Spring 2014

ASSESSING THE USER EXPERIENCE WHEN USING MOBILE AUGMENTED REALITY IN ADVERTISING

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PURDUE UNIVERSITY
GRADUATE SCHOOL
Thesis/Dissertation Acceptance

This is to certify that the thesis/dissertation prepared

By Shanshan Li

Entitled
ASSESSING THE USER EXPERIENCE WHEN USING MOBILE AUGMENTED REALITY IN ADVERTISING

For the degree of Master of Science

Is approved by the final examining committee:

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Head of the Department Graduate Program Date

ASSESSING THE USER EXPERIENCE WHEN USING MOBILE AUGMENTED REALITY IN ADVERTISING

A Thesis

Submitted to the Faculty

of

Purdue University

by

Shanshan Li

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Science

May 2014

Purdue University

West Lafayette, Indiana

To my parents Xuesan and Jian: for raising me with confidence, persistence and unselfish love.

To myself: for persistent hardwork and passion throughout this tough journey in conducting this thesis research.

ACKNOWLEDGEMENTS

I would like to thank my chair Dr. Mihaela Vorvoreanu for taking the time to answer my questions and providing me with valuable contacts and references for my research. She is a really good mentor to me both in my research and lives. In my research I adopted her research protocol for website experience analysis. It is really applicable and helpful for my study. Also thank you for letting me try on the Google glasses for the first time in my life. It has truly been an unforgettable experience for me.

I would like to thank Dr. Patrick Connolly and Dr. Zhenyu Qian for providing invaluable guidance and support for this study. Thank you for working with me through many changes in my thesis topic and inspiring me with good ideas.

I would like to thank George Takahashi at Purdue University Envision Center for allowing me to visit their advanced facilities. Also, I would like to thank him for sharing with me some of their latest platforms that I can use as testing tools and for answering my technical questions at the beginning of my study.

I would like to thank my dear friend Jennifer for her unselfish help and patience in reviewing and editing my paper.

Finally I would like to give my personal thanks to anyone who has ever helped me in life or during my study at Purdue. It is their encouragements and supports that

make me feel confident and motivated. Without the help and dedication of the people mentioned above, I could not have successfully started my study. They helped me understand the real meaning of research. As a beginner in research, a person never tries to reach the success in a single bound but keeps working towards the destination step by step and should be conscientious and rigorous about every detail in a study.

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ABSTRACT

Li, Shanshan. M.S., Purdue University, May 2014. Assessing the User Experience When Using Mobile Augmented Reality in Advertising. Major Professor: Mihaela Vorvoreanu.

Facing huge profits brought by applying augmented reality (AR) to advertising on mobile devices, this study investigated the user experience from four dimensions as emotional, instrumental, motivational and social experience when using AR as an advertising tool. It aims to help designers understand that how the user experience emerges during the use of AR advertising tool. In addition, providing some design suggestions to AR designer. Eighteen participants were recruited and the data were collected through observation and interviews. According to the results, users evaluated their emotional experience higher than the other three dimensions. The AR's value in building brand awareness was more effective than persuading users to buy a product. Social functions were advised by users but should be more diverse than just share function. Participants hoped to see how creatively and widely AR can be used in future. Results also indicated that novice and experienced AR users evaluate this AR advertising tool differently, which could be a future direction for this research. Finally, suggestions are provided to AR developers on three categories: contents and interface, interaction and functionality.

CHAPTER 1. INTRODUCTION

This chapter provides the background of this study to give readers a basic understanding of the research topic. I discuss the research motivations and problems in the field of study. I also argue for the significance and define its key terms, assumptions, limitations and delimitations.

1.1 Statement of the Problem

Augmented reality (AR) is an approach that combines real and computer-generated digital content into users' view of their physical environment. Although AR technology has already been studied for two decades, it was not until recently that it has been applied to day-to-day activities in human life, ranging, for example, from entertainment, education to marketing and advertising (Adhani & Rambli, 2012). In general, the research on AR has largely focused on its technical development rather than on assessing the user experience, which has, to a large extent, restricted the widespread use of AR (Olsson & Salo, 2011).

In some specific industries like advertising, AR's potential has been supported by prior research, such as generating product interest (Connolly, Chambers, Eagleson, Matthews, & Rogers, 2010), enhancing customers' memory about this brand and

motivating the customers buying decision (Hidden Creative, 2011). As a result it has been gradually used in advertising as a marketing tool for making profits (Bulearca & Tamarjan, 2010). This new means is quite different from traditional forms of viewing ads in newspapers, magazines and printed media. It overlays an extra layer containing digital contents to the physical space while at the same time allowing interaction with those digital elements as if they belonged to the real world (Olsson & Salo, 2011). Such an augmented layer enhances users views of physical worlds, actively interacts with them, converts them from passive information receivers to active information seekers, thus creating a digital trend in advertising (Elkins, 2013).

However, AR's future in advertising is uncertain because the long-term effectivenes of AR is unknown due to the scarcity of longitudina user evaluations and a well-designed framework in assessing AR applications (Gabbard & Edward, 2005). Most academic research has focused on the advancement of AR technology and software development and few have included user-related evaluation. Even though some user studies were included, most of them were informal and limited to testing the user task performance (Gabbard & Edward, 2005). Prior researchers believed that the AR advertising campaign was not only about creating access to prdocuts but also creating an entire experiencefor customers (Rambli, 2012; Gabbard & Edward, 2005). Without sufficient user data and a well-designed evaluation framework, marketers cannot make their decisions on what to be included in AR advertising campaigns and therefore can hardly succeed in AR advertising.

In light of this situation, the purpose of this study is to conduct a mixed research, collecting both qualitative and quantitative data to assess AR's value as an advertising

tool. Firstly I will establish a proposed user experience evaluation framework for AR advertising, secondly explore how these experience originate and finally provide some design suggestions for AR developers in the advertising market.

1.2 Research Questions

The questions in this research are:

1. What components of AR ads are experienced by users that can contribute to the instrumental experience, emotional experience, motivational experience, and social experience?
2. According to the users' opinion, what features are important to enhancing the overall user experience while integrating AR into advertisements?

1.3 Significance of the Study

AR creates a digital layer within a digital devices (e.g. smartphones, tablet, etc.) over the real world image that people cannot see with the naked eye. This indeed allows for an innovative method of advertising (Dubois, 2011). Recently, a debate was released online discussing whether AR was the future for advertising (Yahoo! Inc., 2013), indicating a promising future for AR ads. In the meantime, we have been witnessing an increasing number of mobile phone users installing AR applications on their mobile devices. As smart phones have became a popular and reasonably priced commodity for most of people, it is one of the most promising avenues for applying mobile augmented reality (MAR) technique in advertising. A market analysis report (Juniper Research, 2012)

has shown that 43 percent of all mobile subscribers use smart phones and the global revenues for MAR apps are expected to reach $1.5 billion by 2015. Facing such huge profits, it is worthwhile to investigate how to effectively design AR applications for advertising on mobile devices.

In terms of the contribution to the methodology, even though previous studies indicated some abstract categories for AR user experience (Olsson, 2013), they were not specifically designed for advertising field. This study proposes a theoretical framework for evaluating user experience in AR advertising applications, based on certain subjective criteria. This operationalized evaluation framework consists of four dimensions. These four dimensions (emotional, instrumental, motivational and social experience) and their included evaluated criteria were selected from previous predominant user experience categories in consideration of their relevance to AR and advertising (Hassenzahl, 2005; Hassenzahl & Tractinsky, 2006; Desmet & Hekkert, 2007; Buccini & Padovani, 2007; Gentile, Spiller, & Noci, 2007; Abideen & Saleem, 2011; Olsson, 2013).

In addition, the relationship between components in this AR advertising service and the four dimensions were established through analyzing the qualitative data from interviews. The design guidelines extracted from the results of this study will be valuable for AR developers to better utilize the characteristics of AR attributes in the future.

1.4 Definitions

Advertising: “A paid and non-personal communication from an identified sponsor using mass media to persuade or influence people” (Richards & Curran, 2002, p. 78).

Advertising Response Modeling: “A model provides a framework to evaluate advertising performance by integrating several multiple measures used in copy research” (Mehta, 1994, p. 62).

Augmented reality: “A technology that blends real and virtual objects in a real environment, registers real and virtual objects, and runs interactively in real time” (Azuma, 1997, p. 2).

Emotional experience: It relate to the “subjective emotional reactions originated from the user of a product” (Olsson, 2013, p. 214).

Instrumental experience: This experience relate to “instrumental aspects in product or service use” (Olsson, 2013, p. 213).

Marker-based AR: An AR system that depends highly on the visual markers that must be printed beforehand used for detecting the additional contents superimposed on the screen of devices (Craig, 2013).

Markerless AR: An AR system that relies on natural features without ambient intrusive markers that are not part of the environment (Craig, 2013).

Mobile Augmented reality: “An interface on smart phones or tablets mixing real and virtual world by enabling the original invisible information to be visible by digital contents” (Craig, 2013, p. 209).

Motivational experience: “Motivational experiences are created when the use of owning a product or service causes a certain behavior in the users” (Olsson, 2013, p. 217).

Print advertising: “Advertisements that are printed on traditional printed media such as newspapers, posters, magazines” (Jurca, 2010, p. 323).

Social experience: "Social experience relates to and originate from human to human interactions and are intermediated by technology" (Olsson, 2013, p. 216).

User experience: "User experience is regarded as a holistic concept describing the subjective experience resulting from the interaction with a technological product or service" (Olsson & Salo, 2011, p. 76).

1.5 Assumptions

Assumptions for this study are:

1. All participants partake in the research voluntarily
2. The participants answer all interview questions honestly based on their experience of using augmented reality for advertisements.
3. The questions designed in interview are properly presented and there are no leading questions.
4. The participants feel comfortable with observation and their behaviors won't be influenced.

1.6 Limitations

Limitations for this study are:

1. The study is restricted to the background diversity of participants and also the sampling area the author can reach.
2. Participants' previous experiences with augmented reality may be quite different. This factor may inherently influence the results of this study.
3. The final four-dimensional model of augmented reality experience is created through

the researcher's review of previous user experience framework. These components have not been fully verified through large numbers of research in augmented reality fields.

4. Only one AR application is used in this research, thus the experience might be influenced by the imperfection of this application.
5. The testing environment was set up in laboratory, the real customer experience might be slightly different when asking participants to view ads in public places.
6. Only three popular AR ads are selected and paricipants might not like all of these ads thus influencing their emotions.

1.7 Delimitations

Delimitations for this study are:

1. Due to the large number of potential participants in the study population, the subjects involved in the current study are only students at Purdue.
2. This study uses BlippAR, an AR application for advertising, to evaluate user experience of using AR technology in print advertisements.
3. Due to the length of the study, a long term influence of using AR in advertisements was not evaluated.
4. This study uses iPhone as the testing platform.
5. Only mobile augmented reality is examined in this study, the AR experience on desktop, or head-mounted displays such as Google glass won’t be included in this study.

1.8 Summary

In summary, this study plans to use the proposed multidimensional evaluation framework to assess user experience of when using a mobile AR application for advertising by reruiting college students from different majors. It aims to help understand how different experiences are originated in the AR environment and therefore help designers better utilize the values of variours components of AR.

CHAPTER 2. LITERATURE REVIEW

Augmented reality (AR) provides a bridge between computer-generated digital information and the physical world in an interactive way (Craig, 2013). This feature makes it a promising topic that is attracting the increasing attention from researchers. With great advances in developing various technologies including mobile processing, image recognition, object tracking and orientation, AR technology has in recent years increasingly been used in daily life (Olsson & Salo, 2011; Olsson, Lagerstam, Kärkkäinen, & Väänänen-Vainio-Mattila, 2013). In mobile advertising, the businesses want to use it as an improvement over print media offering greater reach, better relevancy and higher engagement (Yahoo! Inc., 2013). The implementation of AR in physical ads has grown rapidly becoming one of the advertising trends with the most potential for bringing huge profits to the market. (Mallory, 2012). However, few researchers have investigated that how user experiences are influenced by the use of this technology in advertising and what kinds of AR elements contribute to that experience. This gap represents a need for greater analysis of the user experience of AR advertising.

This literature review chapter introduces the relationship between three main clusters: mobile AR, advertising and user experience as shown in the graph below (see Figure 2.1). The first subsection introduces some technical background information about AR in

general and provides further information about mobile AR (MAR). The second subsection introduces studies applying MAR in advertising and discusses its potential, the evaluation research and its current development.in the market. The third subsection discusses the evaluation methods used in prior user research of AR. The last subsection shows the process of creating a multidimensional evaluation framework which connects and integrates the information from the three clusters.

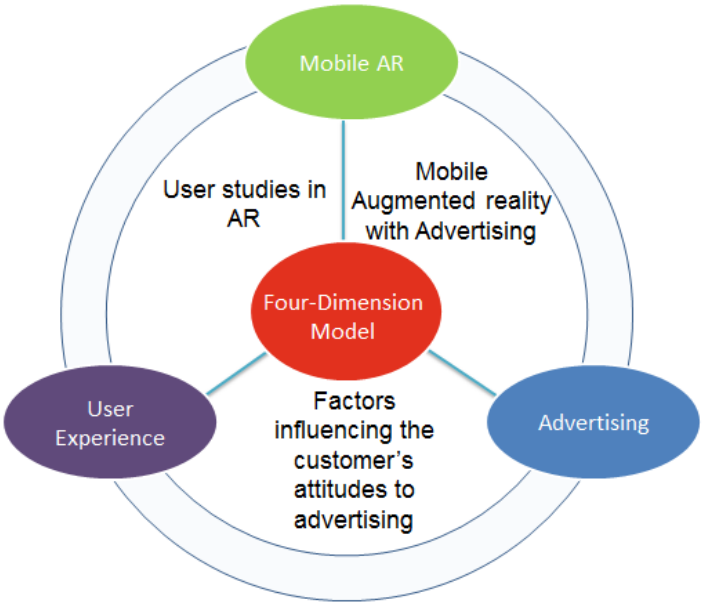

Figure 2.1. Structure of the literature review

2.1 Background inforamtion about AR and MAR

This section begins with a brief introduction of AR technology in general and further discusses the MAR in details.

2.1.1 Brief history of AR

Ivan Sutherland (1968) was the pioneer in AR field. He and his students created the first AR prototype in the 1960s, which enabled people to see 3D graphics through a head-mounted display. Caudell and Mizell (1992) first coined the term "augmented reality" to describe the digital display showing a virtual graphic on physical reality used by aircraft electricians. In the next few years, AR technologies were primarily developed in research labs and required a high level of technical expertise and knowledge to manipulate. During that time, AR application ran only on stationary desktop computers and required users to wear cumbersome head mounted displays (Caudell & Mizell, 1992). Since the development of the first outdoor MAR game (Thomas & Piekarski, 2002), the mobile devices combined with a camera, screen, GPS technology, and image recognition capability, have become the most popular platform for AR experience (Juniper Research, 2012).

2.1.2 Definition of AR

A popular definition of AR was proposed by Milgram and Kishgino (1994). They allocated AR in between a real environment and a virtual environment (see Figure 2.2). Unlike virtual reality, AR attempts to enhance the personal environment instead of replacing it. AR builds up a continuous chain between the real and virtual world, where their bounds tend to be vague as they interact with each other. A more concrete and commonly accepted definition of AR was put forward by Azuma (1997) that the three features of augmented reality are:

(1) Combining real and virtual worlds

(2) Real-time interaction

(3) Registering real and virtual objects

Figure 2.2. Virtually continuum (Milgram & Kishino, 1994).

2.1.3 Two types of AR

Typically, AR systems were categorized into marker-based or makerless-based (Craig, 2013). People utilize QR codes as the markers to convey two pieces of information in the marker-based AR system. One is to tell a computer what kind of digital content to display and the other is what angle of view to present this virtual content within a physical environment (Craig, 2013). Only when a marker comes into view, does the overlaid digital data appear. In contrast, markerless AR systems rely on natural features of images taken from a camera. It takes advantage of the Global Positioning System (GPS) and uses the position of the device to find nearby points of interests. Once the information is located, the user gets additional information or direction in real-time (Craig, 2013).

2.1.4 Overview of MAR

As mentioned before, MAR has become the fastest growing applied platforms in the AR field. Currently some important MAR application areas included sports, games,

cultural heritage, medicine, education and training, marketing and advertising (Adhani & Rambli, 2012). According to Juniper Research (2012), MAR is defined as information or digital products that are represented as overlays to the view from the device's camera. The activation of these data is triggered by something in the real world such as physical locations or an image on the wall that has been detected by a the portable device. Other researchers considered MAR as an interface on a handheld device mixing real and virtual worlds by enabling the original invisible information to be visible by digital contents (Papagiannakis, Singh, & Magnenat-Thalmann, 2008; Specht, Ternier, & Greller, 2011). It seems that MAR is an extension of AR that is implemented on hardware one can take with you. However, this understanding might confuse the reader as to whether carry-on electronics can be regarded as platforms for MAR. Craig (2013) clarifies that only smart phones and smart tablets were considered mobile technology. He also points out that many head-mounted displays though portable, are not termed as MAR because most people do not wear them on a daily basis and thus they are not the research focus in MAR (Craig, 2013). The key point to differentiate MAR is that users are not required to own some particular facilities to "remind you that you are doing something special in order to experience the augmented content" (Craig, 2013, p. 211).

Current available MAR applications can be categorized into two main forms: AR browsers and image recognition-based AR applications (Olsson & Salo, 2011). AR browsers augmented information in the physical world through a camera view, which can be described as a "magic lens" (Azuma, 1993, p. 50). So far a large number of commercial and open-sources AR browsers have come into existence, such as Junaio, Layar, Wikitude, ARViewer and Sekai Camera (Grubert, Langlotz, & Grasset, 2011).

Image recognition-based AR uses visual recognition technology to connect surrounding objects with digital information. For example, GoodGuide provides third-party evaluations of products and companies through scanning barcodes; Google Goggles provide relevant search results about any objects in the users' vicinity (Olsson & Salo, 2011).

2.1.5 Advantages of MAR

Although there might be other ways of achieving an augmented reality experience, mobile devices are the most well-suited and promising platform for AR applications and thus the focus of this research. There are several reasons to support this idea. First and foremost, compared to the price of some special-purpose devices such as Google Glass, solid hardware support ensures the low cost of MAR. Fully developed hardware components, such as the touch screen as an output display, an embedded camera, integrated orientation and advanced graphical 3D rendering provides a technical guarantee for the implementation of MAR. Second, MAR brings a type of ubiquitous user experience (Henrysson & Ollila, 2004). Unlike the desktop computer that constrains users to a fixed location, smart phones and tablets foster the mobility of users due to their lightweight. People can carry them in their pockets and easily operate them no matter where they are. Thus it makes possible mobile location-aware AR services that can work anywhere to visualize the superimposed layer of information related to the users' real surroundings whenever desired (Kaasinen, 2003). This means "users' physical, social, and task context, as well as the technological resources nearby can be extracted, interpreted and utilized in mobile augmented reality application" (Olsson, Kärkkäinen,

Lagerstam, & Ventä-Olkkonen, 2012, p.30). One scenario might be that if you were a foreign traveler and wanted to learn more about the history of a popular tourist attraction, and an MAR app would help you gain additional historical information about different locations (Rasinger, Fuch, Beer, & Hopken, 2009). Third, MAR has a large market. Juniper Research predicted that an unprecedented market awaits for MAR and its revenue will reach 5.2 billion dollars in 2017. The report also revealed that over 2.5 billion mobile augmented reality apps will be downloaded annually by 2017 (Juniper Research, 2012). These statistics have convinced people of a bright future for MAR. According to a previous survey of current MAR applications, this technology has been applied in several areas such as education and training, games and entertainment, advertising and marketing, medicine and cultural heritage (Adhani & Rambli, 2012). In the next section, the current development of MAR applications in advertising and marketing is discussed.

2.2 Mobile augmented reality with advertising

This section contains a discussion of AR's potential for print ads, some prior academic research on evaluating AR's effectiveness in advertising and the current development of AR as a advertising tool.

2.2.1 AR's potentials in print ads

According to the definition, advertising is a "paid, non-personal communication from an identified sponsor using mass media to persuade or influence people" (Richards & Curran, 2002, p. 78). It includes television, radio, outdoor billboards and print media. However this definition is too broad, and in this study, we only focus on the use of MAR

on print media. As an innovative combination, first the rationale for adopting AR in print ads should be put forth.

Though print media (including books, newspapers, magazines and posters) has not been replaced by other ways of advertising so far, they have suffered from some intrinsic limitations (Jurca, 2010). First the linearity of communication restricts interaction. The linear communication starts from the sender who always plays an active role and ends with the receiver who cannot respond in any way to the sender during the communication episode. Second, print advertisements have hardly changed over time because the static nature of the content has made this difficult. Third, in this format of advertising, the information is closed, which means contents are not context-based. Finally, it is mono-media; video and audio cannot be transmitted by print advertising (Inglobe Technologies Srl, 2011).

AR can be a good solution to the four limitations of print ads. First as AR requires interaction between physical and virtual environments, it turns the one-way communication into an interactive communication between customers and the advertisement. Second, AR creation platforms allow users to consistently update the ad's content by adding or changing the original advertisements. Third AR can help users "browse the location-bound contents as visually superimposed on a real-world view" (Olsson, 2013, p. 203), which makes the contents context-based. Finally, AR allows users to explore multi-media contentsas a whole experience with video, animation, image, audio to helping to engage and entertain the users. Some merchants have already started online that there is a need to dynamically provide advertisements in an augmented reality environment (Yahoo! Inc., 2013).

2.2.2 Prior research on assessing AR's effectiveness in advertising

Even though all these advantages of AR ads mentioned above exist, marketers still don't know how to implement it (Duke, 2012; Rambli, 2012; Perey, 2011, Inglobe Technologies Srl, 2011). A previous online survey on current mobile augmented reality showed that the full potential of AR has not been tapped in current applications because of few user studies have been done to assess the AR's effectiveness in specfic areas (Olsson & Salo, 2011). In Kolb's (2011) study assessing the effectiveness of AR ads, 79 respondents were instructed to view the AR ads on a car magazines. The result showed that 63% of the participants checked out the AR ads beyond the 3D animation by browsing the website and considered them impressive. More interestingly, 86% of participants remembered the brand after viewing such an AR ad. However, this research was limited to collecting quantitative data and didn't explore what makes them feel this way. Other researchers examined the effectiveness of AR ads by measuring the information retention and recall from users after asking them to view a video record of an AR ad experience. The results revealed that 2D print media is more effective in delivering real information for later recall (Connolly, Chambers, Eagleson, Matthews, & Rogers, 2010). However, the imcompletely developed AR system might have influenced the result of the study because the researcher only asked participants to view a pre-recorded video demonstration of an AR ad experience. Another study conducted by a marketing communication consultant investigated the effectiveness of AR in children's toy ads. It compared the effectiveness of 2D print ads and AR ads. The results showed that AR ads performed better in engagement and increasing consumer purchase interest (Hidden Creative, 2011). However, this study mainly measured some objective aspects

regarding system performance rather thanevaluating the overall user experience. Reviewing this research, I found that none of them have analyzed how MAR advertising influences behavior and overall user experience, which is nevertheless, a very critical part of creating successful MAR services for consumers (Olsson, Lagerstam, Kärkkäinen, & Väänänen-Vainio-Mattila, 2013). This research will allowdeeper insight into the participants' minds and an understanding AR's effects on experiential value.

2.2.3 MAR applications and development platforms in advertising and marketing

Recently, more and more businesses have used AR as a new strategy to market their products. There are several examples of AR being integrated into a wider brand campaign listed online (Smith, 2009). Using this technology, the viewers are able to manually control a virtual image of advertisements or product packaging using cellphones or tablets ubiquitously. Moreover it is a more innovative way to imprint product-related experience on consumers' memories compared to static images in print advertisements. Some examples of applications are demonstrated below.

- Beyond Reality (2010) released a makerless advertisement magazine of 12 pages that could be recognized and animated by software downloaded from the publisher's website. This starting point for enjoying theAR experience attracted more users to pay for accessing additional contents and functions such as seeing a full movie, turning the magazine into a movie ticket.
- IBM Corporation unveiled their use of MAR in helping consumers in daily shopping. This app gave consumers coupons and the ranking of a commodity

based on customers preference predefined by themselves, which shows a great advantage over traditional brick-and-mortar stores (Stampler, 2012).

- Starbucks used AR to make images come to life on decorated cups in holiday season. A free downloaded application allowed consumers to view different set of animations attached to different cups. It helped Starbucks promote themselves to customer in such as an inspiring and novel way (Justin, 2012).

Other than these self-developed AR advertising applications by a few brands, two public AR creation platforms for non-programmers made it possible to popularize the use of AR ads in more companies and organizations. Aurasma (2011) is a platform for creating AR experience without programming skills. Since it launched less than two years ago, an incredible number of enterprises have adopted Aurasma as the platform to do brand promotion. The process to create an AR experience on Aurasma is very simple (see Figure 2.2). Users create and place markers that activate the viewing of "Auras", which could be videos, images, or sound files. Auras are created by simply taking an image from surroundings through mobile device or selecting a "marker" in the Aurasma preset list. The desired media is then associated with that marker (Aurasma, 2011). Another application is BlippAR, the first image-recognition phone application aimed at adding AR experience and instantaneous content to newspapers, products ,posters, and magazines (BlippAR, 2011). The process of creating AR ads is similar in these two platforms. With the help of these two free-open platforms, marketers can build their personalized AR ads ,attach them to their existing print ads, and finally publish. Customers only need to download the Aurasma or BlippAR mobile application and then find the print ads to enjoy the exciting experience in the shopping mall, street and other

places. For researchers and AR lovers, they can go through the website to view the latest ads from different companies and pick up examples ads to test.

All these have paved the way for the continued use of AR technology in advertising. However, some researchers have questioned whether the success of using AR in print and publishing is mainly due to the novelty and "Wow" factor of the technology itself (Perey, 2011; Inglobe Technologies Srl, 2011). Most of marketers have rushed to venture into this new approach to advertising, but ignored the fact that some analysis of user exeperience and a conceptual model to enhance the user experience are needed before implementing its widespreaed use (Rambli, 2012). Other discussions online have restated the importance of incorporating user experience into the evaluation, which indicates that marketers who view AR as a pure technology are not quite right, instead, AR is an intangible, utilitarian and evocative experience from a consumer's point of view (Duke, 2012). To avoid making AR a gimmicky, advetisers need to understand how MAR and its different features influence different aspects of user experience. This research is one of the initial efforts to make AR go beyond the "Wow" factor and reach its full potential.

Before an in-depth discussion about the how the evaluation model is conceptualized in this study, an overview of current user studies in AR is briefly discussed in the next section.

2.3 User studies in AR

Just as with other technology, a user study is critical for evaluating AR tools before its widespread use in any given field. Gabbard and Edward (2005) reported that the first

user-based experiment in AR was conducted in 1995. They also categorized all the user-based experiments in AR that had been conducted until 2004 into three main related areas:

(1) Human Cognition and Perception in AR: experiments that examined issues such as perceptual effects of rendering techniques and depth-perception in AR context.

(2) Performance: experiments that examined user task performance of AR application within a domain-specific context.

(3) Collaboration and Interaction: experiments that examined social and communication issues for collaborating within the AR context.

Dünser, Grasset and Billinghurst (2008) then took things further. They not only added an extra category named "system usability" to the classification of AR user evaluation but also proposed another classification scheme based on the main evaluation approaches. In the survey, they pointed out that the use of formal qualitative analysis, which was only found in 9 publications, was inadequate compared with the large body of quantitative, objective measurements found in 75 papers. The objective measurements which most AR studies have utilized evaluate an AR system based on quantitative properties such as task completion time, scores or error rate, etc. (Barreira, Bessa, Pereira, Adão, Peres, & Magalhães, 2012). This imbalance between objective measurements of systems and qualitative analysis of user experience might have lead to the current situation of the AR market. Although there exist several AR applications, its number of users is still limited. In order to understand how to reach users with desirable AR designs and identify issues that are worth targeting in design, a previous study (Olsson, Lagerstam, Kärkkäinen, & Väänänen-Vainio-Mattila, 2013) suggested two specific perspectives to look at when conducting usability research. One was understanding the

expected user experience in AR interaction. The other was obtaining user-originated requirements that affect user experience. All these indicate that a well-designed user experience study is needed in the field of MAR. In the following two sections, different classifications of general user experience are discussed. Finally a multidimensional user experience evaluation model for MAR in advertising is proposed based on the common categories in these classifications with a consideration of the factors influencing customers' attitudes towards advertising.

2.4 The multidimensional framework of user experience

According to ISO standards, user experience is defined as "a person's perceptions and responses resulting from the user or anticipated use of a product, system or service" (ISO DIS 9241-210, 2010). There are two concepts that need to be demarcated before our discussion, the concepts of usability and user experience. Usability focuses on relatively consistent and objectively defined measures such as task completion, effectiveness and ease-of-use (Olsson, 2013). User experience moves towards a more emotionally oriented relationship between users and products or services, which broadens in scope to cover both pragmatic and hedonic aspects. In this study, unlike usability studies in which the comparison aspects are subjective and dynamic (Olsson, 2013), the user experience is evaluated and analyzed. Even though previous studies have proposed different frameworks to desribe user experience (Hassenzahl, 2005; Hassenzahl & Tractinsky, 2006; Desmet & Hekkert, 2007; Buccini & Padovani, 2007), these were not technology-specific or context-related. As a result, a new conceptualization of the user experience should be designed to cater to the requirements of both MAR technology and in the field

of advertising. The next two subections will examine the MAR-specific user experience and factors influencing attitudes towards advertising.

2.4.1 Selection of MAR-specific user experience

Hassenzahl (2005) categorized user experience into two abstract components, pragmatic and hedonic. Hassenzahl and Tractinsky (2006) believed that user experience is a combination of the user's internal state (e.g., expectations, motivations and needs, etc.), the features of the designed system (e.g., usability, functionality) and the context within which the interaction occurs (e.g., social setting, meaningfulness of the activity). Other researchers distinguished three components of experiences with interactive products: aesthetic experience, experience of meaning and emotional experience (Desmet & Hekkert, 2007). Buccini and Padovani (2007) created a model of product experience, categorizing it into six subclasses: sensory-related such as touch and appearance, feeling-related such as subjective emotions, social experience, cognitive experience, use experience, and motivational experience. In evaluating the relationship between the company and customer, a prior study extracted six components to conceptualize the customer experience (Gentile, Spiller, & Noci, 2007), sensorial, emotional, cognitive, pragmatic, lifestyle and relational. The sensorial component refers to the product's ability to address multi-sensory feelings so as to arouse aesthetical pleasure, excitement, and a sense of beauty. The emotional component involves one's affective system so as to establish an affective relationship with a company, its product and brands which was called the go-mechanism in prior study (Tan, 2008). The cognitive component connects with thinking and mental processes, for example a product may engage customers'

creativity. The pragmatic component comes from the practical value of a product. The lifestyle component relates to the product's adhesion to certain values through the adoption of a lifestyle. The relational component involves the user and his or her social context and relationship with other people.

Recently a study roughly classified the six possible user experiences that might happen during the MAR service, as "instrumental experience, cognitive and epistemic experience, emotional experience, sensory experience, motivational experience, and social experience" (Olsson, 2013, p. 212). Interestly, this MAR-related user experience framework has some overlap with the previous four frameworks of user experience mentioned above. The four most common dimensions emotional experience, instrumental experience motivational experience, and social experience were found across the research and as a result they were selected from the six experiences. The next four paragraphs explain the meaning of four dimensions and how to measure each dimension.

The first category, emotional experience, refers to the subjective emotional reaction rooted in interaction with a product: for example, "pleasure, entertainment, evoking memories and facilitating positively valued feelings overall" (Olsson, 2013, p. 214). It is also defined by Hassenzahl (2005) as the hedonic components in user experience and by other researches as one single channel in user experience (Desmet & Hekkert, 2007; Buccini & Padovani, 2007; Gentile, Spiller, & Noci, 2007). So it has been chosen as the first dimension of user experience in this study. Regarding approaches to measuring emotion, amazement, playfulness and liveliness have been selected as the three specific emotions related to AR based on previous study (Olsson, 2013).

The second category, instrumental experience, originates from utility, product performance and support for the user's activity (Olsson, 2013) which agrees with the pragmatic aspects in other researchers' studies (Hassenzahl, 2005; Gentile, Spiller, & Noci, 2007) and users' experience in the product experience model (Buccini & Padovani, 2007). This dimension relates to a product's ability to support achievement of behavioral goals. In the context of advertising, the goal is to first draw the attention from customers as much as possible and persuade customers to buy their product (Mehta, 1994). So it can be evaluated by whether AR ads draw attention and increase the purchase interest.

The third category, motivational experience, is created by inspiration or motivation. The action is motivated by owning a product or with the help of technology (Olsson, 2013). This component is mentioned by Hassenzahl and Tractinsky (2006) as the roleof internal states in construing the user experience. In the context of advertising, it can be evaluated by whether the customers' desire to further understand the brand or other products after viewing the AR ad.

The last category, social experience, originates from the features that make users feel they are participating and interacting in a user community but at the same time feel comfortable and safe (Olsson, 2013). The social experience happens because of the actions of other participants and because of the product itself (Buccini & Padovani, 2007). Other researchers interpreted it as the relational component of a product that encourages use together with other people or lead to the creation of a community(Gentile, Spiller, & Noci, 2007). In the context of advertising the social factor can be measured by whether the user feels comfortable and safe sharing the information and also the extent of connection and interaction.

In the end, the MAR-specific user experience is defined as the four dimensions shown in the image below (see Figure 2.3), and the some subjective measurements are extracted from the literatures discussed above. However this model doesn't include the factors related to advertising, which will be discussed in the next subsection and merged into the final evaluation framework.

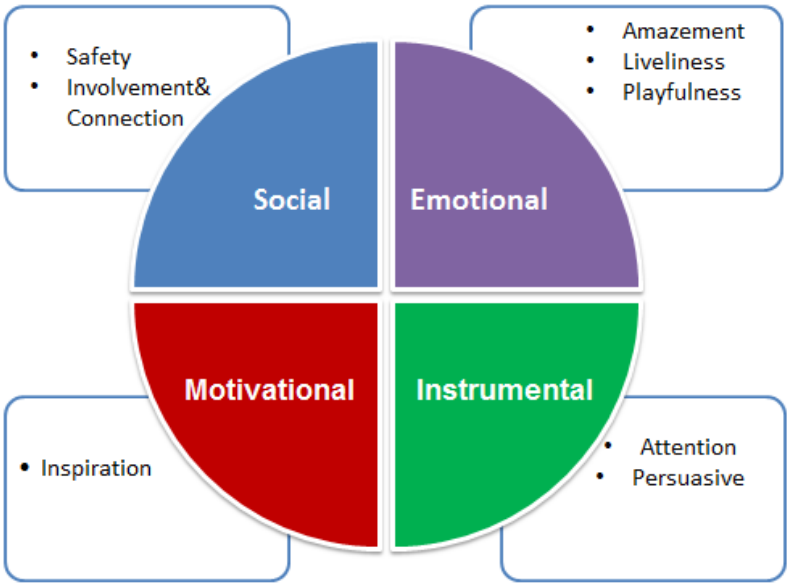

Figure 2.3. Four dimensions of user experience

2.4.2 Factors influencing attitudes towards ads

Lutz and Mackenzie (1989) developed an Attitude-Toward-the-Ad model based on previous studies showing that attitudes towards the ad were generated from consumers cognitive and affective reflections related to advertisments. In this model, they concretized these two abstract perspectives into five factors: Ad credibility, Ad perception, attitude to the advertiser, attitude to the advertising and mood. In this study the attitude to the

advertising is most important and can be further broken down in the Attitude Toward Advertising model proposed by Ducoffe (1996) into three factors: entertainment, informativeness, irritation. He belives the ability of advertising to entertain can enhance the advertising experience of consumeres. He also thinks that the informational role of ads should be considered as the main function not only in terms of whether it is a good source of media to present the information but also whether it can supply the product information relevant to customers' needs. The last factor, irritation, indicatea that an ad should not interfere with users goal-oriented tasks. The factors of entertainment and irritation can be incorporated into the emotional experience in the total MAR user experience. Other factors such as customers' involvement, and their ability to recall the brand (Abideen & Saleem, 2011) can be integrated into the social experience and instrumental experience.

2.5 Refined user experience framework

Drawing from the extant literature of potential MAR-specific user experience and the factors that influence attitudes to advertising, a four-dimensional user experience framework is proposed as shown in the image below (see Figure 2.4). Such a model is tailored to evaluate MAR applications for advertising purpose. The emotional dimension consists of amazement, liveliness, playfulness/entertainment and irritation. The instrumental dimension is evaluated by the functionalities of ads in attention, persuasion, informativeness and recalling the brand. The motivational dimension is assessed by the extent of inspriation. The social dimension is measured by the safety and involvement of the services provided in the AR advertising tool.

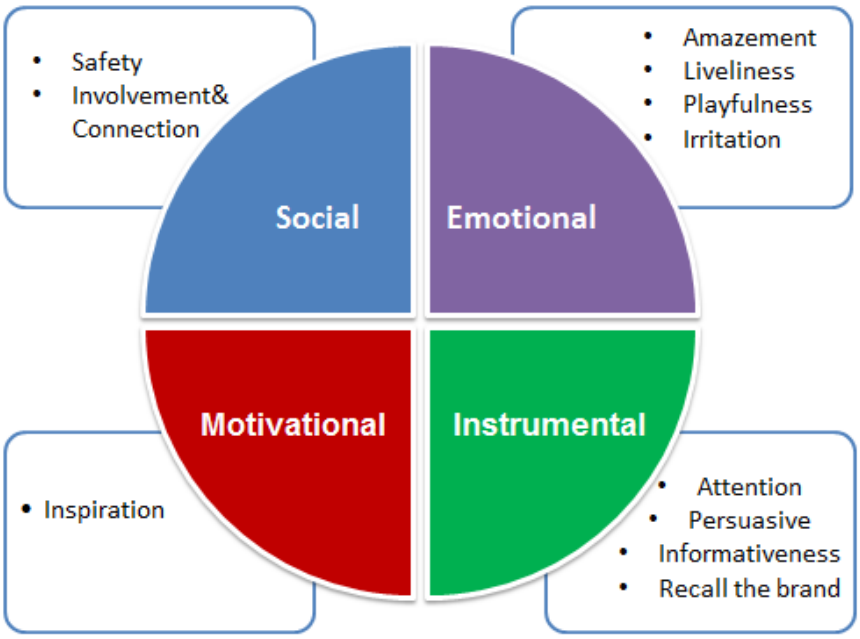

Figure 2.4. Final Four-dimensional Evaluation Framework

The explanation of measures for each categories and the theretical models that support each dimensions are presented in the table below.

Table 2.1 The MAR user experience framework in advertising

Categories	**Measures**	**Theoretical models**
Emotional experience	Amazement: feeling of experiencing something novel, extraordinary.	MAR user experience model (Olsson, 2013) User experience model (Hassenzahl, 2005; Hassenzahl & Tractinsky, 2006;) Experience with interactive product (Desmet & Hekkert, 2007) Product experience (Buccini & Padovani, 2007) Customer experience (Gentile, Spiller, & Noci, 2007)
	Liveliness: vivid and dynamic content evokes positive feelling of vivacity	

Table 2.1 Continued

	Playfulness/ Entertainment: feeling of joy amusement and playfulness	Attitude to advertising (Ducoffe,1996)
	Irritation: a feeling because of interference with users' goal-oriented tasks	
Instrumental experience	Attention: the ability to catch customers' attention	MAR user experience model (Olsson, 2013) User experience model (Hassenzahl, 2005; Hassenzahl & Tractinsky, 2006;) Product experience (Buccini & Padovani, 2007) Customer experience (Gentile, Spiller, & Noci, 2007)
	Persuasive: the power of supporting even changing consumers' decision to buy products	
	Informativeness: feeling of being provided with useful information	Attitude to advertising (Ducoffe,1996; Abideen & Saleem, 2011)
	Recalling the brand	

Table 2.1 Continued

Motivational experience	Inspiration:feeling of inspiration and eagerness to try new things for new purposes	MAR user experience model (Olsson, 2013) User experience model (Hassenzahl, 2005; Hassenzahl & Tractinsky, 2006;) Product experience (Buccini & Padovani, 2007)
Social experience	Safety with information sharing: sense of privacy resulting from what kind of information about the user is shared	MAR user experience model (Olsson, 2013) Product experience (Buccini & Padovani, 2007) Customer experience (Gentile, Spiller, & Noci, 2007) Attitude to advertising (Abideen & Saleem, 2011)
	Involvement and connection: social connection and communication with friends	

2.6 Summary

In this section relevant literature has been examined across the areas of AR technology, MAR and its specific use in advertising. In addition, some development platforms have been provided to support the testing in this research. More importantly, a multidimensional user experience framework has been proposed as the evaluation tool. In the next section, I will talk about the methods of collecting data.

CHAPTER 3. METHODOLOGY

In order to increase the diversity of my dataset, I decided to use both observation and interview to collect data. As I mentioned before, this study is a mixed study but focused more on qualitative data analysis. In the next sections, I will explain how the research was conducted in detail.

3.1 Research method selection

Due to the novelty of AR, there is no typical and operational theoretical framework to assess the user experience in an AR environment. In light of this, the purpose of this research is to explore how user experience is evoked and through which components of an AR environment. Thus the qualitative approach is well suited to find out what has been experienced by users in depth and details according to Patton (2002). Moreover Olsson (2013) points to three methodological considerations for evaluating user experience. First in order to evaluate the experience both verbal and behavioral data should be collected. As a result, I used both observation and interviews to inquire about the user experience. I played the bystander role of observing the subjects in terms of their facial expressions and their behaviors, which would be used later to ask follow-up questions in the semi-constructed interviews. The observation sheet (See appendix A) was prepared for taking notes. Second, Olsson (2013) recommended studying the user

experience through a field study. However previous study has shown that field testing may not add significanly to the valdity and thoroughness of usability testing (Kaikkonen, Kekäläinen, Cankar, Kallio, & Kankainen, 2005). Given this, in order to ensure the quality of the recording and the privacy of participants, the testing took place in a private study room in Hicks library at Purdue. Third data triangulation was suggested to help explore multiple perspectives (Olsson, 2013). To achieve such triangulation, two data collection methods were used in this study, observations and follow-up interviews.

In terms of the design of questions in the semi-structured interview, the format of questions was adapted from the study of Website Experience Analysis (WEA), which aimed to understand and assess experience-oriented features of website elements in the organization-public relationship (Vorvoreanu, 2008). The similarity between the WEA study and this study made it a good choice to guide the structure of the questions. In the WEA, the researcher first broken down the organization-public relationship into five aspects. Similarly in this study, the four-dimensional framework of user experience has already been determined in the above chapter. Two questionnaires were adopted in WEA, one was for background information collection, and another five pairs of questions were for addressing the organization-public relationship from five different dimensions (Vorvoreanu, 2008). Having inspired by this research protocol, the interview questions were divided into two main parts as well. The first part contained some background information questions and the second part contained the experience-related questions from the four categories of experience (See Appendix B). In each category or topic, the questions were projected onto some specific measures in order to make the experience

easier to interpret. The questions were grouped in pairs with one statement measured by a 7 points Likert-scale and one open question related to a statement.

3.2 Research setting

This subsection discusses all the preparation before the testing including the introduction of the testing application and advertisements selected, and the testing environment.

3.2.1 Testing application

BlippAR is the "first image-recognition phone application that enables users to view newspapers, magazines and posters with AR experiences" (BlippAR, 2011, para. 1). It consists of markerless image recognition and recognition tracking techniques available anywhere in the world. Now it supports IOS and Android and has all the social media plug-ins built in. So far BlippAR has worked with several brands to help them advertise their products including Unileve, Nestle, Heinz, Diageo, Xbox, Samsung, Cadbury and Domino's (BlippAR, 2011). Because of its popularity in advertising and its ability to work on the two largest mobile platforms, this study uses BlippAR as the testing application.

3.2.2 Testing environment and preparation work

In this study, I used smartphones as the testing device because they are the most popular platform for MAR. Data from Juniper Research showed that 43 percent of all mobile subscribers use smart phones and global revenues for mobile augmented reality

apps are expected to reach $1.5 billion by 2015 (Juniper Research, 2012). Before user testing, the BlippAR application was downloaded to the testing device- an iPhone 4. Three print advertisements examples (See appendix C) were selected because of their popularity and success based a blog post by BlippAR ("Best of our summer campaigns," n.d.). All the testings and follow-up interviews were conducted individually in a pre-arranged quite place.

3.3 Data collection

This study was approved for Exemption status by the Institutional Review Board of Purdue University on January 23 2014 (Ref. #1311014227).

Before testing, the subject was asked to read and sign the participant information sheet (See appendix D). Then they spent about two minutes learning how to use the AR tool to view the ads. The three ads were labelled with numbers before testing for easy rating later. Right after that, participants started to give a rating to the three print ads by naming their number and then used BlippAR to experience the AR advertising service. Finally, they were required to participate in a follow-up interview.

3.3.1 Sampling

The target population of this study was college students who tended to be the early adopters of this AR technology because of their high education background. According to the diffusion of innovations theory, the early adopters are characterized by more years of formal education (Rogers, 1995). In addition, the students had to be able to use the iPhone without any operating problems. The recruitment messeage was distributed

through email through the department emailing list and was also sent to my friends. In the end, twenty participants were recruited which satisfied the number of fifteen, the smallest acceptable sample size for qualitative research (Guest, Bunce, & Johnson, 2006).

The collection of participants' data was conducted within a month. Initially twenty participants were recruited, however, two were eliminated from the data analysis because they did not finish the testing due to personal issues (one participant need to leave early because of an emergency call, another participant was too impatient to go through all the functions); therefore data from a total of eighteen subjects were analyzed.

3.3.2 Observation

As mentioned before, the observation was used to explore some possible problems that cannot be identified by the interviews, especially something that was very likely to be concealed by words but easily identified through user behaviors. When the intial contact was made between the subjects and me, I asked the participants' permission to observe them during their testing. After providing informed consent, I shadowed the participants, recorded the user interactions with the interface, and observed their actions and behaviors during the testing. Unless users asked for help, I did not interfere with them during the testing.

The observation form (See appendix A) was used for taking notes of the facial expression, vocalization, hand motion, body language which can be both used as quantitative and qualitative measures in observation ("HCI Evaluation: Usability Testing," n.d.). These are "sensitizing concept", which are "loosely operationalized notions that

can provide some directions as researcher inquires into how the concept is given mearning in a particular circumstance" (Patton, 2002, p.278).

3.3.3 Interview

The semi-structured interviews were conducted individually in a relatively private place in order to create a comfortable environment allowing participants to share their thoughts freely. The format of the interview questions was adapted from the WEA. There are unequal numbers of items in each group of questions asking participants to rate their experience with respect to four dimensions. The form for the close-ended questions would be 7-point scale Likert-statements, because previous research indicates that people are more neutral when using the 5-point scale than the 7-point scale (Colman, Morris, & Preston, 1997). The follow-up questions are open-ended asking participants what makes them feel that way, which helps to find the relationship between AR features and a specific experience. In order to create unbiased and valid questions, I first took advice from professors who were experienced in designing interview questions. In addition, I conducted five pilot studies to test the validity of the questions before the actual interviews. During the real interviews, subjects were given some time to read through all the questions and then were asked the questions. The basic structure of the interview questions was predefined as shown in the appendix B, but some questions might be added based on the prior observation of individual.

3.4 Data analysis

Right after the data collection, observation notes and audio records were initially transcribed into individual documents for each participant in a total of fourty-six pages and kept in a password-protected computer. Then the partcipants background information, grade of the Likert-scale questions, transcriptions for open-ended questions and observation sheet were aggregated in a whole excel file with four different sheets: Background information, Quantitaive data, Qualitative data and Observation note.

The mean of quantiative data were calculated to show the overall grade for each evaluated measure in four dimensions from 1 to 7 scale. Thematic analysis was applied to the qualitative data to identify, analyze and report patterns that emerged. The advantage of this analysis method is its flexibility to highlight similarities and differences within a data set (Braun & Clarke, 2006).

In order to better keep track of the data from different participants, I used NVivo software (NVivo, 2012) to analyze and organize the data. This software allows for congregating and dividing codes efficiently and also helps to easily find the codes in its original context. All the prepared documents were imported into this software. At first, some distinctive key words were highlighted in the transcripts as the initial codes, such as interacting with interface, problem of blackscreen, etc. Based on the literature and research questions, some codes were deleted and grouped into a more abstract category and then interpreted as themes. Then guided by the rule of Braun and Clarke (2006) that "the guidance for determining a theme should be flexible and it is not dependent on quantifiable measures but in terms of whether it captures something important in relation to the overall research question" (p. 87), I iteratively refined the themes by referring back

to the research questions and looking back for the details in the data. In the final step, the themes were interpretated and organized in the context of the four dimensions of user experience.

3.5 Summary

This chapter presented the data collection and analysis process. By making my data into fragments, I could easily discover the difference between groups of users such as users with high ratings and low ratings. In addition, I rereaded the transcript to recode the data to ensure that I had a consistent coding system for my dataset. For future study, it is better to ask for several researchers to code and analyze the data.

CHAPTER 4. PRESENTATION OF THE DATA AND FINDINGS

The main purpose of this study is to understand which aspects in the AR advertising service results in the four dimensions of user experience. Another objective of this study is to provide some design suggestions for improving the user experience in AR environments to satisfy users' expectations as they mentioned in the interviews. In this chapter, the background information of participants, results from the observation and interviews are presented as follows.

4.1 Participants Information

The participants consisted of six males (33.3%) and twelve females (66.7%). Six of them were PhD students (33.3%), eight of them were Master's students (44.4%) and the rest were undergraduate students (22.3%). The majors and number of the subjects were: four in computer graphics technology, four in management, three in civil engineering, two in computer science, two in consumer science, and one for each in communication, agriculture, biology. Before the testing, all the subjects were asked questions regarding their prior experience of AR and their ratings for the three print ads.

In terms of their prior AR experience, half of the participants mentioned that they had tried AR before and half of them had never heard about this technology. Surprisingly,

among those who had tried AR before, they regarded the example of Haagen-Dazs's Concerto Timer App as the most impressive. When further asked about why they liked this app, most of them gave me the word "miracle" to express their first feeling when viewing the AR. They felt that even though it was the same action as scanning the QR code, the AR was much more creative and intriguing. Regarding their first impression of the three print ads, most of them liked the "Good Food" print ad because of its colorful appearance and the food category which stimulated their appetites. Next was the Fashion print ad because they said the figures in the ad quickly captured their attention. The one with the lowest rating was the Pepsi ad because it had too many words and an unclear brand message.

4.2 Data from Observations

Observation was one of the data collection methods in this study. I not only wrote down the observation notes but also analyzed the videos that captured the interaction between users and user interface of the application to identify some user issues.

During the testing, one of the biggest challenges for novices was to manipulating the AR virtual layer. The testing started with an explanation of the basic steps to manipulate the AR ads. However two participants were still lost and confused and asked what they should do to control the screen after viewing the superimposed layer on the screen. Though the rest of the participants had no problem with the operation, they spent some time in adjusting the screen from the beginning. Another problem was the constraints of the fast Internet speed as the one basic requirement for running this app. Sometimes the software crashed because of bad Internet access which to some extent

interrupted the user experience. In the following subsections, some common user behaviors were identified from the observation of the user interaction with three different AR ads.

4.2.1 Operation of AR Interface

It was quite interesting to find that users reached out and attempted to shake their hands in the air at the place above the print ads and below the mobile screen after the virtual layer jumping into the view. They said they wanted to try to see if something would happen on the screen when they were waving hands in the physical environment. Once the print ad in the physical environment was identified, the virtual counterpart jumped onto the screen which made most users feel amazed. However when participants moved the screen away from the print, the orientation of the interface on the screen slightly changed which made it hard to view from the users' points of view. Seven participants tried more than twice to adjust the orientation or size of the screen by moving closer to or pinching it in order to see the whole interface. Another problem was observed from eight participants that they found it difficult to find the exit of the AR ad. Two participants pressed the home button on iPhone after finishing the first ad and then clicked the BlippAR app again to start the second AR ad. Some of them noticed that there was a little close icon on the right top of the screen. But when they were ready to press, the close icon disappeared because of the slight movement of screen.

Inside different AR ads, participants tried out different features designed for this particular brand. During this process, some problems were observed. Next, the observation notes for the three ads are discussed in the following three subsections.

4.2.2 Observation notes for the First Ad

The first print ad was a food magazine with a wide range of color scheme. There were four optional functions in the AR ad. The first finding from this ad was that the animated button drew the users' attention even though the function was not what they were intending to try. The unique icon was on the left top in green with the subscribe function, which was jumping all the time (see the Figure 4.1). During the testing, eight participants tried this function first even though five of them said in the interview that it was impossible for them to subscribe the information without buying this product for one time.

Figure 4.1. Interface of the GoodFood AR ad

Another finding was when participants created the magazine cover in the photo booth function, four participants tried to click the four images at the bottom which they assumed as photo templates (see Figure 4.2). However when they touched the bottom images, a photo would be taken without notification and then the sharing photo page jumped out which was something they didn't expect to see.

Figure 4.2. Interface of the photo booth function

4.2.3 Observation notes for the Second Ad

The home page was hard to manipulate because it moved for a few seconds after it was expanded from the view of print ad on the screen. When some users were about to click the menu, the screen zoomed in and the menu disappeared with even just a slight movement of screen.

Another common issue occurring in this ad was the unclear clicking areas. Some users expected to view the videos by clicking the background of the videos showing on the home page; however they didn't see anything happening after several tries. Actually the right way to play the video was to click the word 'VIDEOS' on the interface (see red circle in Figure 4.3).

Another interesting finding was that some users didn't realized that the rectangular black shape was something clickable during the first few seconds and they only clicked the videos on the top and the three social icons at the very bottom (see Figure 4.3). When asked the reason why, they said the color of the buttons was quite similar to the background of the ad so they considered them static shapes in the background.

Figure 4.3. Interface of the Fashion AR ad

4.2.4 Observation notes for the Third Ad

There were four main findings from this ad. First, the AR layer was inconsistent with the physical orientation of the print ad. After scanning the print ad in a portrait orientation, the virtual playground automatically converted from a portrait view (see the right image in Figure 4.4) to a landscape view (see the right image in Figure 4.4) which forced users to rotate the screen and some participants complained about this as a usability issue that interrupted their experience.

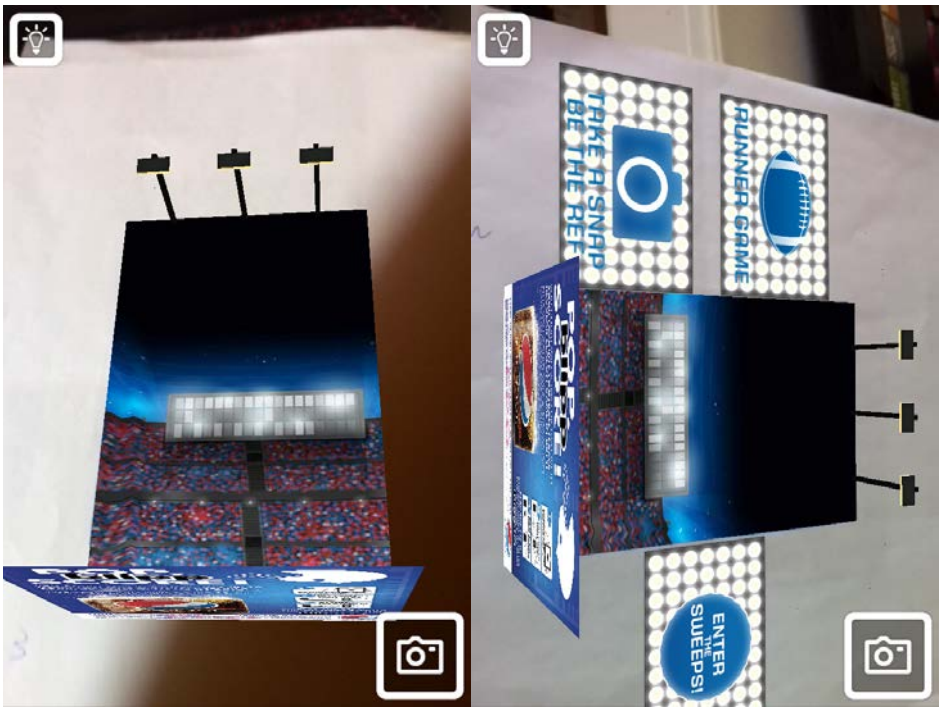

Figure 4.4 Inconsistent orientation in the Pepsi AR ad

When participants clicked the running game icon, a black screen appeared without any feedback and the processing bar delayed for a few seconds to appear, which made five participants press the home button on the iPhone to exit because they thought it was

a bug and four participants felt confused asking “What’s going on here?” “Did I do anything wrong?” “Your phone is out of battery.”

When participants played the video games, a very interesting finding was that only one out of eighteen participants read the game instructions before playing the video game and it turned out that few of them had figured out how to control the player in the game. When being asked about why they choose not to view the instructions in the follow-up interviews, most of them said they felt it was unnecessary and believed that they could figure it out when playing the game. It was observed that almost all of the participants first tried to use very simple swipes on the screen or tilt the device to control the player and they all failed. When some of them clicked the exit button to read the game instructions, the app led them to the home page of the app so that they couldn’t find the game instruction dialogue. Most of them ended with giving up this function and tried another one. Other participants asked for help after several failed attempts.

Another finding was that four participants tried the photo booth function more than twice in this AR ad to play the virtual role as a referee (see Figure 4.5) and said they would like to share this amusing photo with friends. Two of them even asked to be sent the images after testing. Other participants expressed their interests in to a more advanced function for example creating some personalized images by allowing users to edit the background.

Figure 4.5 Interface of the photo booth function in Pepsi

4.3 Data from Interview

In the individual interviews, participants were asked to rate their real feelings through 11 questions based on four dimensions of user experience. In the next subsections, the average score for each criterion in the evaluation model is presented first and then followed by a presentation of corresponding factors.

4.3.1 Participant ratings of four dimensions

Eleven questions were asked in four groups as the emotional (Questions 1 to 4), instrumental (Questions 5 to 8), motivational (Question 9) and social (Questions 10 to 11) dimensions. Each question was measured with the Likert scale from 1 to 7 which

represented the extent from not at all to very much. The last question asked how much possibility participants there would be that participants would recommend this AR app to their friends. The average score for the possibility was 4.722, which meant users may recommend this app but as they mentioned they expected more functions and a more convenient manipulation.

The bar chart below indicated that participants evaluated their overall emotional experience in AR environment and AR's function in drawing attention at a high level, but gave low grades on its ability of persuading to buy a product and connecting people(see Figure 4.6).

Particularly the first three questions were asked about their positive feelings such as whether AR was beyond their expectations, provided a sense of vivacity, or evoked a playful and amusing feeling. The scores in these three questions were all close to six points which meant participants had an overall positive impression of this new ad format. However as indicated by question four which was asking whether users felt interrupted sometimes when interacting with this AR advertising tool, participants rated the extent of interference as medium. This was mostly resulted from usability issues of the application which will be discussed later.

The results from the fifth to eighth question regarding the AR's roles in displaying the function of advertisements shown that AR ads' function to persuade purchase was not as well as its function in attracting audience, delivering information and recalling the brand. As shown in the graph, the grade for persuading purchase-the question six was the lowest among all the questions (see Figure 4.6).

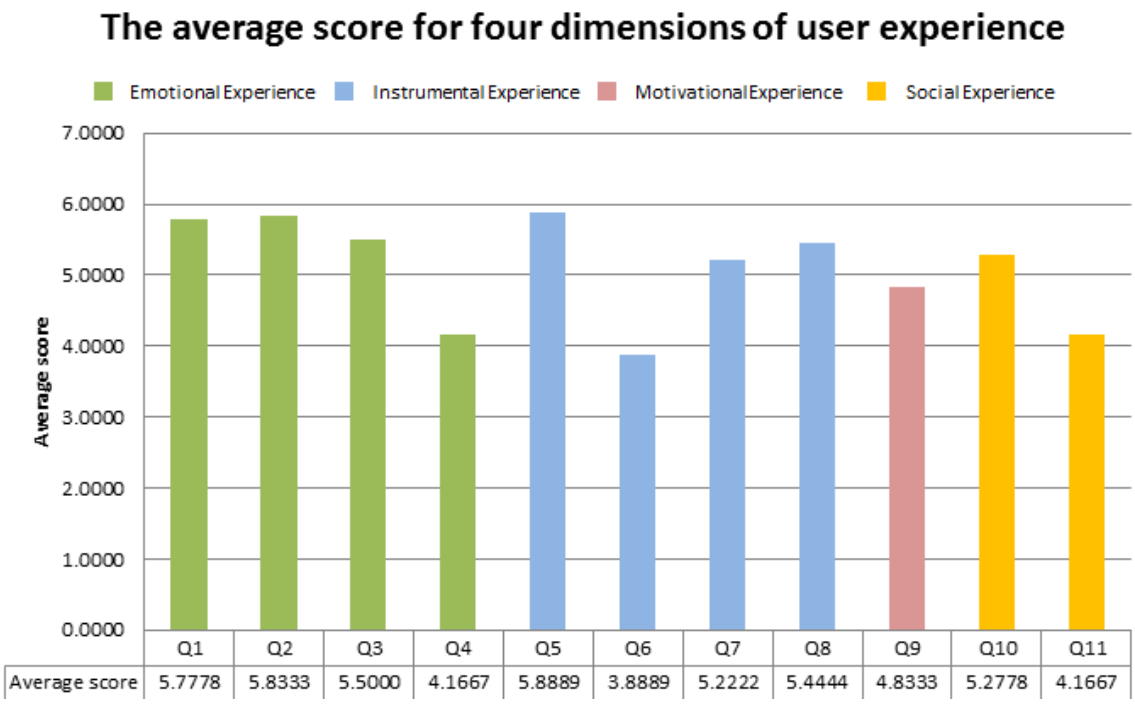

Figure 4.6 The average score for four dimensions of user experience

In terms of AR's motivational dimension, participants no matter whether they were AR novices or prior users all indicated that they would like to try new AR service for other purposes and believed the AR encouraged them to view ads in a novel way in that it was no longer just an information delivery tool but also a multiple-service provider. This can be demonstrated by the overall high grade in question nine.

When asked about some social functions in these AR ads with regards to the safety and connection with friends, they gave relatively low grade for AR's value in making connections with friends. Most participants were not overly concerned about safety and they expected to see more diverse ways to increase social connections not just by sharing a photo on social networking sites.

4.3.2 Factors Influencing the Emotional Dimension

The first four questions in the interview addressed the emotional dimension from the four following abstract criteria: *Amazement, Liveliness, Playfulness/Entertainment* and *Irritation.* The first three were asked for participants' positive feelings and the last was for negative feelings. As mentioned before in the quantitative data, the high grade for the first three items and low grade for the last one meant most participants had a positively valued feelings overall. Through the analysis of participants' reasons given for each subjective emotion, some AR aspects in this advertising tool emerged from the data as the main theme that contributed most to different criteria.

4.3.2.1 Amazement

The main AR features that participants indicated as the reasons why they felt this new format of advertising beyond their expectations were: AR's charm of innovation/novelty, the use of interactive multimedia and service functionalities. These three main themes were mentioned by respondents from the interviews with such a high frequency as to be considered as major themes. One participant's comment below illustrated the importance of the innovation and novelty in creating a sense of extraordinary feelings:

> *This AR ad provides me a novel perspective in which I can see through this piece of paper and view some virtual layer jump out from this print ad. I felt it a miracle. This kind of technology I never saw before and felt it extremely innovative and novel to me.*

Another theme that emerged from participants' comments on the AR aspects related to amazement was the variety of multimedia and its interaction:

The manifestation of advertisements is far beyond my expectation. I originally expect to view some digital images just as normal e-book, however, I am provided with different kinds of multimedia but more important they are interactive, such as 3D, videos, interactive games and clickable buttons. It is really amazing.

The final major AR aspects related to the amazement were the service functionalities. Some participants anticipated to see some promotional events and geographic information related services in future:

I have to admit that this AR ad provides me not only a visual feast, but also some sort of services. This is something I didn't expect before. I really like the service of photo booth which is not only interesting but also allows me to share the news with my friends.

Well I would like to view more functions. I think if this AR app adds some coupon searching and download service or GPS service that would be even better.

4.3.2.2 Liveliness

The most frequently mentioned AR components that were able to create a lively view and thus evoked a positive feeling of vivacity were: 3D objects, and multisensory interaction.

Eight participants attributed their positive feeling of vivacity to the 3D objects created in the AR ads. Even though some of them mentioned about the other media such as videos, websites and games, the 3D objects in the Pepsi ad were the most welcomed as

something resulting in a vivid view. One interesting finding was that the less favored Pepsi ad became the most favorite ad when participants were asked to rate these three ads after using AR. The liveliness of this 3D playground helped a user recall his happy memory.

> *I see something gradually expanding from a folded piece of image as what I view in this print ad and then a 3D playground appears which is quite vivid. At that moment it reminds me the memory of my childhood when my parents and I watching the football game.*

Apart from the 3D objects, another frequently mentioned AR aspect was multisensory interaction. Even though this AR app only involved visual sense, six participants shared their experience in the Haagen-Dazs's AR app and most users looked forward to including multisensory interaction in the future apps.

> *I remembered the experience when interacting with the Haagen-Dazs's app. I can not only view the fancy 3D violin player standing on the lid of ice cream box but also hear the beautiful music. In some moment, I felt like that I was in a live concert which was quite lively.*
>
> *So far I can view the behind scene of making the cake, which is more lively than just viewing this print ad. However I am wondering if I can not only watch the video but also smell the flavor of the cake, which I know is crazy. But I think it would be cool if you have multisensory interaction involved in the AR environment.*

4.3.2.3 Playfulness/Entertainment

One interesting finding from participants' responses for this question was a subtle and obscure relationship between the playfulness and liveliness. Lots of participants gave their answers as the same or similar to the question asked for liveliness. One participant said:

> *I felt this question is quite similar to the prior two questions. Usually I think if I can view something vivid and realistic, I would definitely feel them interesting to play with.*

Other than the reasons given for the liveliness, participants also mentioned the game was a good way to create an entertaining feeling. However, it depended on some factors, for example the factors of user preference, characteristics and how the game was tailored to this product and brand orientation. Participants felt that an upscale and luxury brand was not suitable for including a game in its advertising because it might lower its grade. As a result, the game should be tailored to deliver the brand message, and fit personal circumstances.

> *I felt that even the game give customers a sense of entertainment, it might have negative impact if you give it to a wrong population or a wrong brand. For example, if you asked me to play a game in a Chanel ad, that was ridiculous. Also if you ask an elder customer to play the game, she/he might just ignore this function.*

4.3.2.4 Irritation

This was the only question asked about users' negative experience in order to know about something inconvenient in this AR app. Some usability issues were observed during the testing and some of them were mentioned by participants in the interview. The table below concluded all the usability issues from the high to low frequency.

Table 4.1 Usability issues

Issues	Description of the issue	Frequency
Game is hard to operate	None of the users figured out how to play the game without reading the game instructions. Most of them play the game by swiping on the screen and tilting the screen but the right way is to press the right or left side on the screen and hold for a while to control the direction.	18
Slow loading process	Overall the time for recognizing the image was acceptable to most users, but the loading time for some videos or games was quite low.	12

Table 4.1 Continued

Black screen without loading bar	Before loading the game, a black screen came out for a few seconds without any loading bar. Some users just press the home button on iPhone, some users asked researcher and some just wait with confusion.	9
Hard to find the exit	Users expected to click the exit icon in the interface to switch between one to another. However the location of the close icon was unstable and hard to click.	8
Hard to adjust the size or orientation of screen	Users wanted to see the whole view of the interface on the screen; however the augmented layer took a long time to remain still. A slight movement of screen resulted in a partial disappearance of interface.	7
Internet constrains	Some users were concerned about the internet access, either the availability of internet in some areas or the speed of internet.	5

Table 4.1 Continued

Too sensitive clickable areas	When users tried the photo booth function in the Good Food ad, a photo would be taken if they carelessly touched any of the four images at the bottom which they thought were template.	4
Affordance of the clickable icon	Users could tell whether the black shapes on the interface were still or clickable icon. Because their color was similar to the background of the ad and hard to differentiate.	2
Distracted background on the interface	The blue text against the little white dots background made it difficult to tell the read.	2

4.3.3 Factors Influencing the Instrumental Dimension

AR's role in drawing attention, persuading, conveying information and helping recall of brand were defined to evaluate the instrumental dimension in the user experience of AR advertising.

4.3.3.1 Attention

AR contributed a lot to drawing customers' attention. Except for two participants, the rest indicated that when the virtual layer jumped into view, their attention was focused on the screen for the first few seconds. They accredited it to the dynamic contents and the creative idea of using AR in advertising. Some reasons were related to ones that contributed to the amazement and liveliness in previous dimensions. The following comments illustrated the importance of dynamic contents and the new way of presenting information in drawing users' attention.

> *It immediately catches my attention when the still images turn into dynamic contents.*
>
> *It draws my attention because of the technology itself, which gives a sense of amazement and liveliness. I feel the way it presents information is quite unusual and it is something different from QR code. The idea of combining AR with print ad is a new way for me to experience.*

4.3.3.2 Persuasive

The answers for AR's contribution in persuading customers to buy a product were quite diverse. As stated by those participants who considered themselves consumers of impulsiveness that are easily influenced by external factors when making their decisions, the creativity and emotional attachment of an ad might persuade them to buy a product.

> *Sometimes if I am impressed by a very creative and cool advertisement such as something I experienced today, I am very likely to buy this product. I think the*

creativity of this technology give this ad additional value that makes me want to buy this product.

I would not consider for a long time to buy a product once I am inspired by an idea presented in an ad or if an ad deeply touched me even sometimes I don't have a need for this product.

Another group of participants who considered themselves sensible were less likely to be persuaded to buy a product after viewing an ad. They owned the success of persuasion less to a particular aspect embodied in the AR service but more to their internal needs, price and other customers' recommendations.

It is not the fault of this ad. No matter how fancy and creative technology that is used in ad, I would seldom influenced by this mere factor. First I do need to have an immediate demand for this product. Second I need to evaluate its price and quality from online customers review or suggestions from my friends who used this product before.

Another interesting finding was that though AR might not entice an instant purchase behavior, it might increase the conversation rate over time because it leaves a deep impression on customers. As stated by several participants:

The AR ad does not necessarily persuade me to buy a product but of course gives me a deep impression of this product, which might convert me from a potential consumer to an actual buyer.

I feel that it is required too much for an ad. From my opinion, its purpose is not to persuade customers to buy a product but to impress customers, leave something in

their minds and therefore increase the chances to buy this product. I think it works in terms of these functions.

4.3.3.3 Informative

In response to the question about what feature in this AR app made participants feel that they obtained product information, they commented that the product information was manifested in different multimedia channels such as videos, websites, games and 3D animations. They indicated that they would rather view the videos than read text on print ads to get product information. As stated by one participant:

This AR ad gives me a more comprehensive understanding about this product from different channels. I can browser its website if I want to purchase something or know details about this product. At the same time I can feel the brand culture when playing the game. Most important, it saves me trouble of reading tons of words on the print ads to know the product. I would like to view some videos to know about this product.

4.3.3.4 Recall the brand

The innovation and interaction of AR technology were perceived as features that would help participants recall the brand in the future. First with the help of this novel medium, participants indicated they were more likely to be attracted by these advertisements so that they would spend more time reading and remembering the name of the brand and recall the brand if they saw it again. As stated by participant:

This is my first time using an AR app to view an ad, it must be impressive and I would like to spend more time exploring what will happen in this AR environment.

Every time using different functions in this app, I can view the brand name for another time. It is easy for remember.

Second, participants were impressed with some interactions from AR environment so that they remembered the brand later.

I remembered the brand name Good Food because I made my own flyer of this brand using the photo booth function. It is quite impressive because I can try different poses and interact with the environment.

4.3.4 Factors Influencing the Motivational Dimension

As defined by Olsson (2013) the motivational experience is created when a service or product motivates users to do something for new purposes by the use of this technology. In this study, the ninth question asked whether participants had been motivated by AR technology so that they were eager to use AR services for new purposes. The responses indicated that both novice and prior AR users were motivated by this technology. When future asked about what kind of new purpose they would like to utilize AR technology for, two main themes emerged.

4.3.4.1 Inspiration

There were two main AR aspects indicated by participants that inspired them. One was AR's feature in visualizing information in physical environment. Users implied that this feature could be applied in movie trailer, instructional information, and academic presentations. With AR, they can obtain more information in an interactive and vivid way.

AR should be used for making a promotion videos or movie trailers. For example when you scan the movie flyer, a movie trailer will pop up on your mobile.

It would be a good idea if we use AR in education, for example we can train the medical students to tell the location and shape of different organs.

I am thinking if I can use AR to make my presentation. It would be cool.

Another feature was related to its values in location. MAR valued in its interaction with physical environment and its portable applied device. AR can bring about additional values in location-aware services which are favorable in tourism and navigation system. As participants mentioned, AR can be used as a convenient navigation service or a portal to parallel experiences of past and present.

I think it might be useful if AR technology combines with GPS. For example, I go to a shopping mall with a print map, and I would like to find a store. By scanning this location or number of the store in the print map, I would like to obtain the exact location information with google map voice navigation.

I come up with an interesting idea if we use AR in tourism. For example I travel to a foreign country and want to know more culture and history about a scenic spot, I can scan this spot and then it lead to an AR experience introducing the history and showing some old photos of this place. I can view different view simultaneously.

4.3.5 Factors Influencing the Social Dimension

Social experience was rooted in human interaction and also was intermediated by the technology. Whether users would like to share their information depends on several factors, this study particularly investigated the safety factor because of the nature of the

interaction environment. It must be ran under the condition of networking. Another criterion to evaluate was connectedness which was relevant to whether technology could facilitate connections between users (Olsson, 2013).

4.3.5.1 Safety

Participants accredited their unwillingness to share information to their personal interest or creativity of ads but not the safety. Eight participants said that if they were asked to connect with social networking site account, they would accept because they usually do the same thing for other apps. But they said they had better be notified and asked for permission before auto-login.

> *I didn't find anything unsafety when using this app. First there is no other functions expect for the share of image that ask me to log in my social networking to input my personal information. Second it is quite common to connect with social networking sites in other mobile apps which I have been used to it. Third I have the options to whether input or not my information. So it is quite safety for me.*

However even though they found it safe to connect with social networking websites, some participants were concerned about the safety of online shopping if applicable. They said they would rather use a specialized shopping app or website such as Amazon to buy something on mobile phones than shop in such an additional function in this non-professional shopping app.

> *For me I would not use this app to make my online shopping for example it lead me to the official website. Because it is more like a platform to display the product*

but not specific to shopping and I never heard BlippAR before so I might not trust it as much as Amazon.

Another reason mentioned by participant for the insecurity of online shopping was unfamiliarity with the AR technology. They considered the transaction page as something belonging to the virtual environment that they needed to ensure its connection with something in the physical environment.

Will this shopping page disappear? Because I remember only when I scanning the print ad, the digital contents including this webpage come out. I am wondering if they are disconnected, my online transaction will have some problems. I don't want to take a risk because my first time using such a new technology.

4.3.5.2 Involvement/ Connection

Users felt that the social feature mediated by the AR technology was simple in this app because they were only allowed to share their images on social networking sites. Some participants believed that a social connection was more than just sharing information created in the AR environment. It was supposed to be an interactive activity with friends no matter as opponents or partners.

I would like to see a multiplayer and real-time game so that my friends and I can compete or collaborate in the game.

Because you are intended to create a connection with friends, at least it should have some interaction with your friends. I think the idea of 'you draw something and I guess' is great because in order to complete this game you two need a close cooperation.

Another interesting theme from user responses was to add AR technology in social networking sites as an alternative viewing mode.

> *I think most of students use social networking in their daily life. They use desktop or mobile phone to view the information. After experienced with the AR ad, I came up with an idea to use AR technology as the entrance of your social networking website. For example, by setting your social networking sites as AR mode, you can collect and view your friend's information from his/her social networking sites immediately just by scanning his/her photos or even his/her personal item.*

4.4 Integration of qualitative and quantitative data

In order to synthesize the data, participants' responses were categories into two parts based on their ratings for each criterion within the four dimensions. The median four was selected as the breaking point to separate the high and low grades. The two groups were users with high ratings that evaluated above four points and users with low ratings that evaluated below or equal to four points. Their responses were compared. In addition, the ratio of novice and experienced users was provided as N/E in the table to help analyze if there is any relationship between the highly evaluated dimensions and characteristics of users. From the table, we can tell that in most cases participants had high ratings which meant AR brought a positive user experience except for persuading users to buy the products and help connect with friends. Though the specific reasons accounting for the high or low ratings were different, the users' judgments of the emotional dimension focused on whether the service was interactive enough with the

physical environment, whether the elements were multisensory and whether it was convenient and novel to use. From the ratio, we can also tell that AR novice had a higher emotional rating than experienced users especially in the aspects of amazement, liveliness. In terms of AR's contribution to the instrumental dimension, Users with high ratings in the instrumental dimension were more likely to attribute this to the reasons for their positive emotion, while users with low ratings were more driven by the internal factors rather than the external factors. All AR novices evaluated AR ads as an effective tool in drawing their attention. In the motivational dimension, people were less likely to be inspired because of their unfamiliarity with AR technology which can be indicated by larger N/E ratio in the low rating group. Participants who felt safe using social functions in AR were frequent social networking sites users. More users gave low grades for increasing connection with the help of AR because they acquired more interesting activities than just sharing photos to build friendship.

Table 4.2 Comparison of users with high rating and low rating

User types / Criterion	Users with high rating (>4)		Users with low rating (≤4)	
	Number of users	Reasons	Number of users	Reasons
Amazement	16 N/E:9/7	Interactive media Interesting functions Novelty of AR	2 N/E:0/2	Limited interaction with physical world Only visual elements
Liveliness	16 N/E:9/7	3D objects Dynamic and interactive contents	2 N/E: 0/2	More sensory channels
Playfulness	16 N/E:8/8	Game Vivid contents	2 N/E:1/1	Some usability issues
Irritation	10 N/E:5/4	Too many usability issues Scanning action	9 N/E:4/5	Few usability issues are found
Attention	16 N/E:9/7	AR's novelty Dynamic contents	2 N/E:0/2	Requested by researcher not out of willingness

Table 4.3 Continued

Persuasive	7 N/E:3/4	Leave a impression and more likely to buy	11 N/E:6/5	Personality-driven not because of technology
Informativeness	13 N/E:5/8	Provided by different multimedia channels	5 N/E:4/1	No special values added in the information Too many words
Recall the brand	13 N/E:5/8	Influenced by the factors drawing attention	5 N/E:4/1	Depends on how much time user spend Brand messages are not obvious
Inspiration	11 N/E:5/6	Use for information visualization applied in education Use in location-aware service	7 N/E:4/3	Can see its potential but hard to describe because of limited awareness of this technology
Safety	13 N/E:7/6	Usually connect app with social networking sites	5 N/E:2/3	Unfamiliar to use AR Worried about online transaction

Table 4.4 Continued

Connection	8 N/E:5/4	Share photos with friends with this new technology. Discuss AR with friends	10 N/E:4/6	The social service should be more cooperative, and interactive between friends.

4.5 Summary

This chapter presented the findings from observations of the three print ads and the participants' demographic information. The responses from the Likert-scale statements were quantified as the average scores in the bar chart indicating users' overall ratings for each dimension. Some emerging themes were presented in details with quotations from users as the contributing factors for each dimension. Finally, the integrated qualitative and quantitative data were presented.

CHAPTER 5. CONCLUSION AND RECOMMENDATION

This chapter starts with the conclusions of findings in observations and interviews. Then it discusses how different components influenced the four dimensions. Then some design suggestions are proposed from three aspects: contents and interface, interactin and functionality. Finally the limitations and suggstions for this study are provided as well.

5.1 Conclusion and Discussion

This section concludes and discusses the results of the observation and interviews respectively in order to address the research questions of this study.

5.1.1 Discussion of observation results

First the main findings from the observation are categorized into three groups in terms of the problems of operation, confusion with interface and interests in interactions (see Table 5.1) followed by the a discussion of reasons.

Table 5.1 Summary of the observation findings

Categories	Findings	Frequency	Reasons
Problem with the operation	Users fail to play the game without reading the instructions first	18	Don't want to read instructions, hard to control

Table 5.1 Continued

Problem with the operation	Users have difficulty in adjusting the orientation and size of the screen.	7	Unmatched orientation, cannot view the whole interface
Confusion with the interface	Users are confused by the black screen and try to press the home button to exit	9	No hints, wrong guess
	Users cannot find the exit button easily	8	The exit icon disappear sometimes
	Users click the wrong areas resulting in a wrong function	6	Poorly defined clicking area
Interests in interactions	Users first click animated buttons on the screen (Good food ad)	8	The jumping icon draws attention

Table 5.1 Continued

Interests in interactions	User use the photo booth function in the Pepsi ad to interact with the physical environment for more than two times	4	Interesting and to be one part of the virtual world
	Users shake their hands in the air at the place above print ads and below the mobile screen	2	Curiosity of touching the augmented contents in the physical environment

Among these findings, the first five are usability issues that hinder the user experience. Some of them can be prevented by some general design principles such as the Nielsen's 10 usability heuristics for user interface design (Nielsen & Molich, 1990). Few users read the game instructions before playing because they don't want to overload their memory by learning extra information, which is demonstrated by recognition rather than recall principle. So a synchronized window of the game instruction should be provided along with the game when necessary rather than a separated dialogue. Also in order to reduce the cognition load, the game controls should be intuitive and follow normal gestures such as tapping and tilting the screen to move. Users first felt uncomfortable to see the rotated screen of the Pepsi virtual playground appearing on the screen which contradicted the orientation in the print ad. It is because the unmatched orientation made

the information appear in a unnatural way. Later, when users moved the screen away from the print ads, sometimes the screen flipped and therefore lost its original whole view of the interface. All these are unwanted states that makes the system inconsistent and hard to control. The problem of black screen is resulted from the invisibility of system status and it could be solved by adding a instant processing bar. When switching to another ad, some users cannot find the exit button because it is not fixed on the screen at some moments. A clearly marked and still exit button is better for user control. The unexpected functions are created because of poor error prevention design and inconsistency with platform conventions. For example, the background images used in the photo booth function should not be clickable to open the camera in case someone mistakenly touches them. The standard playing icon should be used to control the videos instead of a word 'VIDEOS' to follow the conventions of multimedia icons.

The other three findings are not usability issues but are useful to consider when designing AR app. Users are more likely to be attracted by the animated buttons and engage in some activities that involve their own to be one part of the virtual world. Thus in order to emphasize some important functions and contents, some animated buttons are suggested. In addition, to make the AR service more engaging, users recommend role-play in the virtual world. The users' behaviors of waving hands in the air can be explained by their curiosity of touching the augmented contents on the transparent device in the physical environment. The transparent device means that even though the screen blocks the sight of objects in physical environment, these objects are still visible and allows users to interact with them on the screen. Users feel that they are interacting with the environment rather than with a device and they can feel and touch the augmented

contents in physical environment. As a result, they put their hands out and want to see some simultaneous changes occur both in the physical and virtual environment.

5.1.2 Discussion of findings from interview

Next the conclusion of factors related to the four dimensions of user experience is provided which addresses the first research question, followed by a discussion on how the user experience in AR advertising is constructed and influenced by these factors.

Table 5.2 Components that influence user experience

Dimension	Rating Score	Evaluated characteristics	Related AR features and factors
Emotional	5.7778	Amazement	➢ AR's charm of innovation/novelty; ➢ The use of interactive multimedia; ➢ Service functionalities
	5.8333	Liveliness	➢ 3D objects; ➢ Multisensory interaction
	5.50	Playfulness	➢ Vivid and lively elements ➢ Game is good if it is tailored to fit the brand message and individual circumstance (related to liveliness)
	4.1667	Irritation	➢ 9 usability issues make user unsatisfied

Table 5.2 Continued

Instrumental	5.8889	Attention	➢ Dynamic contents ➢ The new way of presenting information, similar to AR's charm of innovation/novelty (related to amazement and liveliness)
	3.8889	Persuasive	➢ Personality-dependent not technology-dependent -Impulsive customers: creativity of technology, emotional attachment -Sensible customers: internal need, price, recommendations ➢ AR has potential in conversation rate
	5.2222	Informative	➢ Multimedia channels ➢ Don't like to read words but watch videos to get the information
	5.4444	Recall the brand	➢ AR's charm of innovation/novelty ➢ Interactive functions in the AR (related to attention)

Table 5.2 Continued

Motivational	4.8333	Inspiration	➢ AR's feature in interactively visualizing information in physical environment, which can be applied in movie trailer, instructional information, and presentation. ➢ AR's Location-aware feature can make navigation easier; provide a parallel experience from different time period.
Social	5.2778	Safety	➢ Habitual behaviors of connecting social networking websites ➢ Worry about online shopping because of its professionalism. ➢ Unfamiliarity with the AR
	4.1667	Involvement/ Connection	➢ Share photos through social networking sites ➢ Cooperate or compete in an interactive environment

As indicated by the average score of statements concerning different evaluated categories under the four dimensions, AR ads are a highly-evaluated tool in drawing customers' attention, which is strongly related to its values in bringing a feeling of

amazement and liveliness. Users interact with such an environment enriched with AR contents that are characterized by interaction, novelty and service functionalities, and therefore are impressed by this new advertising tool. However, AR does not help too much in persuading customers to buy a product as indicated by the lowest score, because purchase decisions are more driven by the internal factors and different characteristics of customers. The inspiration of AR technology for new purposes is evaluated as a medium score and contains two major categories, which might be increased with a better awareness and a wider popularity of this technology in the future. In terms of AR's values in supporting social connections, users can be made aware of the information created by the others and thus form a sense of community. This sense can be enhanced if there are some collectively or competitively created AR contents, and be continued if these socially constructed contents can be utilized in different ways, for example in some location-aware services.

From the participants' responses, it is hard to say that one dimension of experience results from one or several exclusive AR aspects. There are some overlapping factors that result in the occurence of certain experiences and an interrelationship also exists between several dimensions. In terms of the nature of components, they vary with regard to whether they are specific AR features or some general factors. For example AR's charm of innovation and multisensory interaction is more specific to AR because of its novelty, while using multimedia to create a sense of amazement is a more generally-applied feature. These factors and aspects are involved in multiple areas not only specific to the AR technology but also in multimedia technology, social networking, and human cognition.

The whole user experience is constructed not only by the AR technology itself but also other related funtionalities included in this AR advertising tool which are created by other related technologies. So when inquiring about how the user experience originates, it is better to ask for aspects that are involved in this entire AR service than look for a specific characteristic of the AR technology. The occurrences of the four dimensions of user experience do not follow a strictly defined order and they interrelate closely with all kinds of factors and components in such an AR advertising service. Reading an AR ad is different from reading in print ad and normal operation of mobile phones which first requires users to scan the print ad and hold their devices until the virtual layer pops out. Thus, it changes the role of customers from a passive information recipients to active information seekers in the process of watching advertisements.There must first be some stimulus to activate such as an unexpected interaction, such as a service, or coupons. The novelty of AR technology plays an important role in arousing users curiosity and thus brings a feeling of surprise. This feature along with the lively digital contents further help with drawing and holding users' attention in order to facilitate building the brand awareness. The multimedia contents and interactive funtionalities evoke a feeling of vivacity and thus make users entertained satisfying the emotional need. Insensibly, customers are exposed to brand messages all the time through multiple channels. All these work together to continuously inspire users' positive emotions and make them remember the brand. In this process some usability issues should be reduced in order to maintain a good user mood and facilitate processing of product information. A favorable social function can add additional values to this AR advertising experience not only because it can help the businesses spread their product information but also create a

connection between friends. But it should not only be the ways of sharing photos on social networking sites. Finally, if users get some benefits either materially or spiritually from the AR service, they will very likely to purchase the product in the feature or at least remember the product. To better leverage AR technology in advertising, the time, place and individual needs should be also considered as a whole. Tailored contents should be delivered to the end users at an ideal time and place and in their favorite formats based on their habits which can increase the likelihood of purchase. In addition, customers need to be educated and adapted to using AR technology in their normal life in order to reduce their concerns because of unfamiliarity to with this technology.

From the above discussion, the novelty of AR, multimedia,multisensory and personalized contents, interactive, social and context-aware services are all important components to produce a impressive and interesting AR user experience.

5.2 Design suggestions

One purpose of this study is to provide researchers some categories and AR components that they can further investigate and evaluate for user experience, another objective is to give AR developers some design suggestions if they want to successfully utilize this technology in advertising and other areas. The suggestions provided here will be feasible with the successful development of AR hardware, such as powerful processors, precise recognition, and wearable technology.

The following design suggestions are derived from the present study and fall into three groups: contents and interface, interaction and functionality.

5.2.1 Contents and interface

This category includes some suggestions regarding how to design effective contents and interface in the AR advertising tool. The contents included both digital ones in the virtual environment and non-digital ones in the physical environment. The interface here means the areas on mobile applications where users can manipulate control of the software.

1. Keep the AR interface as clean as possible. Users don't like complex and unorganized interfaces. They care more about how designers connect different functions together to create a unexpected user flow than whether a visiable interface exists or not. As one participant said:"I don't like to have too much clicking on the interface. For example even though there is no visiable interface in Häagen-Dazs AR app, I still like it because it engages me in its flow." The future interface could be a collapsible interface that users can freely expand and compact according to their needs .

2. Provide strong clues on the interface to guide the operation. First thing is to include obvious signs on the print ads to mark the AR ads. Second as indicated in the usability issues, the modalities of the clickable buttons should be more obvious, such as animated buttons capturing the attention at first glance.

3. Place the instructions on the interface along with user flow. In this app, the game instructions were placed in the wrong place which made for no successful case of game play. Instead of placing it in a separate menu which is outside of the user flow of playing a game, make it accessible at the place of user flow.

4. The contents on the print ad should deliver a compelling brand message and AR contents should help to intensify this impression. In order to lead customers into an AR

experience, the print ad should impress people and catch their attention within a few seconds. Consumers preferred to see bright colors, less text and lively characters on the print ads. The 3D objects and multisensory elements created in AR environment are favored by users.

5. Provide realistic AR contents. It is more interesting for users to play with something real than to play with the flat screen. For example spatial objects are better than something on a flat surface and also the quality of digital contents is very important.

6. Integrate offline and online data. This means the achievement of sharing online and offline data in AR service when Internet is inaccessiable. In this app, the Internet limitation resulted in a slow loading which hindered the user operation. In the future, some multimedia contents used in AR service should be pre-processed or preloaded so that they can be used offline.

5.2.2 Interaction

Interaction contains the way of controlling and providing the input information from the physical environment, interacting with AR contents and the social interaction between AR users. The following suggestions are related to these categories.

1. Resemble interactions in physical world with wearable technology. In the physical world we pick up an object, manipulate it with our hands, and receive feedback based on our actions. Wearable technology might make AR do the same without scanning.

2. Include multisensory interaction. Users would like to not only see feedback but also hear, smell and touch when interacting with some digitial contents just as they

experienced with physical objects. For example, having a conversation with a virtual character.

3. Reduce the burden of "warm-up" activities for users. The warm-up activities refer to downloading the AR app, scanning the print ads and adjusting the device. In oder to enhance the user experience, the design needs to make sure the virtual objects appearing on the screen appear in the right proportions and angles to the physical environment. All these tasks should be reduced to one action in the future with the development of technology.

4. Include some try-on functions in AR app. In this study, most participants said they liked the photo booth function because they could take funny pictures of themselves. As one suggestion for clothing ads, they could include a virtual fitting room function to see how users look when trying different styles.

5. Social interaction should establish a way of cooperation or competition between users. Participants said they would like to see more cooperative activities or competitive games to have fun with friends beyond just sharing photos. For example users first pick up in-game characters and replace with their own head or other body parts, they can then invite their friends to join the game to compete with each other. Another case could be several users working together to create and beautify augmented digital contents in virtual environments.

5.2.3 Functionality

Suggestions in this category are more related to what kinds of services and technologies can be integrated into the AR services and how to incorporate them in order to provide a satisfactory user experience.

1. Integrate AR with location-based services. This combination might be useful in map-based services, which might affect the experience of liveliness. It can create a multiple view of the location-related information with the additional digital information that can be accessed in AR. For example, this future could be used to introduce scenic spots and local delicious food, provide a map of tour routes, and book tickets and hotel reservations on the trip.

2. Proactively provide personalized information or service in AR apps. Because of the portability of mobile devices, the MAR app can take advantage of using context-aware computing. With its help the future app can automatically and adaptively generate personalized digital contents by understanding information from four aspects as initiated by prior researchers: (1) computing context such as network connectivity, (2) user context such as the user's social situation, (3) time context such as the time of day and (4) physical context such as the temperature conditions (Chen & Kotz, 2000). For example, to advertise or push selected content to pinpoint targeted individuals at a particular time and place.

3. Encourage users to use social media to enhance brand engagement. One way is encouraging users to share their liked AR ad through social media channels by giving them some coupons. Another way is to involve users in their own-created community where a group of users can work collaboratively to create, modify and share information.

5.3 Limitations and Recommendations

This study was conducted based on a four-dimensional UX evaluation framework in order to explore the how the user experience occurrs and origintaes from certain aspects of this AR advertising service.

The three ads were selected based on their popularity measured by the official website of the testing app. Since the materials were previously created, the author was limited by the diversity of the advertisements so that they might not perfectly match the personal preferences of each participant. Thus it may bring an underlying factor influencing their experience that happened during the interaction with AR ads. For example female participants may not like the football game in the AR ad and male participants may not like the fashion brand. In future studies, more non-gendered ads samples for different types of products should be provided to participants.

This study was limited by the testing environment as well. The testing was conducted in a private study room in an attempt to control the noise and easily record. However there were no guarantees that the participants would have a similar experience when viewing the AR ads in a public place such as a shopping mall. The recommendation is to conduct a filed study in the future and compare the results with this study. In this study, these four predefined UX dimensions and factors were selected based on the term frequency in previous literatures of categorizing the user experience and potential AR user experience (Hassenzahl, 2005; Hassenzahl & Tractinsky, 2006; Desmet & Hekkert, 2007; Buccini & Padovani, 2007; Gentile, Spiller, & Noci, 2007; Abideen & Saleem, 2011; Olsson, 2013). However, as indicated by a previous researcher it was quite hard to theoretically describe user experience because it was inherently limited with regard to

comprehensiveness (Olsson, 2013). This theoretical framework might not incorporate the entirety of experiences that may occur in the mobile AR advertising service. The diversity of user experience can be further broadened by more extensive studies and opinions from experienced AR users. In addition, more studies should be conducted to assess the relevance of the selected UX dimensions and test the effectiveness of this evaluation framework in future mobile AR services.

In addition, this study was limited by the time. It is challenging to predict which dimensions will be emphasized by the AR's influence over time, especially some categories that are influenced by AR's novelty. A longitudinal study is suggested in the future to examine and evaluate AR values in advertising over a long period of time.

Finally this study was limited by the diversity of the demographic. This study only recruited college students at Purdue because they tend to be the early adopters of technology with their high-educational background. Other researchers should be cautious about extrapolating the results of this study to other groups. But at least this study can be used as the stepping stone for future researchers to conduct a similar study for other groups of peopler beyond just students.

5.4 Summary

The main contribution of this study is the multidimensional evaluation framework to assess the AR user experience in advertising. This model can be used and modified by other researchers to evaluate AR applications for other purposes. In addition the factors that are associated with the four UX dimensions can be used as variables to investigate

their impacts on the user experience in an AR environment. Finally, I hope this user study can help AR designers to better understand users' requirements and expectations.

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APPENDICES

Appendix A Observation form

Observer:_____ Date:_____

Participant:____

	Time:	Time:	Time:
Context or circumstances			
Facial expression			
Vocalization			
Hand motion			
Body language			

Appendix B Interview questions

Part I：Please fill out the background information before the testing.

1.Gendar:_____

2.Education Level:_____

2.Have you ever heard about Augmented reality?

Yes

No

3.If yes, what kind of AR application you used before?

4.Please rank the three print ads and give the reasons.

Part II: Please rank the three AR ads first and then answer the questions below.

MAR ads experience analysis questions

Emotional experience

1. Assuming that you never heard about this brand before, does this AR ad makes you feel that you are enjoying something beyond your expectation of viewing a ad? (not at all)1 2 3 4 5 6 7 (very much) What features or which part in this app makes you feel this way?
2. Does this AR ad provide you a positive feeling of vivacity (the quality of being attractively lively and animated), compared with print ad? (not at all)1 2 3 4 5 6 7 (very much) What features or which part in this app makes you feel this way?
3. Does this AR ad evoke a playful and amusing feeling that engages you compared with the print ad? (not at all)1 2 3 4 5 6 7 (very much) What features or which part in this app makes you feel this way?
4. When you viewing the AR ad, did this interfere or interupt you at any moment? (not at all)1 2 3 4 5 6 7 (very much) What features or which part in this app makes you feel this way?

Instrumental experience

5. Does this AR ad draw your attention? (not at all)1 2 3 4 5 6 7 (very much) What features or which part in this app makes you feel this way?
6. Compared with the print ad, does this AR ad persude you to buy this product? (not at all)1 2 3 4 5 6 7 (very much)

What features or which part in this app makes you feel this way?
7. Does this AR ad efficiently provide you with product information? (not at all)1 2 3 4 5 6 7 (very much) What features or which part in this app makes you feel this way?
8. Will this AR ad help you recall the brand in the future? (not at all)1 2 3 4 5 6 7(very much) What features or which part in this app makes you feel this way?

Motivational experience

9. Does this AR ad demonstrate elements that are able to inspire and stimulate you, which enables you to use AR for new purposes in future, if so what is your idea? (not at all)1 2 3 4 5 6 7(very much) What features or which part in this app makes you feel this way?

Social experience

10. Did you feel safety when using the sharing function in this application? (not at all)1 2 3 4 5 6 7 (very much) What features or which part in this app makes you feel this way?
11. Does this AR ad makes you feel better connection and interaction with other people? (not at all)1 2 3 4 5 6 7(very much) What features or which part in this app makes you feel this way?

12. What kinds of featuers do you like to add to the existing application in order to enhance your oeverall experience?

13. What do you think about the questions asked to evaluate the application, do they make sense to you?

14. Will you recommend this app to your friends?
(not at all)1 2 3 4 5 6 7(very much)

Appendix C Three example AR ads

1. Pepsi AR advertisement

2.BBC good food

3. River island

Appendix D Participant information sheet

This information sheet will be given to each participant as part of the recruitment process and before starting the testing.

Purpose of Research

This research project aims to understand what components and attributes of AR advertising influence the user experience and what experience customers think is important to enhance the overall shopping experience.

Specific Procedures

To participate in this research, you will be first shown how to use the augmented reality tool and then we would like you to experience some AR ads examples for about 10 minutes and try to understand what your experience is during this process. Finally we will ask you some experiential-related questions in an interview. Some handwritten notes and video, audio will be recorded for the purpose of the accuracy of our data.

Duration of Participation

The exact time for this research depends on participants' answers in the interview, but it should take about one hour for the whole process.

Risks

All research carries risk. The minimal foreseeable risks are that your identity might be accidentally revealed to parties other than the researchers, should there be a confidentiality breach. However, we are taking several measures to protect your identity. These are described in the Confidentiality section below.

Benefits

There are no direct benefits to you other than a $10 Amazon gift card after this research but you will commit to answer any possible follow-up questions after the research within one month. The research data may benefit society at large, because it may help producers of innovative technologies understand how to develop new, or modify existing AR application to better meet users' needs.

Confidentiality

We will take several measures to keep your personal identity confidential. We will not record any identifiable information like your name along with your interview. All research reports will present aggregate data, or quotations without any context that makes it possible to identify the source. The interview data will be stored in a password-protected computer account until the project finished. The project results will be disseminated in industry reports, the news media, and at academic research conferences and journals. The project's research records may be reviewed by departments at Purdue University responsible for regulatory and research oversight.

Voluntary Nature of Participation

You do not have to participate in this research project. If you agree to participate you cannot withdraw your participation at any time.

Contact Information

If you have any questions about this research project, you can contact:

- Shanshan Li, Computer Graphics Technology, 765- 775-6737, li1217@purdue.edu
- Dr. Mihaela Vorvoreanu, Computer Graphics Technology, 765-496-7709, Mihaela@purdue.edu

If you have concerns about the treatment of research participants, you can contact the Institutional Review Board at Purdue University, Ernest C. Young Hall, Room 1032, 155 S. Grant St., West Lafayette, IN 47907-2114. The phone number for the Board is (765) 494-5942. The email address is irb@purdue.edu.

Documentation of Informed Consent

I have had the opportunity to read this consent form and have the research study explained. I have had the opportunity to ask questions about the research study, and my questions have been answered. I am prepared to participate in the research study described above. I will be offered a copy of this consent form after I sign it.

_____

_____

Participant's Signature Date

_____