the app /playing the game?
- What's the most frustrated you've felt using the app / playing the game?

- I don't have any more questions… is there anything you would like to add?

Closing

It's a wrap! Thank you so much again for your help. If you have any questions, don't hesitate to contact me. Otherwise, have a nice day!

d) Observation Summary

MR

- "Ohhhh!" Sound of excitement, enchantment when the character first shows up
- „There are a lot of question marks…"
- "It's not a scary game… right?"
- "Is it waiting or… hmmmm…_ I don't understand the circle." Confuses the circle which is used to show what you're aiming at with the "waiting wheel"
- Presses the house button and places first object: "whaaaat?" surprise
- Inteaction with the character: "Helloooo!" - "He's pretty cute!" "Yayy… I can also move the guy!"
- Sounds of surprise when new items pop up
- Unclear about game: "I'm not really sure if I'm following the rules of this game"
- She first sits at the kitchen table and tries to play the game sitting. As it becomes increasingly difficult and she bends a lot in weird, directions, I encourage her to also get up and move if necessary.
- Putting the cloud up "misses" the ceiling, resp, drags the cloud rather than the stander and takes three times to put t up, then, she is very excited: "Oiii… What? Cool!" " I got it!" "This is pretty cool actually."
- AR Glitch: The game had lost its tracking and when it came back: "Everything is in the closet now!"
- Rotation interaction: Not clear how it works, moves it lot, randomly presses buttons. Confused facial expression. "Now I'm just pressing everything'
- When she first makes a flower grow: "Ohhhh" sounds of excitement
- "Am I playing it correctly?"
- "What does it mean with this…." –the closet button. Figuring out how to get the stuff back in inventory-
- Surprise, amazement: strong reaction to the moon tinting the screen. "Woahhhhh!'
- "So now there's mushrooms on the door, and my house is still there… and the sun is over there!" – checks if everything is in order as she placed it
- "I don't really understand whats going on what am I doing.
- Vfx Trails / Clouds, rain: player looks up and down to follow the rain
- Giggling, laughing at the growing flowers
- Moments where the AR felt real: She looked up from the screen to the physical space to figure out were she placed the game objects. "I'm looking at the sun" Also, she moves "around" the objects she placed on the ground: "I don't wanna step on the plants… you're standing in my plants" – "I feel like there's something here.'
- Game objects appear on walls: "There's stuff growing on the walls… this is pretty cool."
- "I think I could play this for quite a while."
- Logical ordering. "I got a little garden here!"
- Pyramid/Ufos: "Wait whaaa…. Whats going on? You said it wasn't scary!"
- Talks to the characters of the game: ("Bye bye"), mocks the noises they make
- "I don't know what I am doing; I am just pressing everything I can."
- "I feel like I'm tripping."
- Walks closer to game objects to see better, bends down, looks "inside the pyramid."

- Often stays in one corner of the room to get a better overview of the room, since it's small and there is a lot happening on the screen
- Enjoys rearranging the objects, s they look neat and orderly: "This is a very messy garden now."
- “This is such an ugly world” – comment on the cluttering of the screen
- Pyramid: “I think it’s annoying, so I move it somewhere I can’t see it” – didn’t figure out how to get the object back into the inventory “I’m gonna have a nicer garden now’ – cleaning up the clutter
- Seems overwhelmed by the number of objects around and doesn’t always know where to look, moves the screen around a lot
- Remarks on the phone heating up: "The phone is getting warm."
- Spends a fair amount of time with playing with the shrink and grow guns, makes
- Another moment of AR and R clash: “It’s so weird, I want to move (real) objects on the table, like annoying coffee cup, go away!” later she puts cups and coffee pot away from the table to have more space for the virtual objects
- Found it hard to interact with objects that were "Hidden under the table" … Didn't seem to find the "trails" that indicate the occluded objects helpful
- Plays around with the grow ray and grows mushroom object to the max (“is it gonna explode?”)
- “There are a lot of question marks on the wall too, does it mean something is happening there too?”
- Failed occlusion/mapping: "I think it's in the oven."
  “I’m kind of confused because there is so much I can do, so I don't really have a tactic."
- Remarks on the heaviness of the phone: "It's tiring to hold."
- “My eyes are getting tired of all the popping …”
- Uses the shrink and grow rays on real objects in the world
- About the game object Pyramid: "Didn't like it."
- Aliens: "Scary."
- Feels the need to “clean up the stuff”, declutter the screen
- “The guns are just adding more chaos”

AO

- Places the first object (house) on the sofa.
- Places cloud on the ceiling: "That's pretty cute!" That’s kind of cool. Plays with the dongle
- VFX trails: “So cute, the rain is coming at it. “
- Laughs at the growing plants "that's kind of cute."
- “shocked” when she accidentally grabs the things and puts them in the inventory (just pushing on buttons randomly)
- Occlusion: “Funny that it’s disappearing…. Maybe it didn’t register”? The game character “disappeared” under the couch, and one could see his outlines to hint that he’s under the couch. The participant took it as a glitch and not as sth intentional
- Lots of laughter and giggling at the sight of game objects
- Unclear about the game play “So I’m winning things, but….”
- The object hints seem to work (missing objects, or what to do)
- "Why would I want it to rain on a sandbox?)

- Confused on how to interact with the rockets and the character, taps the objects menu buttons but does not use drag and drop ”I don’t know how to do this, it said attach…”
- Laughs at the appearance of the aliens, unbelievingly
- Follows the game objects, e.g., follows the aliens with the phone as they fo through the ceiling
- Wants more space (even though the living room is quite spacious). Squeezes into the corner of the room to get an overview of everything that is happening in the room
- Makes room of whats happening on screen
- Quickly annoyed by the rockets messages. Tries to make them fly many times.
- Lost in the game play, does the same things over and over again
- I tell her to look more on walls and ceilings and crash sites to find new objects
- “Uh oh….” Second time the aliens appear
- I explain the take back function to her after she mentioned she loses the overview
- Vfx trails / clouds: follows rain/snow trails
- Looks up from the screen to see if the sun is there
- “tracking lost” - Pyramid glitch
- Seems unmotivated, randomly clicks around

IT

- Very excited from the beginning and throughout the whole game play: “This is so cool!”
- Amazement: “How do they do this?” “How do they detect the walls and stuff? It#s crazy”
- “So I need to go through all the question marks…?” confused about the mapping. One can actually start after a bit, and the phone keeps scanning.
- Confusion about game play / the sense of the game: "What do I need to do?"
- Laughs a lot, copies the sounds of the character
- Placing of the cloud: "That's cool!"
- Needs few times to figure out the interaction with the cloud: "Why is it not working?"
- Bumps into me “Where are you?”
- “Oh my god it’s raining…. Awesome!”
- Plays around with placing the flower on sofas, tables: “This is so cool, I can place it everywhere!” – “Oh my god “ - Best thing is you can do whatever!” "I'm rearranging everything it's awesome. I want structure, it’s getting messy.”
- Aliens: "OMG."
- Excited about all the game objects… “What do I have? What did I get?” but also forgets about them in the inventory.
- Enjoys he grow shrink rays: Okay “It’s Denmark, I want more sun” (grows sun), grows a lot of other objects
- Randomly taps the character and imitates its sounds
- Moves a lot around the room, sitting down, crawling on the floor to get closer to objects
- Bumps into walls a few times while playing the game, seems pretty absorbed
- Making things grow with the sun and clouds: “This is sooo good. It’s so cool…. I think I’m an easy target for this… what a great game."

- Unsure about the game play “I need to figure out what to do next” – “now I’m stuck’ clicks randomly on objects and shoots with the rays
- Follows VFX trails from clouds: “Omg it rains!”
- Seems to be a bit impatient, doesn't wait for animations to end, e.g., when the character goes into the pyramid, he continues tapping it, until the game breaks and the character is lost. We need to save and reload the game to fix this.
- Seems to be very engaged and involved in the game.
- “Sorry I need to tell more what I am thinking, but it’s so funny!”
  - It's so funny, why is everything just so random stuff (toilet and poop)
- “Wohoooo…. Eiii… oh.” Rocket crash.
- Talks back to the game characters
- “There is so much stuff going on the room!” – feeling of presence of the game objects, a bit of visual clutter on the screen
- “can I download this?”
- Plays a lot with the shrink and grow rays. Makes some "Logical" arrangements, e.g., growing the house object to fit the cooler inside
- First one to “finish” the game. Gets to play the sandbox mode too.
- After the goal of the game is achieved, a lot of f things drop on the floor, and the room is flooded. The flood animation/visualisation does not work as well as the room is cluttered with a lot of stuff and the tracking seems to be lost in between. There is water on the walls etc. "It's super hard to see now what to do."
- Amazed by the “hole” in the ceiling: “Look I can see the little guy flying around.”
- “Ohh man… that was exhaustive… intense! I’ve been locked to the screen; I haven't seen the real world… Wow! I need to relax for a moment. That was seriously a bit intense in the end. It's weird to look at the phone and hold it the whole time. I really like it; it's really fun."
- “I’m done. I’m a wreck. It was really intense.”

KL

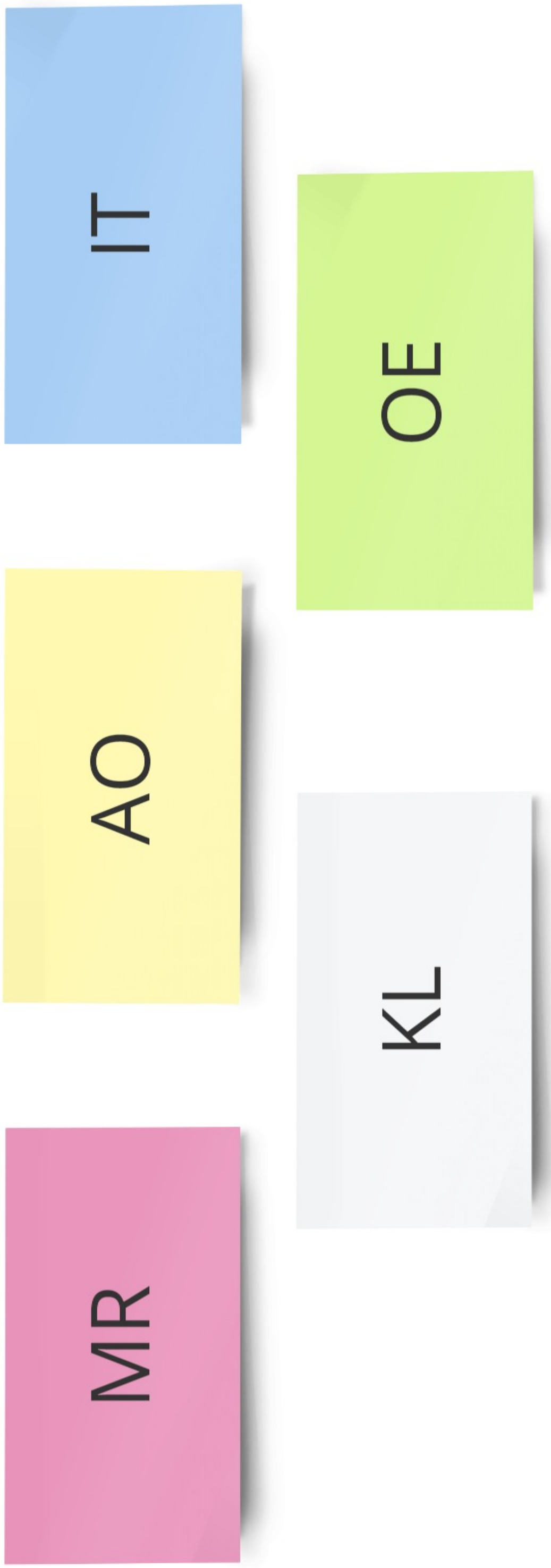
- "I guess I need to scan this properly, otherwise it doesn't work?"
- Tries to make all the question marks disappear
- Doesn't understand the spinning wheel, clicks it a few times before he understands how to interact with the objects. "It doesn't work."
- The game character walks on walls, but the participant takes it as an error: "I think it's just floating around."
- Fails a few times to put the cloud on the ceiling, because he drags the cloud instead of the socket.
- Impressed by the rain: “Woah”
- "I want more stuff."
- "Sorry, I am the worst player."
- The glass wall is a problem early on. The character walks around outside the room.
- Stuck pretty early in the game, now knowing what to do. Seems frustrated. The hints the game is giving don’t seem to capture his attention. After a while of frustrated looking around, I tell him to look at the floors and ceiling as well
- Other people living in the dorm are present as well. They eye the participant while he's moving around the room playing the game. They ask him what he’s doing and he shows them a bit whats happening on the screen. "it's a game, not a narcicist thing" hinting at that it looks like he is taking a lot of selfies while he

is holding the phone up to place objects. They giggle and think it's cool, but move on to prepare their meal. Ask if they could try it later.
- Surprised by tinting of the screen/moon: "It's dark in here”
- Shows little interest in action happening on the screen, e.g. ignores aliens largely and looks around the room even when they're not gone yet.
- Shrink/grow ray interaction: again, the participant clicks on the spinning wheel thinking it will elicit the grow rays. Then he tries to swipe the guns.
- Another person enters the room and asks for a lighter. Also, asks what he is doing. He shows whats happening on the screen again and then hey go together to his room to get a lighter. He's taking the phone with him just holding it in his hands, but not paying attention to it. The phone loses tracking, and when he comes back to the room, all the objects he had placed in the room are all "outside." (the room is on the ground floor and has a large window wall which the camera apparently cannot map)
- We try to save and load the room, but it doesn't fix the tracking. For the fun of it we go outside and try to "find" the objects, but the tracking cannot keep up. We restart the game, and he has to start from the beginning.
- Seems annoyed by the elements in the room "the sun is in the way," feeling of presence
- Does not see new game objects on the ceiling
- Sounds seem to guide his attention better
- Affordances: The sparkling question-marks which are designed to hint at the player that the object is of interest and should be further examined, do not seem to work for him. He looks at the objects for a while, but does not tap on it and moves on.
- As we had to restart the game, he had to do many of the things in the game twice. Still, he did not remember what to do with many of the objects, even though he had just done them before. Does not speak for a lot of investment.
- The presence of other people n the room seems to make him hesitant to share his thoughts, he's more quiet then before. Or: just bored.
- Many objects on the screen: "It's messy."
- Moves objects in the corner he wants to have out of the way
- I explain to him that he can use the grab control to get them back into his inventory, he didn't notice it before
- Impatient, does not wait for animations to end, moves away and looks for new things.
- Annoyed by the rockets, what they're saying and that you have to click on them again and again
- Reflection of light on the tiles disturbs tracking
- Throws objects at me

OE
- Room: living room in shared apartment, quite cluttered with furniture.
- His girlfriend walks into the room while he plays the game (twice) and tries to sneak on the screen from behind, but he doesn’t notice her
- Accidentally places the first object (house) on the wall, just tapping around on buttons to figure out what they're for: “Ah no, it did it wrong!" – Seems to think the phone is mistaking the wall for the floor. While it is actually meant to be open for interaction.

- “I need some more houses" to put it on the floor. Does not understand he can drag and drop.
- Drag and drop of the cloud unclear. Drags the cloud itself to the ceiling, not the socket.
- Confuses the things in his room (colorful painting) with object in the game
- Moments and laughter of joy when objects appear and in interaction with objects
- “How will I get more things?” game play unclear
- Excited about interaction with the cloud: "Look, I made it grow! Yay!”
- Game play and goal unclear: "I'm still a bit confused."
- Swipes shrink and grow ray guns to elicit shots.
- Kneels down and moves closer to pyramid and tries to look into it
- "Oops" – "Ouch" – Sounds of "empathy"
- Puts objects in the big cup to "make soup"
- “stupid cloud” misclicks on objects hanging from the ceiling which is in the way
- Does not see the "crash sites," which give new important objects for the game. Tell him to pay attention to them,
- “Yesssss” – sound of achievement
- Outs things in order, e.g., places flowers and sprouts on the window sill, so they belong there, and so he will know where they are
- “It’s so Japanese!” – commenting on the general visual style of the game and interactions, e.g., the snowman and game character sitting at the picknick table and talking
- Also, finishes the game til the end.
- “funny that it’s right where the chandelier is” – rockets went through the ceiling where the chandelier is hanging
- “I’d really make sense of this and tidy it up” – wants to play longer and “clean up” the space from all the new objects that came in when he finished the game
- Played for a quite a while and still wanted to keep doing and spend some extra minutes in sandbox mode.
- Mimicking the sounds of the objects
- Place huge objects in room (donut, toilet), hangs multiple suns on the ceiling
- “if the rays would work on my can of beer, that would be dope” – trying rays on real objects
- A lot of creative play in sandbox mode: “look, I’m playing beer pong!”

d) Affinity Diagrams Pre-Test Interview



AR: Expectations and Experiences

AUGMENTED REALITY

CONTEXT

SOCIAL

Amazement

SC: I was pretty impressed by the filters and how they stick to the face, the facial recognition... but then m boyfriend said it is actually not that high tech, and I thought that it was.

Google Translate: Otherwise, n the beginning it was really mindblowing, real-time translation. It changes reality kind of... like it changes the packacing. I think I used on a pack of Aspirin in Belgrad and... it kind of feels like the package is changing in front of you

PG: But it was funny in the beginning... OMG there is a POkemon on the table!

Presence

AR TV Quiz: In that particular moment I was hooked... it's more interactive than just sitting in front if the TV, especially if it's like a Quiz Show, you feel like being there yourself. But it's nothing compared to virtual reality.

Playfulness

Experience with an experimental marker-based furniture app: " The fun part was you could lift that sheet of paper and pretend you lift like a huge shelf and make funny pictures with it."

SC: If I move my head it just maps it perfectly on my face. It's super natural. I remember when I was with my niece and we just played around with SC and snapped faces, and made rainbows coming out of our mouths... that was very playful.

SC: Stickers, anytime I place them all over the pictures, or the filters.. especially the little meer cat one. But it'S purely for entertainment value. Its just funny, it adds to your little video.

AR Yearbook: "If you move your phone over the book, you will see a video of the person. It was super cool, it adds so much to the book! A static picture can become a video, that's really cool"

Relevancy

SC: Filters based on locaton or events

SC: Sometimes when new movies come out, a Harry Potter filter or Game o THrones... then I think it's more relevant and more fun. Because itÄs more related to what is happenng there and then, fex GoT and you can send them to your friends.

Relatedness

SC: Faceswaps, Animations. I really like the simplicity of the faceswap. I could spend hours with this! At parties and stuff it's really fun.

Pokemon Go: It was super nice that we actually went for walks, me and my boyfriend we would go all over the place to collect pokemon and go to gyms...

SC: If I move my head it just maps it perfectly on my face. It's super natural. I remember when I was with my niece and we just played around with SC and snapped faces, and made rainbows coming out of our mouths... that was very playful.

PKG is also a social thing. In my home town, we went onto these raids at night, just a gorup og guys going around the city and we walked for kms to kms. .. so the game stimulates you to walk.

AUGMENTED REALITY

Detachment

GoogleMaps AR: "It's also a new thing, it's just weird to take out your phone and look through it to find something, instead of using a map."

PG "People are so much on their phone and it's super dangerous, like their walking in the real world but on the phone they see were they are walking and where the Pokemon Go is, and it's so dangerous."

GoogleMaps AR: "I think ti's a really good idea and it would work ... but it also really disconnects you from the reality. Of course it's an overlay. When you have the ma, you're static and you just look at the map and then at the real world again, and now you have this thin layer between it. "I just don't like that you're holding the phone and that you have an extra layer between you and the world, for me it feels weird. Maybe for the next generation it will be supernormal. I just want to experience the world in real life and not through an extra lense. And although it gives me all these extras... I just want to see it myself in a way. I don't want to look through a screen to see the real world."

Rendering/Tracking

"I think I downloaded IKEAs app like a long long time ago, but it was really really shit. Cause you could like place out the furniture in the room it was like hacked, the furniture was liek floating in the air.. none of the shadows looked correctly... i might just as easily cropped out a picture and held it and... "oh that looks nice".

Google Translate: "I don't use it too often, because it is a bit laggy and the recognition doesn't work like a 100%, so I get better result when I'm just typing it off.... There was like a block of text, and then it would translate only 75%. There were some blocks of text that were missing, and then out of context, it doesn't get the translation right. That's always a bit disappointing.

Google Translate: "...you have to be so steady with your phone. You can't even shake a little bit. Because then it starts the recognition process again. And then it lags. And then it doesn't recognize a specific piece, then it tries to rearrange, then it takes some seconds again to rebuld the image... and then you have it and you shake and then its gone."

PG: I played PG quite seriously, I caught quite some cool Pokemon. It was just a video on your camera, and then they would place the Pokemon just anywhere, and it didn't care it was a surface or on your head or sth, they would just place it. And if you move around, then the Pokemon doesn't stay at the same place.

SC: When it doesn't recognize your face at night... or it does not recognize your cats 'S fair.face. but I guess that.

WOW effect

PG: Seeing the Pokemon Live didn't fo that much for me... I actually turned that off. Also it was easier to catch them without it. With a lot of background noise in it, it was harder to throw the ball. Plus it drained the battery a lot.

PG" I always turned it off bc I think it adds no value to the game. It's fun in the beginning, especially when there is a Pikachu on your head, but it doesn't really add a lot"

CONTROL

SC: It made me feel old when I couldn't use it and I thought it was more high tech than it actually is.

SC: At first, I was like, this is nor for me. I couldn't figure out how to use the stickers, it was kind of not intuitive.... so Snapchat made me feel kind of old. And then my friend showed me how to use it and then it was okay.

I guess my expectations always get higher... it was very cumbersome to download the app, and figure it out and to be in front of the screen at the right time, and the show was just going on... it was just very stressful in the moment. Also very exciting, but why didn't it work right away? So I figured it out eventually, but I deleted the app right afterwards. it was completely useless without the show ... the latency for logging in the answer was always quite high. so I was always afraid I was too late

GAMEPLAY

PG: Leveling didnt make sense

PG: Seeing the Pokemon Live didn't fo that much for me... I actually turned that off. Also it was easier to catch them without it. With a lot of background noise in it, it was harder to throw the ball. Plus it drained the battery a lot.

SOCIAL

(Non)RelatednessPrivacy

SC: My sister spent like half the christmas taking selfies and doing faceswaps on Snapchat... and my Grandma was just like... can't you out it down... yeah... I rather wish it was for something useful.

I thought it was always awkward to play Pokeom Go. I'm 26 years old. ItBut it was always awkward when I was in Amsterdam going to my internship and I was on the street, I was always trying to hide it, bcl didn't want anyone to see that I#m playing PKG I was ashamed of it...

PKG: The app itself was kind of fun and entertaining. Some of our friends were quite hooked on it. I also tried it out in Bakken. That was quite fun but also awkward, because people were battling for these arenas and they were like almost standing next to each ithe rbut still like fighting against each other, but also not talking, they were taking this really seriously. When I was walking around like ohhhh yeah, and then I saw some other kid with the phone: yeahhh there's a Pokemon over there! But still... I tried to get in touch with people, but they were mostly in touch with their phone. Even though you have your opponent right over there, they would not interact, and I think that's kind of awakward.

MOBILITY

PG: Battery draining

AUGMENTED REALITY

Technology

Better IKEA app: I wouldnt mind setting u the world, but having like the shades and lights and color correctness of the room.... yeah and scale, seeing how big everything is. that would be cool.

Google Translate: "I would speed up to process... because you have to be so steady with your phone. You can't even shake a little bit"

Use Cases

Great to preview furniture, or anything for big purchases... maybe people would be more happier with their purchases.

"I think AR can be useful f.ex. in the car, when you have it in the front screen and it could highlight something ahead of you"

GoogleMaps AR: "It could be really cool for tourism. You could be in front of a buliding and point your phone at it and then a video would start playing with the history or something... there are so many possiblities"

"... it would be cool for paintings in a museum! instead if getting an audiovisual tour, you could get an AR tour... you could maybe see the painter in his workshop or sth"

MOBILITY

Captivation

"...I don't want to look through a screen to see the real world. I think it would be better if you had glasses, and you would only see the icons projected on them. I don't like to watch through my phone. People walking around with their iPads taking pictures, I already think that's weird. Why is that necessary?"

If the technology was perfect, you wouldn't have the screen in your hand, you would habe the vision on your eye somehow. Holding a screen really interferes with your environment... I find it a bit disturbing to have this screent hing that you have to hold. But I also don't want to be in this virtual reality. I want something inbetween. AR but better than on a handheld device.

SOCIAL /GAMEPLAY

PG: I would tie it up to the other users more. Most people would go out with friends, but there wasn't much in game contaxct with other users... it would be cool if me and you could trade Pokemon and fight each other.

"In a perfect world, it would be like having toys that you don't own."

First Impressions

To try sth new is quite memorable, and feeling that it triggered my playfulness in an easy way, before being too serious. (building the sky). It felt very fun.

It's funny, you don't need any skills prior to it to play it and it doesn't matter how fast you do stuff, there is no time limit. It feels like a really open easy game. Just explorng, things are happenng and the block guy is just guiding you through everything, you know you can click stuff...

In the beginning it was very enticing, because I think I heard about Project Tango and this phone too, and I remember I was being pitched with this huge screen and the camera so it was really nice to get a hands-on experience with that. As someone who is a bit of a techy guy, it was cool to get the latest project from Google.

"Fun, but disturbing"

If I was a kid I would've fucking loved it. I still liked it

It felt like it doesn't really detect 3D objects in the room yet. It feels like it only detects surfaces, but not for example the table and all the stuff that's on it. The little guy just went through it.

But the game itself was pretty disappointing. It's not really fun, there's no real game play going on, and it's also limited by the recognition abilities. Maybe it works better in different kind of rooms. WIth little objects, a lot of space. Like a jail, for example (laughs)

I don't feel at all to get the app or get a phablet or to use it more... I just don't thin it's very useful. You could also learn sth by playing it.

It felt like a weird dream.

Cute, a bit odd of course witht he poop... but it was cute. But maybe I'm not that much of a gaming person, I was very quickly like... yeah, okay. enough now.

Has seen a demonstration of Tango before; expectations were low and met regardng the technology as such

I would like to use it more for useful stuff, getting information about your surrounding, maybe in a new place. I mean itÄs fun, btu it doesn't help me much developing my interest for AR.

Empowerment & Autonomy

General

It was really fun, it's kind of an endless game but I think I figured everything out, also time wise it was a good frame...

Augmentation

(The failing recognition) also that limited me from exploring, because even though there was more space. I kept to one spot, because I thought Ehhhh, if I go there, it will probably behave buggy. And that really inhibited my desire to explore. .. I had an idea, it works on the couch, but it doesn't work well under the table. That was limiting.

The second time, I was more aware of the restrictions and placed the objects more on easier surfaces. VS I didn't think too much about the limitations

Game Design

"It was fun. I only felt like... I don't know how it is if you play longer, but it is quite linear in the beginning."

Usually when I play games there are certain rules. I'm not used to it being so real. It was so free evrything. it was almost like too much, it became quite chaotic. I could place it everywhere and, you saw it with the pyramid, ti was just in the way and I moved it to the corner. SO maybe because its such a freeplay kind of game it opens up for more chaotic situations.

Meaningfulness

Augmentation

"It didnt matter what kind of room I was in. Like if I was in a kind of weird room, it wouldn't have been any different. Which wouldve been interesting, like if you had sth growing out of every powersocket or sth, that woukd urge you ti find some crazy rooms with a lot of angles. More randomness

I got the feeling that it does not really interact with the environment, but it just maps it. It uses the room where you are as a basis, but after that there's nothing else except for placing stuff. It's not.... that it's interacting with the real world that much. Although I thought the end was really cool when there was a hole in the ceiling.

Interaction

That was nice about the sun and the flower... they were just "obeying"

Game Design

Maybe just... whats the point? You dont really know what youre doing. I guess it's the kind of game where you can't play it wrong.

Hard to know that you're doing everything correctly. There are little rules. You feel ike you donÄt really know what you're doing. That's okay, but maybe not for the long term.

I got a bit restless, and then okay, whatever, next. I didn't have the feeling that I need to figure it out, because I had so many other things to do.

In the beginning attching the clouds to the sky and the sun and the stuff... of course it got a little bit repetitive, but I liked that you could easily move it, and then when you drag the cloud, it would kind of move up and bounce back... and that it knew where the ceiling was.

Efficacy & Mastery

General

I feel kind of stupid. It's very basic and still very confusing.

Augmentation

The ??? - I thought it was just some weird artwork or visualisation, I didn't really notice it as a hint. Then I would ignore it.

Interaction

All the interactions are quite the same in the game, so you figure it out quite quickly.

The house felt like a big fail, because it was attached to the wall. I mean it's the basic idea that the house had to be flat on the ground. Of course it is fun on the wall, but it was also a bit irritating. So already there, I felt like I put it somewhere where I didn't want to.

It worked really well, it always everytime tweaked it exactly the way I wanted it.

Game Design

I couldn't get it to progress. And then I thought, do I need to plant them all?

Just that I couldn't get it to really get further. And I was getting a bit frustrated about the sprouts. I don't want more sprouts!

I only got forward because you told me... otherwise I wouldn't have looked around the walls.

... but it also makes it a bit... I don't know how good I am in the game, there is no sort of competition element in it, it's just exploring things, and there's things on the floor, but I never get the feeling "Oh no, now I really have to hurry up"

"Clouds like ceilings" - They did that really early in the game so you could figure out what to do, that it's real 3D and not just flat surface with the floor. That was really smart.

You don't know how well you are compared to others... I'm really a competitetive guy, I really want that competition at some point to keep me playing.

I could solve the riddles. But they were fairly easy. So you don't feel exactly super proud.

Every little thing you accomplish in the world is a moment of joy, but i mean it's also... not really talking about. I wouldn't tell my friends: Oh, yesterday I unlocked the whole game of WOORLD, or found a new piece of poop....

During the game, I was thinking about some of my friends who would probably perform amazing compared to me, they would have probably finished it in 15 minutes. But I felt comfortable and okay with my performance in the game, but I also think that I'm not very good at it in that sense. Probably getting too old for this stuff.

I felt like I managed to do what I had to do, without having been told anything. I didn't think that I never did anything great, but the game made sure that it always moved forward. When something new appeared, you felt like: Oh, I did sth correct-

The game play is always the most important thing. You know, that's the thing... the best games are always like new graphics coming out and everybody is like WOW, but after you play it for 20 minutes you're just used to it and it doesn't matter anymore.

I didn't know what it was about at all, I figured out quickly that it was about doing these small quests or whatever, but... I just started doing stuff even though I didn't know what i was doing.

Felt stuck quite often - "And then I just pressed the button five times more againa nd then yeah... then I move on. I can't really figure it out, because there's tons of other stuff to push and try"

In the beginning, I was a bit worried because you were here and I thought: "Do I play it fast enough?"

Intuitiveness

Interaction

"It was very drag and click and double-click, a lot of moves you were used from your phone. So that was pretty natural. And also just looking around through the camera feels quite natural"

you know you can click stuff, either you can put it back in your pocket or there's something you can do with it, it's super intuitive

It's quite intutitve eventually, of course in the beginning i's weird and you have to try a few things, but... it taught you how to play the game without having to read the rules.

It worked really well, it always everytime tweaked it exactly the way I wanted it.

It was really easy, I guess because our phones all have touchscreens and this drag and drop...

Even my mother and father could play it. I really like games where you don't need to read the manual. Just by playing it you get kind of drawn into it and get explaned further down..

It was user friendly and realistic... so when something was moving it was harder to catch it. So that was really good. And it made sense and it was easy to use.

The 3D objects are just objects. So you can gab them, put them somewhere, just like in the real world, it's the same. It's siper simple.

"It was more like picking things up, and I picked sth else up, was missing things... that was a bit tricky"

Confused about interaction. Tries more drag and drop, the Greifer is weird... "Whaaaat... what is going on?" Grabs and drops flowers several times

COntinuously uses the swipe control, not knowing what it does (or rearrange)... takes a while to understand what the symbol means.

I think not so much about the environment, it's a living room I know it's more about the app and the buttons you can push and how you interact with the AR part. That was rather simple I would say, even though I was struggling quite hard getting the things back in the pocket.

Game Design

Tutorial: you know you can click stuff, either you can put it back in your pocket or there's something you can do with it, it's super intuitive

It was fun... yeah... it is... it's fun it's exciting. It's somewhat intuitive, you do the same kind of things over and over again, but it's still challenging to keep the overview.

Awarness

Augmentation

Maybe if it could know a couple of rooms here, and then you could "punch" a hole in the wall and see the other room...

It made me see my surroundings that I am vey used to in a new light, that enticed to explore... to place objects on the table I have seen a million times before.

The objects are lame. And throwing around yellow poop in the corridor... would be more fun if it was real. If the objects were really manipulating the environment... if I could place a bomb and it would explode and there would be a hole...

It actually made me more present in the environment than without the device. Because it makes me interact with the objects in the environment that I usually just take for granted as being there. The table is there. It serves me a functon when I need it. But this game made me rethink it. So I was interacting with the world in a way I haven't done before, so it made me more aware of the world.

Amazement

General

Nothing out of the ordinary.

Minute 21, comparing the game with the joy of moving to a new city and discovering the environment: So the way home, driving down Noree Allee... this loooong stretch... (annoyed) in the beginning it was like oh wow, left right, skatepark and so in... and then you start to filter out. With this game, it was kind of the joy of getting to know your surroundings for the first time was brought back. But then I felt like Norre Allee again.

It worked impressively good, also compared to my AR experiences couple of years ago, and oretty much 360 all around. But then again there was also a lot of imperfections. It was good enough for the game, but it was not perfect.

I am very aware that is an app with a lot of limitations. It's fun to play through it, but it's nothing mindblowingly amazing.

Augmentation

I was impressed that it could... that you could quickly scan the room and then it registered pretty well, and it also regisered, you know... "clouds go on the ceiling", what was the ceiling and what was the floor.

I was quite impressed with the technology, but maybe it's just like with Snapchat, maybe I just don't know how far technology has come? Maybe it's something very basic, possibly?

Little bugs in the graphics annoying: The pyramid had like a line thorugh it where you could see the floor stil, I moved it around a bit but it didn't go away. But it wasn't there when it was smaller, I had just enlarged it and then the line came in.

It worked really well, all the objects were always where you put them. That's what really amazed me. The house, it was just always in the same spot, as if it were in the room.

I don't know if it was the room or the light, but it didn't work too well, it lost tracking quite often. E.g.

It's not a big problem, it does not interfere with the fun of the game and stuff... I'm still excited though, I focus more on the parts that work!

(tracking lost, objects were outside): I thought oh well, then I go outside... but there were no boundaries, and the app went crazy. So I had to restart the game.

And then I was scanning the room... it was really intriguing, really cool.

The camera was not so good, it had especially programs with low light situations, you were having all these bleak colours making it look really bad.

Manipulating the real world. Objects stay where they stay.

Interaction & Control

Manipulating the real world. Objects stay where they stay.

In the beginning attching the clouds to the sky and the sun and the stuff... of course it got a little bit repetitive, but I liked that you could easily move it, and then when you drag the cloud, it would kind of move up and bounce back... and that it knew where the ceiling was.

Mobility

Of course you can walk around things and look inside things, but it's almost not worth kneeing down

It's fun because it's your phone and you feel like you can do sth special with it, compared to just having a console.

Game Design

Impressive technology, but I'm not that engaged in the game.

Placing objects: Pretty boring, very repetitive. It was fun the first time Oh hejjj, I can interact with the ceiling... but the magic quickly evaporated. The gameplay was very dry. / Amazement Gameplay.

In the beginning, I was super into it because of the WOW, but the further I got into the game, the less I was, in the end I just was "I just want to sit, not walk around too much anymore, take it easy". It had a real WOW effect, but you get used to it, so quickly... that's why the game needs to be really interesting to keep on playing it.

And then I started playing the game, and the gameplay itself was just... place an objec, click on it, interact with another obect, find another object, and then it continuues.. and that became quit eboring prettty quick.

Surprise

Augmentation

I didn't expect that things would be growing from the walls. Also the mushrooms on the door. That was funny. It was a lot of unexpected elements that came in. But then toegether with everything else, it was a lot.

It was really glitchy. On some level, I was suprised that it would map correctly the sofa, and that I could put it on the sofa, but then things would vanish behind the chairs and stuff like that... when the structure was too complex, it wouldn't recognize it, like the bar stools. They were painte dblack, i think it isjudged it as shadows. Also because it wa skind of dark.

Also when I reloaded it and there was a little sketch of the room and then everything was exactly where I had put it before, that was very impressive to me. I wouldn't have expected that, I had no idea how it was supposed to work.

It's getting much better, I was suprised how much I got a sense of that the floor was actually there, which I hadn't had before.

Step by step you getting further... even just arranging small stuff on the floor, that was really satisfying for me and that you can move stuff around and attach it to the wall, to the ceiling... I did not expect this, at first when I tried to place the clouds... I was really surpised I could put it on the ceiling!

Game Design

I saw a of things that I haven't seen before and I never tried a game like this... so it was alot of fun, and you were surprised by things...(It's not only the novelty) but it was also the sounds and the clicking and the interface.

FInding the Snowman and all the rockets, that came out of nowhere... all these small elements, that kept you surpirsed and in the game.

Design, sounds animations...the music... the little sparkling things when sth new happens. It was never still in the game.

It was so playful and bursting with things... but I think it's also because it's my very first time playing sth like this. I think if I'd get used to it... for me, more of the fun was: Ohhh, Augmented Reality!

It was super lively, and the cute little sounds and tlak to you nd suff they were making... yeah. it was fun.

Playfulness

Augmentation

Yeah it was cute, but in a creepy way. Because you didnt know what was happening, why was this thing running around? But it was fun that you could like find stuff on the wall and stuff.

It was so playful and bursting with things... but I think it's also because it's my very first time playing sth like this. I think if I'd get used to it... for me, more of the fun was: Ohhh, Augmented Reality!

Interaction and Control

It was new, I had never interacted with my environment in that way, it was quite playful.

I really enjoyed that.. probably more than the actual quest. it took a couple of minutes to figure out how these weapons finally work. And when I did... then you have a direct response and you don't have to solve a quest or anything, you cna just change stuff in the world, make it big or small. Idk, it was probabyl the fun part about it. It's fun and fascinating, but also when you make things bigger, you get aware of the limitations of the screen. Because suddenly, you have a big white surfae and you cannot see anything. And that's a bit disturbing again.

It was fun to attach a cloud to the ceiling and water a plant with that and watch it grow.

I really enjoyed making things big and small and stuff...

Game Design

It was super lively, and the cute little sounds thez were making, and they talk to you and stuff. yeah. it was fun.

It felt very japanese, with this weird companion and stuff. It didn't really resonate with me.

This weird box running around... this weird compainon...

It just becomes ridiculous with all the stuff... it doesn't make sense

It's also a lot with the sounds and the music, it's very joyful and easy

Liveliness

General

Quite a lot that happens, a lot to figure out in a short time. You can get lost

It was so exciting, and something was happening right from the beginning. Just trying more and more and put stuff out and you have a lot of stuff everywhere.... you don't really know the basic functions before you start. You plant all the plants and then at some point when it gets too messy, you actually figure out: Oh hey, I can also store them again!

All the little colorful things that move around, that's what caught my attention, not the room itself, that wasn't really a part of it. For me it was more like, random surfaces. It was more the AR on the screen rather than the environment I am actually in.

Augmentation

It was so playful and bursting with things... but I think it's also because it's my very first time playing sth like this. I think if I'd get used to it... for me, more of the fun was: Ohhh, Augmented Reality!

The flooding in the end was really annoying. I think it's a bug. So the water was supposed to be everywhere, but the phone did not detect the chairs, the kitchen counters... there was water everywhere and it looked really messy. There was even water on the wall a bit, that was weird... The water was mostly around the kitchen counter, I think something went wrong with that area.

I can't really get an overview.

And the rockets were a bit messy. A bit chaotic. Just too much happened when they started. When the objects are too big then you feel like you're deifnitely in the game, when it takes up th whole screen and it doesn't really add up with what you're supposed to feel. Then it really disconnects you from finding that virtual vs. real.

It was too much stuff sometimes for me. I spent at least as much time tidying everything up as I spent time putting the objects out there. It was a bit messy for me.

It was also a bit distracting, it was too much stuff. I think if I would play the game again now, I would play it very differently. I would probably have it more in order so I can actually use the surfaces and make the gameplay easier for me and not ahving 10 things in the way when I have to get through to the fridge. That's kind of what happened sometimes..

It was so messy, but I also couldn't be bothered to clean it up. It was hard to look for stuff.

Game Design

Those objects were so inflationary, I became wary of them in a short time. And then there was this lame animation (pyramid) and I just wanted to progress. I didn't really want to see what thse things were doing. I just want to crack the riddle as fast as possible.

Captivation I

General

I feel like it's more a personality thing. Even with board games and card games I'm like... ehhh, do we have to do that?

I felt very focussed in the game. This is very intense, you kind of lose yourself in it a little bit

I wasn't excited enough about it to keep going. I just wanted to stop.

I saw a of things that I haven't seen before and I never tried a game like this

Kind of at first, because it was cute... but later I was like, okay. Maybe if I was just hanging out at home, I would use it and if I didnt have anything else to do... but I wouldnt priortize gaming. I don't feel like I have any desire of exploration in that realm anyway...

I felt really detached from the environment, when I stopped playing it and I stopped watching the phone, I thought "Oh f*ck I am here, and I walked around everywhere and just been in the phone playing the game. I can be really focussed on this kind of stuff but it's also when you're done with it, you realize: Fuck, I don't know how long I have played it, . I don't know anymore, I was so in the thing.

The surounding world just enhances whats happening on the screen, but I don#t feel like I am a part of the real world when I'm doing this game. It's not a parallel universe, but at east I disconnect from the real world and I focus onthe AR world on the screen.

...it was super intense and exhausting and I needed a break after playing... that's when you realize, you're not in the real world anymore. [...] I was in my phone, I wasn't in the environment anymore.

You really get into the flow, that was from second 1, once you put the first thing on the flor, for me at least, you wanna try it out, what does i do, how do i make this work...

Augmentation

Maybe just an interesting point, it felt just as immersive as the virtual reality. Even though it was a cartoon. Can't imagine wht it would be like if it looked more real..

It grew very nice with the surroundings, most of it was very natural, the way it clicked with the environment, like the moon and the sun and the clouds.... it looked like it was one with the kitchen. It blends in naturally.

The games character was a bit annoying. That he moved everywhere. I guess it depends on how big of a room your playing in. This kitchen was quite small. A big livingroom would be better, with few obstacles. And I guess it has to be played in a bright environment.

You're so foucssed on interacting with the world, that menu... like the notification... had transparent box with text... I didn't really recognize it at all. I actually found it distracting. I felt so annoyed by them, bc everything felt so natural, but they really felt unnatural. I actually intentionally started ignoring those messages,because I found them distracting. They felt so off. It would be nice it would be somehow attached to a 3D object, so it would be a part of the world.

And you could feel that the objects where lashed on, and you could tell that things were stuck to the floor, they were not hovering.

I feel like I'm doing things in the real world, even though I know it's not. I think it's the mapping of the digital objects to the real location. It feels the same. It respects the law of physics. As in, I put something there and it will not float and stay there.

There were some things, when I moved angle, everything looked just different. its hard to get the placement perfectly, but when you move around... everything got shuffled. Thats weird. Imagine youre a kid and it builds this really nice thing, and when you log in again and averything is moved. Bec thats what happened, all these flowers and mushrooms I placed where stuffed in this really big lump in the closet

It's not about the device itself, you actually forget about it. Because you get kind of sucked into the experience. I was opening it up to it fully. But then the glitches were alittle bit frustrang, and that made you conscious that you were in a simulation. If it wasn't for that, I think you cna get into a state where you get really lost..

I kept wanting to zoom in (on the screen), but ofc that didn't work... because of the space. You had to walk closer... so there I maybe forgot I was in the environment.

...when there were alot of objects hanging from the ceiling, it was super crowded but also, I didn't want to move that much bc there was not too much space of moving around. it made me feel like I want to get out of here.

When it's too much stuff, it definitely beaks the barrier between... this is real and oh, this is definitely not real, because it's jsut too much. You totally don't feel you're in the actual environment anymore.

Feedback from the surroundings. That's whats missing for AR. I see other applications for this kind of technology other than having some Anime clouds above your head.

The space got small quickly because there was so much happening, which was cool, but it was good that I could easily move around. Might be fun to do it outside.

It was really messy. And I also didn't remove any of the objects, bc I didn't know if I would need it later on. It became very cluttered and crowded. It made me feel a bit claustrophobic.

With other games, I tend to get very invested.... you kind of make it your little home and everything has to be in one way. And it feels like I wouldnt be able to do that in AR, because it still feels so non-stable.

Captivation II

Mobility

I think it can be a little bit too much. It takes a lot of energy to move around and hold the phone and look up and down... it's not as comfortable as sitting on the couch, having a controller. But it depends on the game I guess. Maybe if it wasn't that intense, it wouldnÄt be that draining.

I bumped my head into the ceiling and stuff here. You get really sucked into the game, at least I was, and then I bumped my head and walked against stuff and into you...

I'm in a kitchen holding a device..

On your phone, you have to move it a lot with your hands, and not your eyes. It's much more forceful with thedevice as if you just had glasses or sth. Keeps reminding you thatyou're on a device.

Looking around a lot: You get kind of stuck on the screen, so moving around helps, also for your eyes... its good to move around.

Game Design

I felt like closing the app very soonish, bc it was very repetitive.

I felt captivated at first... but then sheer boredom of the game pulled me out of the experience.

Maybe if it wasn't that intense, it wouldn't be that draining.

It's also the simplicity of it. You can just try around what to do, without sitting through a 5 minute intro...

I got a bit bored. I guess that relates to me not being into gaming. So it's a cute showcase, but it's not super intriguing. Maybe I'm not that excited about finding more sprouts (laughs) And then the rocket kept crashing and if you're more like a gamer, maybe you would want to not make it crash, but I was just like... it's fine.

I have to say... It was fun and stuff, but I wouldn't open the app again, unless there is something new.

Now I completed the game, and I'm thinking... do I want to play it again? I am not a 100% sure. If there would be another element in it... as I said, I am more of the competitive type.

In the beginning, I was super into it because of the WOW, but the further I got into the game, the less I was, in the end I just was "I just want to sit, not walk around too much anymore, take it easy". It had a real WOW effect, but you get used to it, so quickly... that's why the game needs to be really interesting to keep on playing it.

Tangibility

General

When I place things and I see that things are in the way, I feel like I want to move them around... and you give some kind of meaning to places. So that corner was the sun... you expected to kind of be there for a second when you look

You get a feeling that something is there, even though it isn't... because I place it there and it looks normally. And I think my mind just settles that sth is there. Like me not trying to step on the flowers.

It felt like, the living room was too small.

Augmentation

It just immediately becomes your surrounding, even though it's obvious it's just cartoons... It just felt like, they are all in the room.

WHen it's too much stuff, it definitely beaks the barrier between... this is real and oh, this is definitely not real, because it's jsut too much. You totally don't feel you're in the actual environment anymore.

It just super static, it does not really interact with the environment. And your feet are not part of it... I don't feel that the real world is interacting with WOORLD.

Tried to kick the companion

But it is engaging... like you feel you're in it. One time I looked up from the screen to look for the moon.

I feel I am present in the environment, but I can also feel the difference between the game and the kitchen. It did not take me to a new dimension of a kitchen. But I could feel the sun is there and you don't want to step over the house.... somehow the game affects how you perceive things.

...in the beginning it was nice you could structure it. And then I got kind of frustrated because it was being a mess at some point. It's also funny, because it's fake anyway! But I was like "everything is flooded!" and I really hated it. The letters were everywhere and I tried to organize it, but that's kind of nice, that you have the feeling you're doing something artifical... I thought it was really fascinating!"

Right now, when I was playing the game, I felt comfortable with the surrounding, because I mean it's my living room and I know this place, but I wasn't really aware of this being the living room, because I was really focussed on th screen and the augmented things. It was more about the stuff that happens inside the app rather than the surrounding.

The beer pong thing, that was really like a bridge between being onl on the screen and also being in the room and the environment. ... WIth the beer pong thing you actually had the feeling that you're actually doing something with the environment. That was really fun for me. I mean it's completel useless as well, but it was very entertaining for me. That moment was special.

"It would be supernice maybe just to be in my own room and maybe just to click on items or surfaces and just be able to make them big or small. I mean it doesnÄt necessarily have to look good or anything, but if you had a camera and you had that stuffed bird on the wall, maybe you could just play around with it and make it big and small... I think that would be super awesome.

All the little colorful things that move around, that's what caught my attention, not the room itself, that wasn't really a part of it. For me it was more like, random surfaces. It was more the AR on the screen rather than the environment I am actually in.

For me it's not so much about the environment, but more about what's happening on the screen. Otherwise, idk, you would probably see me look at the screen and try to grab it with the other hand. It's an extension if the game, rather than AR as I would like it to be.

It's an extension of the reality since you're in this room and you're kind of interacting with the room, and it's again not so much about the surrounding than it is about the app.

Interacion & Control

Now I needed to tap the screen to do sth, but... for example the drainage, if you wanted to open it, I had to touch the screen, but what if I could just step on in with my foot? Or the flowers on the floor, what about if you could use your hands instead of your screen? It would feel more natural.

You're also not really a part of it yourself. You can't do anything with your hand or your feet or something.

It was really nice interacting with the environment, it really felt like the real world instead of a copy of the real world. SO it felt extremely natural.

Mobility

Even though I wanna move the stuff on the table, I'm still very aware that I'm holding a device. That kind of shuts it down a little bit. Because you're looking thorugh it all the time.

On the screen it kind of fits in organically, it's kind of live and moving around and using the surfaces as they are with our sense of gravity and stuff, si that feels kind of nautral, but not in the sense that you could feel it or something. I didn't feel the presence of the clouds above me. I think it has a lot to do with the handheld device.

Even though it's not a big screen, it seemed big enough. I didn't think twice about it.

Relatedness

Game Design

I don't think I would play this game with my boyfriend. I don't know how two people would play this together. You're kind of just glued to the screen

The thing is, I am not a gamer anymore, I used to play a lot of games, but I don't want to sit at home inside the room and play by myself. That was the cool thing about PKG [...] or the WII, you can play with friends...

Privacy

General

"I wouldn't play it on a bus or in a café. That would be too awkward. I don't think I would enjoy it. Ithink you have to be in an environment where you can let loose and be stupid...because it is really kind of childish the whole game. And you have to really enjoy the game just move around and feel that you can move around"

A prerequesite would be, that people around me would know what I am doing. There's nothing wrong with the app, no offense to the guy who made it, but it's just stupid. Why would I change my surrounding with this stupid stuff? I don't see any reason to do this in another place than here.

You forget quickly, even though you were there I was immersed in the little world, so I was only thinking about the little game.

If people don't know what it is about... maybe they think it's cool. But if they'd know what's going on on the screen... I would probably be embarrassed by looking at someone playing this.

In that department, I am also a bit less sensitive. I don't really mind. I was in my world, not in the real world, I felt like a little bit detached. And in my world, I don't feel embarassed of what I do. I think I am quite aware, but I don't care too much. i also tend to make a point of making a fool of myself.

I was playing this at home, and with my girlfriend waking around I don't feel awkard or ashamed. But I wouldn't play these in public. I would feel a bit uncomfortable. I think it's stupid if I imagine myself being out there and putting these things all over the place to have fun... idk... doesn't really make sense to me. Maybe playing it was someone together would be less awkward. If it was just me and stranger or a location where it is not very appropriate to play the game...

It looks unusual, and when it's unusal it attracts a lot of attention, so people will probably find it weird. But for me personally, it was nothing weird.

Creativity

Augmentation / Interaction

All the things that happen on the screen are so imaginative. You can get super creative and try a lot if things, even though they're similar somewhat.

With this game, it's always the same. Of course it's a bit tricky sometimes, but basically the same. But still it's exciing to figure everything out and try out new things. Like the beer pong! I felt very stimulated to be creative. In the beginning, it was a "Mistake" to put the house on the floor, but then in the end it was like: Oh shit, I can put the sun on the floor and the house o the ceiling, that#s amazing. But its something you learn throughout the game I guess.