Interactive user experience – Effects of augmented reality on consumer psychology and behavior

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ABSTRACT

The saturation of traditional forms for advertising in consumers' everyday lives has led to a gradual loss of the predominance of publicity. In search for innovative and original ways to captivate user's attention, recently many brands have adopted Augmented Reality (AR) in their advertising campaigns. Most of the campaigns, using the technology, rely on an experiential approach concentrating not only on a brand's product or service, but also on an entire experience created especially for the consumer. With AR a consumer can test a product interactively through a 3D representation in real time, possibly achieving deeper brand engagement or even undertaking an action to purchase.

This thesis produced a systematic investigation of the effectiveness of three separate digital shopping platforms, namely a Purely Interactive, an AR Marker-based and an AR Markerless systems. The three platforms were developed to be used for testing in an experimental setting. Consumers' cognitive responses were assessed through an empirical examination through the constructs of Innovativeness adoption, Emotions, Information seeking, Perceived risk, Arousal, Responsiveness, Perceived interface aesthetics, Usability, Organization, Fun, Boring and Brand personality. The degree of elevated purchase intent was registered and compared across the three platforms according to outcomes from participants' cognitive responses and their evaluations of the technological properties of the systems.

Although not all of the hypotheses were accepted, results indicate that differences among the effects of the three tested systems do exist, particularly between the interactive and augmented reality solutions. Thus, it is maintained that AR systems may serve as an acceptable alternative of consumer "direct experience" with a product in order to make an impact on the user.

Keywords: augmented reality, consumer behavior, consumer psychology, purchase intention, user experience

RESUMO

A saturação das formas tradicionais de publicidade na vida quotidiana dos consumidores levou a uma perda gradual da predominância da publicidade. Em busca de formas inovadoras e originais para cativar a atenção do consumidor, muitas marcas adotaram recentemente soluções de Realidade Aumentada (RA) nas suas campanhas publicitárias. A maioria das campanhas, que utilizam a tecnologia, dependem de uma abordagem experiencial, concentrada não apenas no produto ou serviço de uma marca, mas em toda a experiência criada especificamente para o consumidor. Com a aplicação da RA o consumidor pode testar um produto, de forma interativa, através de uma representação em 3D e em tempo real. Desta forma é possível alcançar um envolvimento mais profundo com a marca e até mesmo efetuar uma compra.

Nesta tese realizou-se uma investigação sistemática sobre a eficácia de três plataformas digitais comerciais distintas: uma plataforma meramente interativa, uma com uma aplicação de RA com marcadores, e uma outra com a aplicação de RA sem marcadores. As três plataformas foram desenvolvidas para serem utilizadas em testes num ambiente experimental. As respostas cognitivas dos consumidores foram avaliadas através de um exame empírico por meio de indicadores de Inovação, Emoção, Pesquisa de informação, Perceção do risco, Excitação, Capacidade de resposta, Estética da interface, Usabilidade, Organização, Diversão e Personalidade da marca. Registou-se um nível elevado de intenção de compra, tendo sido feita uma comparação entre as três plataformas, de acordo com a resposta cognitiva dos participantes e a avaliação das suas propriedades tecnológicas.

Embora nem todas as hipóteses tenham sido aceites, os resultados indicam que existem diferenças entre as três soluções testadas, particularmente entre as soluções de realidade aumentada e a meramente interativa. Assim, confirma-se que as soluções de RA podem servir como uma alternativa aceitável à “experimentação direta” pelo consumidor, de forma a ter um impacto sobre este.

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GLOSSARY

Augmented Reality: A variation of Virtual Reality (VR), a technology that supplements reality by superimposing virtual objects into it. It is a live direct or indirect view of a physical, real-world environment whose elements are superimposed by computer-generated sensory input such as video, graphics, sound or GPS data.

Augmented Reality Browser: a class of AR applications that offer a wide variety of AR experiences and themes from more than one content providers. Browser vendors offer a publishing platform and will either host content themselves (in the browser provider's content management system) or offer a mechanism for others to host content that can be served to the browser on demand.

Augmented Reality Experience: An augmented reality experience (also an AR User Experience) is that which is produced as a directly result of combining, in real time, one or more elements of the physical world, one or more augmentations and related user interactions.

Augmented Reality Marker: An augmented reality marker is a 2D (frequently black and white and square in shape) symbol that looks like a 2D barcode and serves as a trigger for an augmentation. It is defined within an AR authoring platform and is unique for each augmentation.

AR system: A mixed-reality system which is used only for AR applications, that is not completely immersive as the case with virtual reality systems/applications.

Camera View: Camera View is the term used to describe the presentation of information to the user (the augmentation) as an overlay on the camera display.

Exploratory data analysis (EDA): an approach for data analysis that employs a variety of techniques to maximize insight into a data set, uncover underlying structure, extract important variables, detect outliers and anomalies, and test underlying assumptions.

Fiducial Marker: A fiducial marker consists of patterns that are mounted in the environment (e.g. printed on a paper) and automatically detected by a digital camera with accompanying detection mechanism (Fiala, 2005). This detection mechanism is usually a software that monitors the incoming video stream from the camera and actively searches for the fiducial marker pattern within the stream. After the pattern is detected, a previously defined event is triggered. In an AR system, this event can be an augmentation of 2D, 3D, animation, or audio signal over the fiducial marker.

Geospatial Augmented Reality: Geo or location based AR refers to augmented reality experiences based on the user 's location and orientation in a geographic coordinate space. Therefore the registration and tracking system relies principally on geo positioning techniques. Most frequently, the user's position is approximated from the location of the user's device based on one or more sub systems such as GPS, WiFi or cellular geo positioning. The user's orientation is approximated from the movement of the device using sensors such a digital compass, accelerometer and/or gyroscope. Together with a location fix, the orientation sensors can provide enough information to approximate the user's 6 degree of freedom pose.

Haptic AR Experience: A Haptic Augmented Reality experience is the result of a system providing the user a vibration, temperature change or introduction of another sign detectable by the user's sense of touch as a result of detecting some trigger in the user's proximity. The trigger may be visual (computer vision), auditory (natural language), geospatial or detection of other environmental conditions such as radio signals.

Head Mounted Display (HMD): A Head Mounted Display (HMD) is a type of headgear, which is often used for training and in virtual environments. An HMD is operated by superimposing a visual information display (3D stereoscopic image) over a viewer's field of view (Liu et al., 2010).

Human Computer Interaction (HCI): a field of research focused on the study of the interaction between humans and computers often in relation to design, development and evaluation of computer based systems and products.

Intelligence Amplification (IA): using the computer as a tool to make a task easier for a human to perform

Interaction: Defines how users interact with virtual objects, how augmentations are presented to the user, how the user can provide input to an augmentation, actions such as search and filtering that the user can perform. Behaviours are a subset of user interactions that relate to how the user interacts with virtual objects. Interactions also describe how virtual objects react to external events and changing condition in the real world. (i.e. event not initiated by users).

Six Degrees of Freedom Pose: The real object in space can have three components of translation - up and down (z), left and right (x) and forward and backward(ly) and three components of rotation - Pitch, Roll and Yaw. Hence the real object has six degrees of freedom.

Telepresence: The feeling of being elsewhere, created by virtual or AR technology.

Trigger: A term for a reality object where the detection system is primed to push an augmentation and any associated interactions to the virtual environment. In computer vision, the term trigger often refers to the salient attributes of the real world object or marker (or sound) that are necessary to facilitate rapid detection. As a result of a match with a trigger, the digital object, and any embedded or associated interactions, is rendered by the device output and display system (including visual, haptic or auditory experience).

Usability: Relates to the perceived or measured ease with which people can use a particular tool or other artefact in order to achieve a particular goal.

User experience (UX): evaluation of an interaction with a product or a system, depending on person's behaviors, attitudes, and emotions.

Virtual Object: A manifestation or rendering of a digital object in a virtual environment. Virtual objects can be scripted with behaviours. These scripts can be integral to the object (for example, a GIF animation) or separate code artefacts (for example, browser mark up). Virtual objects differ from scenes as they include 2d image and text, audio and haptics, as well as 3d content. A virtual object is normally understood as a single entity from the user perspective, even if it is technically composed of several artefacts. So textures, materials and scripts would be bundled together as part of the same object even if they are physically separate files.

Virtual Reality (VR): An artificial environment that is experienced through sensory stimuli such as visual or auditory stimuli, which is provided by a computer and in which one's actions partially determine what happens in the environment. VR is not the focus of this study, but it shares similar properties with AR, such as presence, spatial properties, and the ability to present tactile modality through the use of haptic devices.

Chapter 1

Introduction

The purpose of this chapter is to provide a preface and an overview of the current research. In order to achieve this objective, the chapter is organized as follows: section 1.1 presents an outline of the context of the research and the identified research problems unfolded in the intensive literature review; section 1.2 states the problem of the research; section 1.3 offers an outline of the overall research aims and objectives; section 1.4 is concerned with the primary research questions of the study; section 1.5 provides a brief description of the main research design; section 1.6 talks about the theoretical framework; section 1.8 describes the assumptions, scope, limitations and delimitations of the thesis; finally, this chapter ends with a short summary.

1.1 Context of the problem

In the competitive global marketplace of today, companies are striving to uncover new ways for the promotion of their products. Despite the undeniable capacity of traditional marketing to generate product awareness, it has gradually become ill equipped in meeting the requirements of today's markets. The term "traditional marketing" refers to a canon of principles, concepts and methodologies that marketing professionals have compiled during the last thirty years of 20th century

(Schmitt, 1999) normally including print advertisements, television or radio commercials advertising a business, product or service. Commonly relying on consumer loyalty, campaigns using traditional marketing approach have begun to fail repeatedly in attracting the audiences they once did, thus making professionals face a big challenge. More specifically, the expansion in the number of internet users together with the growing increase in literacy levels have brought near constant change for the marketers in the digital era with audiences moving away from traditional media (Singh & Pandey, 2014). A recent survey conducted by American Marketing Association reveals that marketers are shifting their focus away from newspapers, magazines and radio[1]. Traditional media has suffered the greatest loss of interest, occupying the top five areas for a decline in focus (newspapers, consumer magazines, radio, trade magazines and TV). Furthermore, the generally burdensome estimation of investment return has made measuring reach and response to conventional publicity problematic and not always justifiable. Along those lines budget cuts, long campaign production time and consumers' unfulfilled expectations for social brand engagement have continuously resulted in losses and withdrawal from classical media. In fact, traditional advertising approach was predicted inadequate over two decades ago (Rust & Oliver, 1994) and in spite of its attempts to satisfy the requirements of modern markets, it struggled to provide the desired effect of engaging consumers and increasing purchase intentions.

Today's advertising industry demands dynamic tools that generate measurable results, robust enough to be deployed directly and cost-effectively. Marketers are redirecting their marketing communication efforts from product features and benefits to focusing on the customer. Furthermore, not all consumers are alike; they have different demographic profiles, income levels, business requirements, and lifestyle choices which drive their purchasing behaviors. At present, marketing channels are expected to offer more than just a one way of communication, simultaneously generating useful, customer-specific data. Obtaining such data can be done from many sources, including aggregating data both offline and online, follow recent purchases, gift registries, personal shopper files, responses from Quick Response codes, digital channels brand engagement and others. The purpose of collecting data builds upon the understanding of individual choices and

[1] In 2013, Mobile, Social Lead Shift From Traditional Media to Digital (2013) Retrieved September 5, 2014. http://www.emarketer.com/Article/2013-Mobile-Social-Lead-Shift-Traditional-Media-Digital/1009677

characteristics, thus tailoring dynamically campaigns to match the preference of each and every customer.

Although this direction seems initially straightforward, marketers are still finding it difficult to maintain the attention of their audience with much digital noise around (Thibeault, 2014). An apparent fact about advertising is that if communication does not present itself as relevant to the consumer, it will simply be ignored. Today, the concept of reaching the right consumer, in the right context, at the right time is a prerequisite for planning a brand's marketing approach. However, since the digital space is changing and means of maintaining consumers are more compelling, the applied metrics ought to also be alternated accordingly with an accurate and meaningful measurement (Ryan & Jones, 2009). For companies, it is important to acquire channels that offer measurable reach and conversion metrics customizable for their needs. As a result, online media appears to offer more convenient means for advertisers to execute and measure digital marketing campaign effectiveness across multiple channels to maximize return on their investment.

Aside from the above groundwork arguments for a shift towards new media, a continuous two-way transfer of information between the user and the central point of a communication system seems to be of even greater importance when it comes to maintaining consumers. Interactivity, a feature absent from traditional advertising forms (Miles, 2007), offers the capacity to extend the function of advertising far beyond what conventional media is able to accomplish (Li & Leckenby, 2007). Interactivity can provide a natural approach to product inspection through the interface properties of 3D visualization (Schlosser, 2003) and when combined with a real world environment it can implement even bigger spectrum of possibilities and applications. In the context of digital media, interactivity serves as "a measure of media's potential ability to let the user exert an influence on the context and/or form of the mediated communication" (Jensen, 1998, p. 201).

One important characteristic of interactive technologies is their potential to alter one's feeling of presence. Telepresence, virtuality and simulation are all aspects of interactive systems that make possible for users to perform operations on a given system while showing the effects in real time. Thus, cognizant about potential prospects and in constant pursuit for creating more value for their target audience, advertisers have embraced the idea about developing experiences for their customers (Berry, Carbone & Haeckel, 2002; Schmitt, 1999). This approach, known

as experiential marketing, focuses on the overall customer experience. Experiences occur as a result of interacting with things and provide sensory, emotional, cognitive, behavioural, and relational values that replace functional values (Schmitt, 1999). Augmented Reality (AR) technology - an ultimate blend of real and computer-generated data, has recently been recognized by advertisers as an innovative way of promoting products allowing for a different experience through entertainment, participation and immersion. With AR, a consumer can test a product interactively through a 3D representation, enticing the perspective of deeper engagement or triggering a purchase (Owyang, 2010). Furthermore, virtual environments are identified to have substantial prevalence over traditional approaches (e.g. 2D websites) due to the possibility of adding increased functionality and social interactivity, and may offer enhanced brand experiences contributing towards increased customer loyalty and sales (Arakji & Lang, 2008). All those themes contain features which, in sum, constitute digital channels as novel compared to former media examples.

1.2 Statement of the Problem

As described in the previous section, in a search for more innovative and original ways to captivate user's attention, many brands have realized the potential of AR and have recently adopted it as part of their advertising campaigns. This technology provides an engaging visualization experience by intensifying user's impressions. Computer-generated data are perceived in real-time by the user inside a real environment. This blend of real and computer-generated imagery has been found to enrich human perception and to facilitate the understanding of complex 3D scenarios (Azuma, 1997; Ribo, Lang, Ganster, Brandner, Stock & Pinz, 2002) while creating and enhancing meaning and engagement for the user (White, 2007). Most of the campaigns, which already applied the technology, rely on an experiential approach which focuses not only on a brand's product or service, but also on an entire experience developed especially for the consumer (Yuan & Wu, 2008). Brand experiences are sensations, feelings, cognitions, and behavioral responses evoked by brand-related stimuli that are part of a brand's design and identity, packaging, communications, and environments (Brakus, Schmitt, & Zarantonello, 2009).

Emotional and sensational influences on cognitive processes form an integral part of consumers' decision making, where marketing experiences attempt to create a "memorable, engaging and exhilarating way of reaching customers" (Witthaus, 2004). Consumers, on the other hand, have to seize personal relevance, novelty, surprise, learning, and engagement for a real experience to take place (Poulsson & Sudhir, 2004).

However, although application of AR in marketing is intriguing for consumers, scientific investigation and analysis of such experiential cases have been neglected so far. There are "few mainly quantitative experiential marketing studies" (Bulearka & Tamarjan, 2010, p. 237) and apparent insufficiency of literature on how AR practices influence consumers who are involved in a real-time product experience evaluation. It is unclear whether user perceptions of a brand or a product are in any way influenced by the AR technology they use. Furthermore, there is insufficient number of empirical research that explores consumer motives and premises for the formation of purchase intention within an AR shopping platform, particularly compared with simpler interactive systems. Finally, no universal system of measurements of consumer cognitive response to experiential AR systems has been agreed upon in literature.

The reasons why AR experiences have been overlooked so far in literature may be the only just now arising interest in AR as a marketing tool after various worldwide campaigns already took place. Very few studies have engaged in the topic of AR user experiences, however they have been mainly qualitative and restrained in terms of limited environmental setting, like shopping malls (Olsson, et al. 2013) or using a focus group trial (Bulearca & Tamarjan, 2010). Sung and Cho (2012) conducted an experiment with ninety-five students, however using a single ready-made Marker-based Tissot[2] watch ad. Therefore, the lack of studies to examine the effects of AR in a quantitative manner and conduct empirical investigation for the comparison of AR AR Marker-based, AR Markerless and a purely Interactive platforms led to the undertaking of the current study.

To summarize, the central problem for this research is concerned with the fact that it is unclear whether a AR Markerless system is more compelling, compared to a AR Marker-based and a purely Interactive system in terms of consumer experience. To investigate this issue, the relationship among independent variables (advertising means) and the dependent variables (cognitive factors) is explored through a

[2] Tissot AR Application: http://www.youtube.com/watch?v=m9oeAlOY4Vs. Retrieved Sep. 2, 2014

combination of both qualitative and quantitative techniques together with the development and testing of subsequent series of hypotheses.

Since brand experiences rely on consumer reactions to stimuli to generate specific sensations, feelings, cognitions, and behavioral responses (Brakus et al., 2009), the present research aims to investigate and obtain understanding from those elements empirically. Pertinent constructs to be explored in the study for the purpose of assessment of an experiential event are participants' innovativeness adoption, emotions, information seeking, arousal, responsiveness, organization, fun, system usability, perceived interface aesthetics and brand personality. Younger consumers are most suitable for the purpose of the project because of their open-mindedness in learning about and adopting new technologies. According to Horrigan (2003), the "young, tech elite", with an average age of 22, should be one of the most attractive segments to marketers of innovative technology because their adoption and usage of technological products influence what the majority of the consumers will eventually do. Furthermore, the study plans to acquire a more comprehensive understanding of whether an AR Markerless experience may engage the consumer at a higher level in comparison to a purely Interactive or a AR Marker-based one, as well as to investigate young consumers' subjective experiences while registering their own reflections.

1.3 Research aims and objectives

The first task in any research project is to define the research problem clearly and accurately (Malhotra, Birks & Wills, 2012). In line with this prerequisite, the aims and objectives of the research synthesize the intentions and aspirations of the project as well as the relative goals and statements to define measurable outcomes. Accordingly, the primary aim of this thesis is to develop and evaluate a comprehensive set of criteria for measuring the effectiveness of AR advertising system and to compare it with two more conventional systems by registering consumer attitudes and purchasing intentions. System effectiveness measures may have different definitions depending on the system in question. For this project, in terms of technological properties, effectiveness is seen as the extent to which the user can expect to benefit from the tasks accomplished (Meyer, 1980), however, the focus here is also on exploring the cognitive constructs that determine the evaluation

of an overall experience with a system. In other words, the project aims at providing understanding on whether gesture-based AR system for advertising can operate as a tool for enriching consumer experiences more effectively in comparison to the use of simpler platforms, such as a purely Interactive and a AR Marker-based system. For the purpose of this project, the exploration of AR is limited to its application in marketing and advertising. The objectives of the study are described as follows:

1.3.1 Three separate interactive platforms to be used for testing in an experimental setting will be designed and developed, namely a purely Interactive, a AR Marker-based and an AR Markerless systems;

1.3.2 Consumers' cognitive responses will be assessed through an empirical investigation of the constructs of innovativeness adoption, emotions, information seeking, perceived risk, arousal, responsiveness, usability, organization, fun, boredom, perceived interface aesthetics and brand personality;

1.3.3 The degree of elevated purchase intent will be registered and compared across the three platforms according to outcomes from participants' cognitive responses and their evaluations of the technological properties of the systems.

1.3.4 Recommendations for future use of experience-based AR platforms according to outcomes from system preferences will be made to serve as a reference in further investigation and practice.

1.4 Research questions

Traditionally, retailers have relied on print advertising campaigns or other established media to promote their products. For some time however, the old marketing formula has not been effective enough in delivering results with consumers being harder to reach and increasingly turned off by traditional marketing (Mc Cole, 2004). Being divided in the past, print, media and in-store marketing efforts are favorably merged today into a comprehensive consumer experience via AR. This technology has emerged as a creative marketing tool which allows companies to interact with buyers through a new digital experience that enriches the relationship between consumer and brand and can be used in any location. Integration of AR in marketing efforts aims to build stronger consumer relationship, boost sales and add value to the shopper experience.

An extensive amount of scientific work has been done on topics related to advertising and marketing separately or within other context. However, the studies addressing AR in particular as a present-day tool for shopping experience or in comparison with conventional approaches have not provided enough evidence on the matter of its effectiveness. The main inquiry of this study centers around the issue of whether an experience with an AR-based shopping platform can be more persuasive in terms of consumer's intention to purchase a given product in comparison to an experience with a less sophisticated system. Having defined the nature of the problem stated above, this study seeks to answer the following main research question:

Does change in three different types of advertising exposure (AR Markerless, AR Marker-based and Purely Interactive) influence advertising effectiveness?

In selecting relative work and focusing on the main topic of the research, the following guiding questions are considered: (1) What are the cognitive effects of AR on consumer' psychology and purchase intentions of the advertised brand? (2) How suitable is AR as an application for an experiential shopping platform? (3) Does attitude towards the advertised brand affects evaluation of the effectiveness of the system? (4) Can AR serve as an acceptable alternative of consumer "direct experience" with a product in order to make an impact on the user?

1.5 Research design

This study applied a causal research design with the implementation of both quantitative and qualitative parts. The first step of the research process was a focus group experiment, which was considered essential for the qualitative part of the research in terms of emerging ideas, attitudes, free debates and knowledge. After information was obtained, a preliminary test of the research instrument was performed to assist in the development of the questions and the study's main measurement instrument, as questionnaires should not be used in the field study without extensive pretesting (Malhotra, 2006). This approach contributed to defining the dependent variables, the range of factors that influence the independent variable as well as the causal relationships between them.

The basic design of this study was an experimental, pretest-posttest control group design which took place in a university laboratory setting. Participants were randomly assigned to one of three groups. Each group was given the same pretest measurements, followed by three types of interventions separately, namely purely Interactive, AR Marker-based and AR Markerless. Posttest measurements were taken on each group. For the purposes of the research the groups were matched (Hair at al., 2006) in order to be identical and inferences were drawn from between-subjects experiments by making comparisons among the obtained cognitive information from the different groups.

1.6 Theoretical framework

The theoretical framework of the present study refers to a set of interrelated constructs, that present a systematic view of the phenomena under study. Pursuing the linkage between the theory and the problem at hand, the theoretical framework is viewed as an organized body that gives a brief overview of research to the topic under inquiry. It is the basic of the research problem and explains the aspects upon which the thesis investigation hopes to fill the breach in the stream of knowledge. The domains of psychology that are considered a component of Human-Computer Interaction (HCI) are described here, as well as the most influential theories, models, and research of those areas.

1.6.1 Human-Computer Interaction (HCI)

People interact with computers in many ways, and the interface between humans and the technology they use is crucial to facilitating this interaction. The HCI field is specifically concerned with the investigation of this interaction in a scientific way. The methodologies applied in HCI research are borrowed from other scientific fields, many of which come from the psychological sciences. Also, disciplines such as engineering, art, design, artificial intelligence or linguistics all have relevant contributions to this domain. Encounters from these areas seek to explain the human-computer interplay in terms of the psychological mechanisms of the user. A prevalent definition states that HCI “involves the design, implementation and evaluation of interactive systems in the context of the user’s task and work”, with

respect to all types of computers - traditional desktop or ubiquitous (Dix, Finlay, Abowd & Beale, 2004).

Essential to the foundation of HCI is cognitive psychology which investigates the psychological processes involved in the acquisition and use of knowledge by people. It is concerned with domains such as perception, attention, memory, learning, thinking, as well as the importance of social and environmental influences upon them. Cognitive psychology is a major contributor to HCI research by providing and applying psychological principles to understand and help develop models that explain and predict human behavior. Psychological theory and computer science together can provide foundation for better interface design and are “mature enough to contemplate a serious relationship” (Carroll & Thomas, 1982).

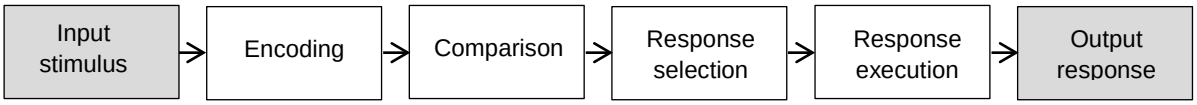
Generally, the theories within the HCI domain fall into three main categories: explanatory, predictive and those, constituted of taxonomies and models. Explanatory theories focus on explaining the interaction between human and computer. Predictive theories aim at quantifying the interaction in order to predict it. Large part of the predictive theories has been introduced even before the computer era, emanating from basic research in ergonomics, psychology and physiology. The theories constituting of taxonomies and models, such as GOMS (Goals, Operators, Methods, Selection rules), are considered abstractions of reality (Shneiderman, 1998).

Central to the rationale of HCI are people, computers and tasks, where the objective of the research is to advance the usability and usefulness of technical systems (Nickerson & Landauer, 1997). One fundamental theory for HCI is the Information processing concept derived from Broadbent’s view on cognition as consecutive series of processes (Broadbent, 1958) and the human as an information processing unit. As an early viewpoint, this theory has been subsequently challenged by frameworks such as Cognitive Systems Engineering (Hollnagel & Woods, 1983) and distributed cognition (Suchman, 1987; Hutchins, 1995), as well as embodied interaction within the design research domain (Dourish, 2004).

One common assumption of the different approaches in HCI is that the user is seen metaphorically as a living version of a computing machine. For example, the concept of the information processing model developed by Lindsay and Norman in 1977 is based on the interaction between a technological system and the human user operating that system, viewing the human as an input-output device much like the

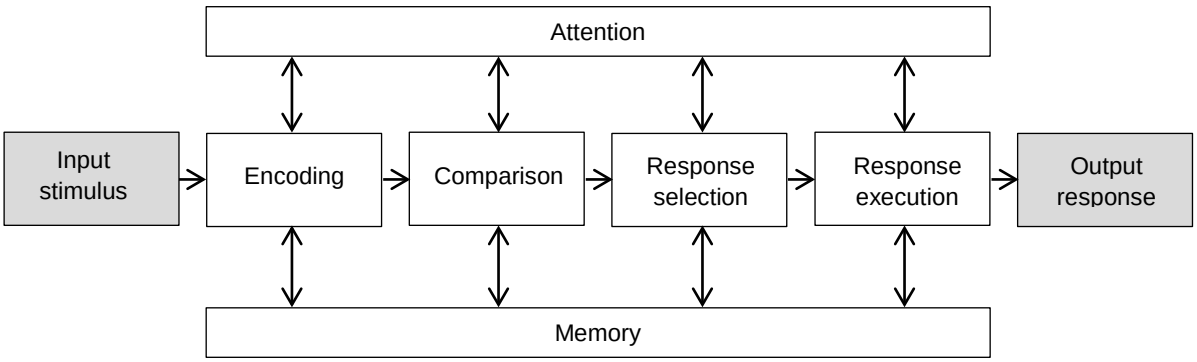
computer. The information, resulting from stimulation of the sense organs is analyzed and transformed by a number of processors each of which takes as input the information output by another processor. This view regards to cognition as computational in nature, with the mind being the software and the brain - the hardware. The flow of information from input to output within a human is explained through series of processing stages, namely encoding, comparison, response selection, and response execution (Figure 1). In this model of human cognition, information enters the mind in various forms, and is then processed internally on several levels, while the mind, or body, produces a response. The processing can consist of comparing and matching while the results are reactions to what has been processed. However, in this model users' perception, behavior and learning techniques are not accounted.

Figure 1
Information Processing Model (Lindsay & Norman, 1977).



Subsequently, Lindsay and Norman's (1977) model was extended to include the processes of attention and memory, which interact with information processing stages of processing (Barber, 1988). Information is perceived, attended and stored in the memory (Figure 2).

Figure 2
Extended Information Processing Model (Barber, 1988).



The information processing model has been a major influence in HCI by categorizing user behavior as well as being able to predict user performance. This view is also an example of how research in psychology and human cognition has been expanded into theories for the design of interfaces. Other basic research findings that have been incorporated into HCI guidelines are discoveries on visual perception such as the use of color and grouping of similar objects, the gestalt laws.

In attempt to further define the field of HCI, various principles, laws and guidelines have been developed. Among these, the most established ones are perhaps Shneiderman's Eight golden rules of interface design (Shneiderman, 1998), Norman's design principles (Norman, 1998) and Nielsen's ten usability heuristics (Nielsen, 1993).

1.6.2 Norman's Action Model (1988)

Norman's model of human action (Norman, 1988) is a theory at the foundation of the human-computer interaction field, whose main relevance is found on the better understanding of how a user-system interaction works in cognitive terms, thus giving a structured indication of the main aspects to consider for designing an interactive application. The model provides a theoretical framework for the definition of the basic cognitive steps intervening in a user interaction. It is constructed of the following seven stages: (1) establishing the goal, (2) forming the intention, (3) identifying the action, (4) executing the action, (5) perceiving the system state, (6) interpreting the system state, and (7) evaluating the outcome.

The seven stages are organised in a repeated execution-evaluation cycle, at the beginning of which users formulate their goals. If goals are not definite or clear they need to be translated in more precise actions, required to support the related intentions and meet the goal. After the users carry out the actions stage, they observe any modification occurring in the system state as a reaction of the execution of their actions. The changes are interpreted and results are evaluated in order to estimate whether the goal has been reached or not. In the latter case, the goal has to be reformulated and the cycle is repeated. Norman's model is widely applied in user behavior research for highlighting the importance of analyzing and modeling tasks within a user interface design.

1.6.3 Shneiderman's "Eight Golden Rules of Interface Design"

To improve the usability of an application it is important to have a well designed interface. Shneiderman (1998) recommends a concise set of guidelines that can be referred to, manipulated or used to validate the design of the interface. These guidelines should be adhered to in order to make the interface as user-friendly as possible: (1) strive for consistency (in procedures and terminology), (2) enable frequent users to use shortcuts, (3) offer informative feedback (for every user action), (4) design dialogs to yield closure (allowing people to know their progress and when they are finished), (5) offer error prevention and simple error handling, (6) permit easy reversal of actions, (7) support internal locus of control (allowing users to feel they control the computer, not the other way around), (8) reduce short-term memory load.

The eight rules offer relevant, yet general guidance to the designer. However, they are intended to serve all systems in general. Guidelines to specific innovative systems (e.g. mobile, virtual or AR) should be adapted accordingly. Each of these points, if implemented appropriately, can alleviate unnecessary cognitive strain for users. This can allow consumers to have more freedom and feel at ease when interacting with a platform.

1.6.4 Nielsen's (1993) ten usability heuristics

Heuristics are general usability principles that "seem to describe common properties of usable interfaces" (Nielsen, 1995). Nielsen and Molich (1990) initially proposed nine heuristics, which were defined based on their experience of common problem areas in interfaces and consideration of guidelines. The results of a factor analysis of 249 usability problems (Nielsen, 1994) lead to 10 heuristics. These are commonly used to evaluate interfaces in general: (1) visibility of system status, (2) match between system and the real world, (3) user control and freedom, (4) consistency and standards, (5) error prevention, (6) recognition rather than recall, (7) flexibility and efficiency of use, (8) aesthetic and minimalist design, (9) help users recognize, diagnose, and recover from errors, (10) help and documentation.

The ten usability heuristics have mainly been a tool for assessing service usability. However, the principles have also been adapted as recommendations for user experience (Arhippainen, 2013), resulting in another set of ten user experience (UX) heuristics: (1) ensure usability, (2) provide utility matching with the user's

values, (3) surpass the user's expectations and minimize the gap between negative expectations and real usage, (4) respect the user, (5) design the product or service to fit the intended contexts, (6) provide several ways to interact and leave choice for the user, (7) respect user's privacy and security, (8) support user's activities but do not force them, (9) go for a perfect visual design and (10) give a surprise gift.

Heuristics are meant to help evaluators identify usability problems (Nielsen 1995), still they seem to be developed only to work in theory. Furthermore, assessing UX is not as simple as assessing usability. Even if the heuristic evaluation for user experience is procedurally similar to evaluating usability, there are fundamental differences between usability and user experience.

Although the advice of the above referenced experts (Nielsen, 1993; Norman, 1998; Shneiderman, 1998, Arhippainen, 2013) is followed, it is important that priority be given to the HCI elements in relation specifically to the application of an AR platform, in order to meet the expectations and needs of consumer interaction.

1.6.5 Knowledge and Mental models

Research of how humans transform information into knowledge also has significant contribution to HCI. Obtaining insight on how knowledge is represented and organized is crucial in the design and development of innovative technology and tools. A great deal of research in knowledge representation, with relation to HCI, has focused on mental models. Mental models are mental depictions of elements and structures of physical objects (Craik, 1943; Johnson-Laird, 1983). Studies in human factors and HCI indicate that it is mental models that enable people to interact with complex devices, including computer systems (Conant, 1970; Gentner & Stevens, 1983). In order to delineate further this matter, Norman (1983) addresses mental models as users' mental representations of the system that they work with. Furthermore, Fein, Olson and Olson (1993, p. 157) define mental models as knowledge that users have about ''how a system works, its component parts, the processes, their interactions, and how one component influences another''.

When interacting with a computer system, the content and structure of mental models are influenced by the selection of presented information to the user as well as the way it is presented. Interpretation of these models specifies how users interact with that system. Research has identified four different models of interplay among users, designers and systems: (1) user's model of the system is the model

constructed at the users' side through their interaction with the target system, (2) the system's model of the user which is the model constructed inside the system as it runs through different sources of information such as profiles, user settings, logs, and even errors, (3) the conceptual model which is an accurate and consistent representation of the target system held by the designer or an expert user, and (4) the designer's model of the user's model which is basically constructed before the system exists by looking at similar systems or prototypes or by cognitive models or task analysis. Several factors influence the way these models are built and maintained. From the users' perspective influential are their physical and sensory abilities, their previous experience working with similar systems, their domain knowledge and also ergonomics and environments in which users live. Finally, mental models are the ones to explain users' performance with the system they interact with (Young, 1983).

From the designers' perspective, it is important to influence the user's model to perceive the conceptual model underlying the relevant aspects of the system. This can be accomplished using metaphors, graphics, icons, language, documentations and tutorials. It is critical that all these materials collaborate together to encourage the same model. The most important task for designers is to make the user interface communicate the system's basic nature well enough that users form reasonably accurate and useful mental models (Nielsen, 2010).

Both cognitive science and HCI have tried to grasp the rudiment to mental models, based on a search for similarities among the ways people view their worlds. Most of the challenges arise from the difficulties associated with setting apart and exploring mental models. Study approaches and results have been dubious with some researchers arguing that the very act of obtaining information from subjects about a mental model can change the mental model itself (Rogers, Rutherford, & Bibby, 1992).

1.6.6 Attention & Memory

Theories of memory have a vast influence for research in HCI, both in design and testing. Research on attention and memory explores the patterns of human information processing, including the structures of storing memory. Those domains aid in decisions regarding what a given interface should provide, as well as in developing guidelines about what can and should be presented in an interface.

Decreasing cognitive load and memory requirements for the user are essential for creating usable systems.

Psychological theories form the fundamentals for investigating the limits of memory. For example, the Information processing theory is concerned with the capacity of short term memory (Miller, 1956). This theory states that a person can remember seven plus or minus two items in their short term memory, where an item can be digits, words, or people's faces. By grouping similar items together, called a “chunk”, short term memory is expanded. People can store seven plus or minus two meaningful chunks instead of individual items.

Correspondigly, Bartlett’s (1932, 1958) work on the issue of memory proposed the concept of schemata. According to his theory, memories of past events and experiences are actually mental reconstructions that are associated with attitudes and personal habits, rather than being direct memories of observations made at the time when it happened. In his empirical work, Bartlett demonstrated that a very small part of an event is truly perceived at the time of its occurrence and that in attempt to recreate the particular event the blanks in observation or perception are substituted with memories of previous experiences. In other words, people create mental models or structures which they use to assist in remembering.

The concept of schemata has been advanced further, with the work of Chi, Glaser & Farr (1988). The theory juxtaposes novice versus expert performance and suggests that expertise is a factor due to an array of predefined schemata that guide perception and problem-solving – a property novices do not have. Chi et al., (1998) argues that the improved performance of experts demonstrates that people develop new schemata in their long term memory through learning. The change in performance occurs because as the learner becomes more familiar with the material, the cognitive characteristics associated with the material are altered so that it can be handled more efficiently by working memory.

Evolving from the above mentioned theories, Sweller’s Cognitive Load Theory combined Miller’s research with the schemata theory. Building upon Miller's research, who showed that short term memory is limited in the number of elements it can contain simultaneously, Sweller presented a theory that treats schemata, or combinations of elements, as the cognitive structures that make up an individual's knowledge base. As a result schemata grow into chunks for expanding memory (Sweller, 1988).

Implementation of the discussed theories for interactive interface systems may help interface designers grasp the way users' memory operate in order to develop systems that are practical and burden-free. For example, the schemata theory is useful in understanding that users' memory works through models that they have developed. Translated to design, this indicates that users can adapt more easily to use a system if it is based on familiar design schemata. When implementing a new software and using these familiar principles, the user will be able to be more focused on learning the new elements, and not be distracted or cognitively burdened by the more familiar interface functions.

1.6.7 HCI Principles and AR Systems

Regardless of how carefully a system is designed, applicable theories must always be examined through usability tests. Usability tests involve typical users interacting with the system (or product) in a natural environment. Observation of the user's behavior, emotions, and hardship while performing different tasks, often identify areas of improvement for the system. In regards to AR, recent research has discovered a lack of assessment of such systems. Dünser, Grasset, Seichter, and Billinghurst (2007) argue that "… there is a need for more HCI and usability research in the field of Augmented Reality" (2007, p. 1). In addition, in present AR research, it seems that the discussion among researchers has been mainly in relation to the technological properties of such systems. This focus spurs technological development, however leaves entirely out of the design process the ones that it is meant for: the end users. In order for AR to make fully the leap from research laboratories into everyday life, the technology must become accessible and simpler to use. Dünser et al., (2007) suggest that knowledge found in basic HCI literature could be relevant to human interaction with different kinds of interfaces, as well as knowledge derived from VR research. Depending on specific hardware, AR system interfaces implement a vast amount of interaction techniques and devices, and can include visual, audio and haptic interfaces. Therefore, is it vital that guidelines are developed or adapted specifically according to each system. Yet, Dünser et al. (2007) claim that general guidelines, based on general design principles identified in AR systems so far, can be a useful tool during prototyping or at an early stage in interface development. Although it is difficult to develop specific guidelines that will

accommodate all AR system designers, the future success of AR systems depends on improved and flawlessly designed user experiences.

1.7 Assumptions, scope, limitations and delimitations

1.7.1 Assumptions

Assumptions refer to concepts that are accepted as truths or “statements about the nature of things that are not observable or testable” (Creswell, 2005, p. 49). Two assumptions guide this study: (1) the obtained data from the experiment are truthful and accurate and (2) findings of the study are evaluated objectively and free from personal biases of the researcher. These assumptions ensure that the conclusions and recommendations generated in the study are reflective to the real environment and occurrences being studied.

1.7.2 Scope and limitations

The scope of the study is confined to survey responses of the 150 university students on the subject of their impressions, evaluations and emotions regarding three presented shopping platforms. Existing limitations of the research include several matters. Firstly, the experimentation took place in a university laboratory and subjects for the study were drawn from a student population which does not fully represent the real world environment, neither the real world buyer. Secondly, the survey was anonymous and accuracy of responses could not be validated. Thirdly, confounding or extraneous variables that could have had an effect on internal validity included, but are not limited to: truthfulness of responses given by participants, their motives or secondary gains, and administration issues of the survey. The study was also limited by the lack of published research on consumer evaluation of shopping AR systems in the marketing industry, restricting the ability to provide reference sources. On the other hand, the data collected from the questionnaire and the approaches in gathering the data may have influenced validity (Creswell, 2005). Finally, a limitation existed also from the fact that perceptions were focalized only to young consumers in a single educational institution.

1.7.3 Delimitations

This study is delimited by the researcher in several ways. First, the decision to use a sample of college students in the Porto area will limit the ability to generalize findings

outside of this area. Second, this sample was selected from a public institution. Those students who are enrolled in private educational settings may bear different characteristics and, therefore, will not be represented by this sample population.

1.8 Overview

Chapter 2 of this study elaborates on literature and previous research to provide the background for hypotheses formulation. The first section of the chapter focuses on the technology of Augmented Reality and its implementation in today's technologically innovative practices. The second section focuses on cognitive psychology and theoretical background for this study in specific, as well as presents the actual deriving of hypotheses.

In Chapter 3 the research method and measures are discussed. This chapter explains how the research experiment is developed and executed. It also elaborates on how the data is collected, inspected and reduced to develop meaningful constructs.

Chapter 4 describes the results of the experiment and in chronological order the hypotheses are tested and outcomes are presented.

Chapter 5 discusses the conclusions that can be drawn from the research outcomes. The chapter reviews the limitations of the study, taken into account before drawing conclusions on the results. The contribution section provides an overview of how the present work expands on current knowledge. The value and use of AR for companies is discussed in the managerial implications section.

This chapter established the need and purpose for the present study, summarized its research questions, its design, its assumptions and limitations. The next chapter reviews selected literature representing the extant knowledge regarding AR technology and its application.

Chapter 2

Literature review, part I

This chapter aims to provide a context for understanding the research issues and to identify the elements of the research model in relation to consumer characteristics and their influence on consumer purchase intentions. The scope of the literature review extends to existing theoretical and empirical literature on consumer experiences and observes their relation to AR applications. Various aspects link closely augmented reality, marketing and consumer experiences, hence it is important to investigate how they work together in creating a system to engage end users. Consumer experiences encompass affective phenomena such as consumer emotions, moods and sentiments, and therefore an overview is provided from relative studies in literature. It is then followed by an exploration of the concepts relevant to consumer experience and purchase intention. An outline of the Augmented Reality Technology (ART) is given in the beginning of the chapter to provide the reader with a basic understanding of its nature and for further referral throughout the rest of the sections.

In order for an application to provide an effective AR experience for consumers there are a number of factors that must be present. Therefore, following the Introduction (section 2.1), section 2.2 gives an overview of the background and definition of AR; section 2.3 discusses the relevant technology and section 2.4 discusses consumer psychology.

2.1 Introduction

The desire for a more authentic representation and the aspiration for perfect fusion between the real and the man-made seem to be the impulse for developing technologies which can be used to create more realistic images (Azuma, Baillot, Behringer, Feiner, Julier & MacIntyre, 2001; Mackay, 1998). In the past years, this pursuit became increasingly accessible with the advancement of computer processing power, graphics systems, power supplies and reduction of device size. The computer concept had its beginning as early as 19th century with Charles Babbage's Analytical Engine - a mechanical general purpose computer and a framework for modern computer design (Weber, 2000). Theoretically ingenious but incredibly complex and hard to finance, Babbage's concept was left behind for other innovations in computer technology such as the ones using vacuum tubes. Computer technology continued to develop actively in the next century with organized research and practice of science leading to the invention of the first electronic digital computer by John Atanasoff and his assistant, Clifford Berry (Brookshear, Smith & Brylow, 2012).

In the next several decades computers were large processing room-sized machines with poor processing power. Gradually, technological advancement such as the invention of transistors and integrated circuits allowed computers to become small enough to be placed on desktops, while processing power was enhanced with the manufacturing of new chip technologies (Brookshear et al., 2012). Portable computers became widely accessible in the 1990s with the development of smaller computer components, lithium ion batteries and matrix LCD displays. Users could already carry a self-powered computer with a color screen and peripherals in just a handbag.

The vast usefulness of computers made them an essential part in every field including marketing, especially since the introduction of the Internet into users' homes in the 1990s. The instant launching of advertising campaigns as well as providing users with unique brand experiences in real time is already possible as a result of the bond between the World Wide Web and the constantly expanding capabilities of technology. Moreover, innovation in computing has appealed for a revision in the way advertisers reach consumers. Digital context solicits for a continuous change for marketers and currently we are in the middle of a transition

phase (Perey, 2011). Market segmentation has led to the gradual exodus of certain marketing channels while others expand in audience. Nowadays, consumers are engaging simultaneously with content across multiple channels thus producing complexities for marketers. In this sense, it is becoming increasingly important for marketers to stay connected with their audience and search for new and intriguing ways to capture consumers' attention (Salo, 2012). In a competition driven marketplace, technology offers marketers the advantage to reach consumers in a rapid and facile manner, while innovation is increasingly embraced. Augmented Reality, also a central topic in this study, represents one of the progressive classes of modern information technology that has already been recognized as an alternative and captivating approach by many brands, and therefore employed in marketing campaigns worldwide. However, as AR has been introduced to the field of marketing recently, academic discussion on the subject is still seeking for a robust evaluation. The debate about the use of AR within the marketing domain continues due to the fact that there is no long-term evidence of its effects, considering the scarceness in benchmarks and research studies (Bulearca & Tamarjan, 2010).

2.2 Augmented reality

Augmented Reality is one of the emerging interface technologies in computing today and facilitates business innovation by enabling real-time decision making through virtual prototyping and visualization of content (LeHong, Fenn & Leeb-du Toit, 2014). The topic has been explored for several decades now, but its most significant growth and progress have been registered in the past few years. Two fields encompass AR, namely computer vision and computer graphics, as the first includes marker and feature detection and tracking, motion detection and tracking, image analysis, gesture recognition and the construction of controlled environments with sensors, and the second - photorealistic rendering and interactive animations. This broad array of technologies overlay a live video stream with a layer of data thus producing an experience in which computer generated input, such as textual information, images, and video, is projected onto users' perceptions of the real world. The effect to accomplish is a seamless overlay between the real environment of a user and the 2D and 3D digital computer content. Hence, the purpose is to achieve enhancement in a user's perception of and interaction with the real world (Azuma, 1997) by adding

information to expand on knowledge and understanding of the environment. Most often AR is used for medical visualization, maintenance and repair, annotation, robot path planning, entertainment, and military aircraft navigation and targeting (Azuma, 1997) and more recently advertising and marketing.

2.2.1 Background

Although perceived as a relatively new implement in consumer markets (Woods, 2009), AR began its development in the 1960's at time when its commercial use was unthinkable. It was initially conceptualized by cinematographer Morton Heilig[3], who created an immersive multi-sensory simulator device called "Sensorama" patented in 1962 (U.S. Patent No. 3050870, 1962). The simulator intended to provide the illusion of reality using a stereoscopic 3-D motion picture with smell, stereo sound, vibrations of the seat, and breeze in the hair for up to four people (Figure 3a). Seven years later, another version of the simulator was constructed - The Experience Theater which offered similar sensations but for a bigger audience (U.S. Patent No. 3469837, 1969). These multimodal immersive machines were an early example of how an artistic approach could be enhanced by a scientific understanding of human senses and perception.

Simultaneously, the world's first head mounted display system with 3D graphics was invented by Ivan Sutherland known as "The Sword of Damocles" (Sutherland, 1968). Through this "ultimate display" Sutherland designed an optimal computer system, where users could interact with artificially generated objects just as with physical objects in the real world. Although its cumbersome design and primitive character in terms of user interface and representation of reality, Sutherland's system was a precursor to all the digital eyewear and virtual reality applications (Figure 3b).

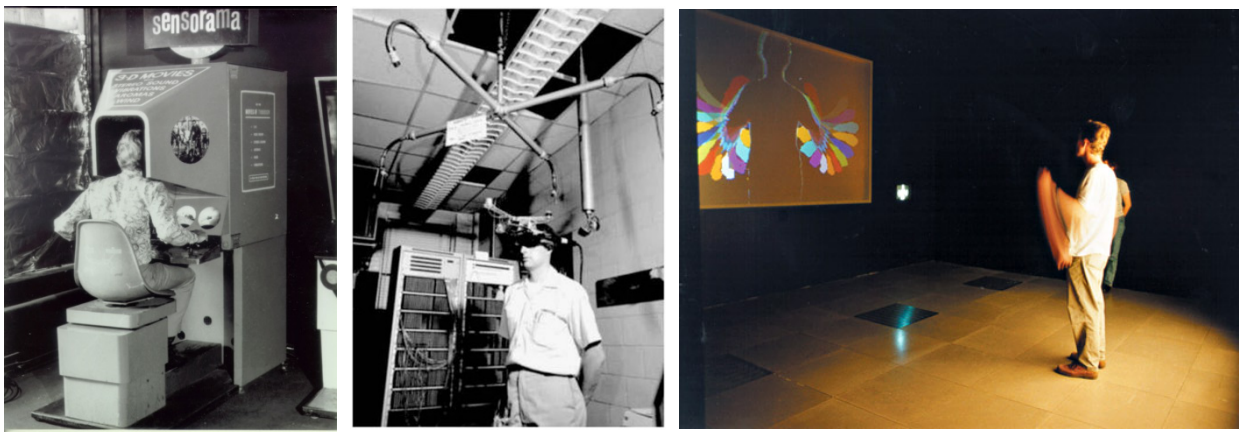
As technology advanced, the first computer system to facilitate image recognition, analysis, and response in real-time was built in 1974 by computer artist Myron Krueger (Krueger, Gionfriddo & Hinrichsen, 1985). He called it "Videoplace" – a computer system designed to respond to the movements of its audience through a complex construction of sensing floors, graphic tables and video cameras. Users could directly interact with the video projections of others in a shared environment. The system was significant in terms of its pioneering approach, and

[3] Morton Heilig's Sensorama: http://www.mortonheilig.com/InventorVR.html.Retrieved Sep. 8, 2014

particularly the development of techniques that permitted the construction of artificial realities where the user could be physically present (Figure 3c).

Figure 3

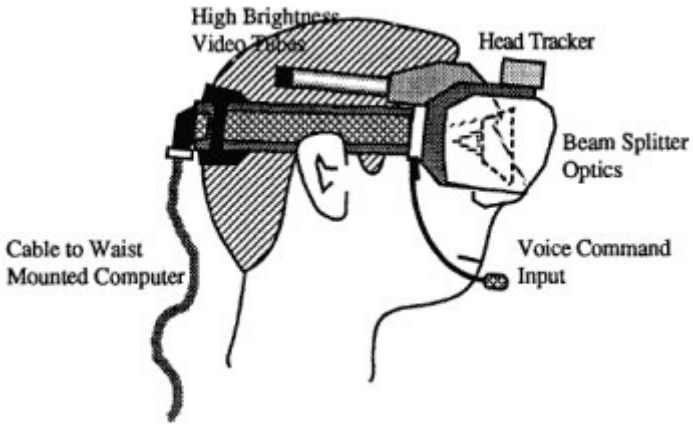
a) Sensorama (Heilig, 1962); b) Sword of Damocles (Sutherland, 1968); c) Videoplace (Krueger, 1985)



Whilst the concept of AR was being explored for some time, in 1992 the term "Augmented Reality" was first introduced by David Mizell and Tom Caudell referring to a head-mounted digital display that guided workers through assembling electrical wires in aircrafts (Caudell & Mizell, 1992). The experimental development meant to enhance the user's perception and represented a system where virtual elements were integrated into the real world (Figure 4).

Figure 4

Head-mounted augmented reality system (Caudell & Mizell, 1992).



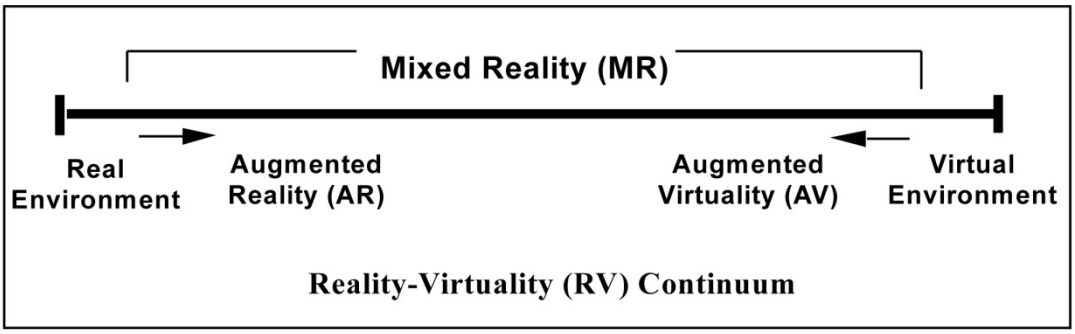
In the beginning, researchers considered AR mainly in terms of particular facilitating devices (e.g. head mounted displays) but the development of the 2D markers allowed for a system to be tracked by a camera with six degrees of freedom (Rekimoto, 1996). In 1999, Hirokazu Kato and Mark Billinghurst presented the ARToolKit open source library, the utilization of which was made possible through fiducials markers and a template-based approach for recognition (Kato & Billinghurst, 1999). Due to its innovative approach for pose tracking with six degrees of freedom even today the ARToolkit is still a very popular tool for building AR applications. From this point on technology advanced with undertaking of various research projects in the field of AR mainly at university labs, including the first AR browser (Kooper & MacIntyre, 2000). Further investigation led to the implementation of a system able to track 3D markers on a consumer mobile phone with a live rendered video stream (Möhring, Lessig & Bimber, 2004). With so many promising computer algorithms, research and projects, AR experienced an evolution which together with the integration of powerful 3D render engines allowed an improved experience for the end user. Parallel Tracking and Mapping systems (or PTAM) could already track the 3D position of a moving camera in real time without the use of markers or natural feature targets, templates or inertial sensors (Klein & Murray, 2007). Subsequently, AR applications continued to emerge across variety of areas, however researchers sought the need to represent this knowledge and development into a definition.

2.2.2 Definition

After the technological breakthrough, researchers realized that the application of AR is expanding more than originally believed. Various studies recognized the demand for a proper definition. Ronald Azuma first outlined the features which an universal AR system should possess: 1) combination of real and virtual world; 2) interactivity; and 3) three-dimensional representation of objects (Azuma, 1997). Simultaneously, Milgram and Colquhoun (1999) “placed” Augmented Reality on a reality-virtuality continuum, where the concept of “mixed reality” encompassed both augmented reality and augmented virtuality (Milgram & Colquhoun, 1999). In their “Reality-Virtuality continuum”, “Reality” on one end, and “Virtual Reality” on the other, encompass “Mixed Reality” (MR) with aspects such as Tangible Bits, Interactive Surfaces, Artificial Environment, Augmented Reality and 3D Games. In a Mixed

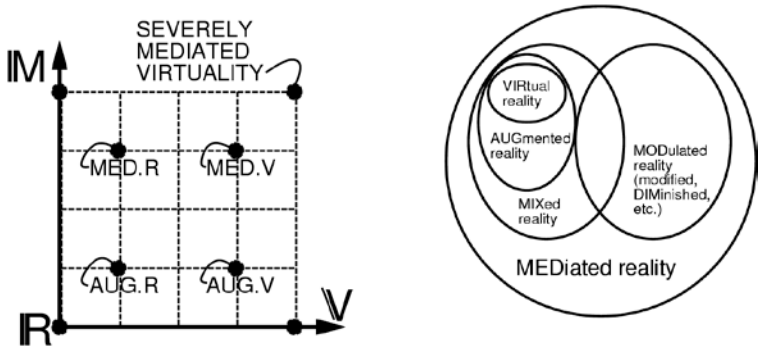
Reality system the real and the virtual worlds are blended in order to generate a new setting where physical and digital objects can synchronize and interact. Mixed Reality itself is broken down to “Augmented Reality” (AR) and “Augmented Virtuality” (AV). What distincts one from the other is that in AR the user is placed into the real world interacting with virtual objects, while in AV he is immersed in a virtual world enhanced by reality, interacting with virtual objects (Figure 5).

Figure 5.
Simplified representation of a RV Continuum (Milgram & Colquhoun, 1999).



In 2002, Milgram’s virtuality-reality continuum was broadened by Mann mainly for adding a modification factor to either reality or virtuality (Mann, 2002). Augmented reality was characterized as aiming to enhance the real world while virtual reality - to replace it. The mediated reality framework describes devices that deliberately modify reality as well as devices that accidentally modify it. On the graph the origin “R” denotes unmodified reality. To the right on the virtuality axis “V” depicts the change from augmented reality to augmented virtuality. The direction up the axis shows modifications of reality and virtuality. Up and to the right are virtual world that have severely modified reality (Figure 6).

Figure 6.
Reality, Virtuality, Mediality (Mann, 2002)



Höllerer and Feiner (2004) defined AR system as the one which combines “real and computer-generated information in a real environment, interactively and in real time, and aligns virtual objects with physical ones” (Höllerer & Feiner, 2004, p.393). Similarly, Ludwig and Reimann (2005) described AR as “human-computer-interaction, which adds virtual objects to real senses that are provided by a video camera in real time” (Ludwig & Reimann, 2005, p.4). To Zhou, Duh, and Billinghurst (2008) AR is a technology “which allows computer generated virtual imagery to exactly overlay physical objects in real time” (Zhou, Duh, & Billinghurst, 2008, p.193.). Klopfer and Squire (2008) built upon the definition and stated that AR can be mainly defined as “a situation in which a real world context is dynamically overlaid with coherent location or context sensitive virtual information” (Klopfer & Squire, 2008, p. 205). Furthermore, AR can provide users with technology-mediated immersive experiences in which real and virtual worlds are blended (Klopfer & Sheldon, 2010). It is the technology expected to develop the “next generation reality-based interface” (Jebara, Eyster, Weaver, Starner & Pentland, 1997), and has already left university research labs to expand its application in variety of ways.

Presently in research, larger part of the definitions of augmented and mixed reality are extended versions of the definitions presented by Milgram, Azuma and Mann. However, the lack of apparent agreement on the above taxonomies makes the categorization of realities hard to specify. One point of contradiction is Mann’s definition of AR as a sub area of MR, while for Azuma there is a clear distinction between virtuality and mixed reality. Nevertheless, in comparison to its theoretical side, currently the commercialized side of AR has received more interest as technology continues to evolve. The following subsections discuss the available technologies for AR and the pursuit to overcome their challenges.

2.3 Augmented reality technology

In the past few years the development of AR, as part of Virtual Reality research, expanded at a faster pace. Reproducing the real world in a virtual reality system proved difficult due to the enormous amount of elements needed to complete a homogeneous view of an equally realistic scene. Simulated environments were either too basic, such as in gaming or too expensive and difficult to produce, such as in flight simulator systems (Koussoulakou, Patias, Sechidis & Stylianidis, 2001). An AR

system is to create a compound scene, immersing the user into a real setting and adding virtually computer generated elements. The primary aim was a design of a system where a simultaneous blend of real and virtual could be acomplished.

To achieve augmentation of a scene various forms can be employed, however the use of AR is not limited only to its visual side. Research on AR system for audio (Lyons, Gandy & Starner, 2000; Rozier, Karahalios & Donath, 2000), haptics (Salisbury, Conti & Barbagli, 2004; Hayward, Astley, Cruz-Hernandez, Grant & Robles-De-La-Torre, 2004), taste and even smell (Nakamura & Miyashita, 2011; Narumi, Nishizaka, Kajinami, Tanikawa, & Hirose, 2011) has been done evidencing the enormous interest in the field. Table 1 summarizes the development fields of AR systems, however, in this chapter only the visual aspect of AR will be considered for briefness.

Table 1.
Augmented Reality systems grouped in terms of output and input devices

	Category	Description	Device	Output	AR information
AUGMENTED REALITY	**Vision**	Handheld	Mobile device	Image	Text
		HMD	Optical see-through glasses		Virtual Objects
		Spatial	Projector		Highlighting
			LCD Display		
			Autostereoscopic Display		
		HMD	Video see-through glasses	3D Image	
		Wearable	Holographic projector		3D Text/ Virtual objects/Textures
		HMD+Spatial	Alternate Frame Sequencing Display & Glasses		
			Polarization Display & Glasses		3D Highlighting
			Analgyphic Glasses+Default Display		
	Audio	Spatial	Speakers	Surround sound	Direction of sound
					Translations
					Additional sound
					Improved sound
		HMD	Headphones	Stereophonic sound	Translations
					Additional sound
		Handheld	Earphones		Improved sound
	Touch	Spatial	Haptic device	Motions	Additional motion
		Handheld	Vibrating mobile device	Vibration	Haptic feedback
			Game controller		
	Smell	HMD	Gustatory display	smell	fragrance
	Taste	HMD		taste	flavor

In order for an augmented reality system to operate efficiently, the relationship among the real and computer-generated objects together with specific hardware, must be designated precisely. The objective of AR applications is to represent the virtual images to the user in a way as believable and as close to reality as possible. To achieve a flawless immersion for the user, several aspects of a system are of major importance. Building compelling AR environments require enabling technologies such as displays, tracking, registration, and calibration (Azuma et al., 2001). All elements taking part in an AR system should be mechanically altered especially to provide an accurate result. This process is complex and requires rigorous design and implementation. Since the state of AR technology is in constant development the three most important research aspects for constructing an AR system, namely tracking, registration and calibration are discussed below.

2.3.1 AR tracking technologies

Depending on the method of how additional information is aligned with the real world there are several categories of augmented reality technologies: vision-based (marker based, feature based or markerless), sensor-based (magnetic, optical or inertial), or hybrid.

2.3.1.1 Vision-based

a) Marker-based

In an unknown environment, visual tracking and analysis of the pose of a camera in AR has been proven challenging due to the fact that the system selects the orientation of the coordinate axis at random (Siltanen, 2012). In addition, the estimation of the correct scale purely based on visual observations is not possible. A solution to this problem is to add an easily detectable predefined sign in the environment and use computer vision techniques to detect it (Siltanen, 2012). Such signs, or also called fiducial markers, are the activators for additional information, with the information being superimposed each time that a marker is detected. This technique is widely used in existing AR applications where the performance of an AR system depends highly on the tracking method for visual marker detection and pose estimation. The method uses computer vision from camera video input to calculate

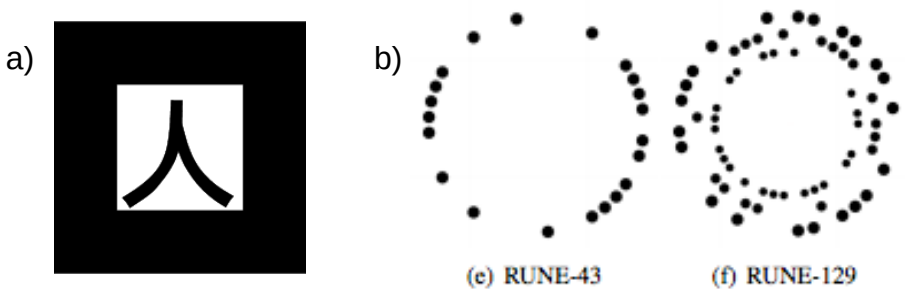
pose in order to perform alignment between real and virtual cameras. The markers are detected in the image and the correspondences between the image and their known 3D location are used to calculate the pose. Markers can either be fixed in a physical environment, so that the location of a moving camera can be identified, or they can be placed on moving objects so that a location relative to either a fixed or moving camera can be computed. A good marker is the one that a computer vision system can robustly detect and identify unambiguously (Siltanen, 2012).

The visual marker's design can differ from one to another. A fiducial marker is composed of a set of visual features, or black and white patterns forming circles, straight lines, or sharp corners and edges (Feng & Kamat, 2012). Visual features are meant to "provide reliable, easy to exploit measurements for the pose estimation" (Lepetit & Fua, 2005). However, the use of visual markers limits the interactivity and is constrained to a range of photos or objects encapsulated within a border to create the marker. Therefore, in order to use this approach, these visual marks have to be previously printed (Dolz, 2012).

Initially, the first square marker system was developed in 1998 and consisted of black frame for camera pose estimation on the outside, and a coded square black and white pattern for marker identification on the inside (Figure 5a) (Rekimoto, 1998). Various patterns can be placed inside the frame and identified with simple template matching. ARToolKit is an example of a software library developed for the building of AR applications allowing for the use of any square marker pattern (Kato & Billinghurst, 1999). More advanced approaches include random dot markers using randomly scattered dots as fiducial (Uchiyama & Saito, 2011) or the RUNE-Tag where dots are distributed on a circle with a predefined pattern coding (Figure 5b) (Bergamasco, Albarelli, Rodola & Torsello, 2011). The advantages of the random dot marker, in contrast with square marker, are its more flexible shape, higher robustness against occlusion and more accurate camera pose due to higher amount of points for pose estimation in cases of noise or blur.

Figure 7

Examples of ARToolkit (a) and RUNE-Tag (b) markers



b) Feature-based

Feature-based tracking is visual tracking that can be based on detecting salient features in images (Siltanen, 2012) and is an algorithm commonly used in computer vision practices. This process is an initial point for many applications, usually beginning by examination of every single pixel in an image for features. When features are detected, a local image patch around the feature can be extracted, resulting in a so called feature descriptor. The types of image feature detectors are edges, corners, blobs or ridges. Object recognition, motion detection, image matching, 3D model building are some of their most frequent applications (Siltanen, 2012).

- Edges are sets of points defining limits of two image regions. In Augmented reality applications edge detection and matching is often applied to model-based tracking or occlusion handling.
- Corners are 2D point-like features in an image, for which there are two dominant edge directions in a local neighborhood of the point.
- Blobs are representations of image structures in terms of regions and can detect areas in an image which are too vague to be detected by a corner detector, e.g. image areas that are brighter or darker than its surroundings.
- Ridges try to capture the axis of symmetry of the object, in contrast to edges which try to capture the boundary of the object. This is particularly useful for tasks such as road extraction in aerial images and blood vessel segmentation in medical images.

- Simple feature tracking

Feature tracking is one of the most intrinsic activities in computer vision and a conventional way of extracting motion information from an image from frame to frame. Generally, the term “tracking” is in common use for describing both 6DOF-pose measurement and 2D-feature (geometrical features) correspondence in image sequences (Neumann & You, 1999).

Conventional feature tracking techniques fall into two categories: correspondence-based and texture-correlation based techniques. The first type extracts a set of features from each frame and then tries to establish correspondences between both sets of features (Smith & Brady, 1995). It is an essential requirement that the same feature can be detected accurately and at all times over different frames. One of the drawbacks of this technique is that correspondence errors can be very big.

Texture correlation-based techniques extract a set of features from the first frame only. The position of these features in serial frames is detected by performing a match inside a “window” to find the best correspondence with the texture around the feature in the first frame. The problems in performance of this method are related to the constant moving of features, or with rotating, skewing or zooming of texture in a consequent frame, although efforts have been made to find a possible solution (Shi & Tomasi, 1994; Kang, Szeliski & Shum, 1997).

- Keypoint tracking

Classical feature tracking techniques work with correspondences between two consecutive frames by extracting a set of feature points from the first frame and tracing their motions onward. In contrast, in keypoint tracking (or natural feature tracking) camera pose can also be determined from naturally occurring features, such as points, lines, edges or textures (Zhou et al.,2008).

Natural features are features from unprepared environments and the process of tracking them involves a lot of complex computational operations (Wagner, Reitmayr, Mulloni, Drummond, Schmalstieg, 2008b). Most previous natural feature tracking methods include burdensome feature extraction and pattern matching processes for each of the input image frames. With natural feature tracking any motion can be identified on the basis of key points with more than 30 frames per

second. A 3D map of these keypoints is created, while the computer estimates the distance and the angle between the keypoints and the camera. The procedure matches the extracted features from the input frame with each of the registered patterns until a successful model is achieved. This method is more robust than marker based tracking due to existence of various keypoints and not just four corners of the marker close together in the scene (Jonker, 2012). In cases of blocked line of sight towards the camera still enough keypoints can be detected and the tracking will take place. One downside of the technique is that natural feature-based approaches are still challenging for mobile augmented reality applications. They perform best only with textures and consistent scenes and require powerful computer systems for fast and reliable tracking. However some developments have diminished the computational complexity of this approach and have allowed for its implementation on a mobile device with a low-speed CPU and less memory (Lowe 2004; Wagner, Langlotz, Schmalstieg, 2008a; Wagner et al., 2008b).

c) Markerless (MLT)

The characteristics of MLT allow for the performance of active tracking and recognition of real environment on any type of support such as objects, faces or movement without the need of fiducial markers. Markerless tracking has the potential to improve both the accuracy of motion measurements and the range of detectable motion compared to Marker-based systems (Kyme, Se, Meikle, Angelis, Ryder, Popovic, Yatigammana, Fulton, 2014). Latest depth cameras with sensors are capable of measuring the depth for each of the captured pixels. Currently, there are two approaches for the development of markerless AR: Model-based and Structure-from-Motion-based. With Model-based techniques, information about the real world scene is gathered before the tracking process takes place, kept as a 3D model for estimating camera pose. Structure-from-motion aims at jointly recovering the structure of a scene as a collection of 3D points and estimating the camera poses from a number of input images (Bao, Bagra, Chao & Savarese, 2012) and no previous knowledge about the scene is necessary. The purpose of this technique is to achieve an estimation of the current position, orientation and the three-dimensional movement of a camera from the captured images, by using only a calibrated camera and without the additional use of markers. In Model-based methods, a 3D model of

the real world is prepared and used for estimating camera pose (Kurihara & Sagawa, 2014). Model based methods are considered simpler but execution of tracking relies on how clearly the objects were formerly modeled in the real world scene. On the contrary, such limitations do not exist with Structure-from-Motion based technique because they allow for tracking of the camera motion in previously unidentified scenes. The markerless method is powerful and allows the performance of complex applications of AR.

2.3.1.2 Sensor-based

Sensor-based tracking techniques are based on sensors that are placed in an environment (Zhou et al., 2008). This type of tracking provides a full immersion experience even when lighting conditions are limited. When the sensors send a signal to the receiver, only the relevant information is processed and displayed to the user through powerful filters. In the past, most of AR systems have used magnetic, mechanical, or inertial sensors, in order to measure the pose of the camera. In systems that allow a user to move around within a physical space, tracking systems detect location, direction and speed. This process is represented by 6 independent variables (3 translational coordinates and 3 rotational angles) or six degrees of freedom (6DoF) tracking systems.

a) (Electro) magnetic sensors

Magnetic tracking systems detect magnetic fields generated by electric current (Potter, 1967). Each one of three perpendicular coil wires serves as an electromagnet, sending information about their magnetic fields to the system's sensors. This estimation determines the direction and orientation of the emitter. A big advantage of these sensors is their compactness; they can be used to perform augmentations almost everywhere. Magnetic tracking is robust against line of sight problems. These systems are inexpensive but they are less accurate compared to optical systems (Ullah, 2011). However, electromagnetic sensors are easily disturbed by the presence of metallic objects in the environment – anything that generates a magnetic field may interfere in the signals sent to the sensors. An electromagnetic tracking system is very sensible, with low levels of latency corrected

via prediction algorithms. Also, the high accuracy diminishes with increasing distance.

b) Inertial sensors

Inertial sensors are utilized in determining the acceleration for position determination and position orientation (Rolland, Baillot & Goon, 2001). The size, mass, performance, and cost of inertial sensors varies between the different technologies used. In general, higher performance sensors are larger and more massive as well as more costly.

An important asset of inertial sensors is their independence from magnetic interference or line of sight constraints. Also orientation is detected rapidly and there is no limit on the range they can cover. However, the method is not accurate for slow position changes. Also position and orientation are only measured in 3 DoF.

In the inertial tracking system, tracking is performed so as to conserve either a given axis of rotation (mechanical gyroscope) or a position (accelerometer) (Rabbi & Ullah, 2013):

- Gyroscopes measure specific force and provide a rate of rotation which can be used to determine orientation changes of a user's position. There are three main types of gyroscope technology: spinning mass, optical, and vibratory, each of which based on a different physical principle.

- Accelerometers measure angular rate or the linear acceleration of a user's position to determine translations. Most accelerometers are either pendulous or use vibrating beams. This sensor is lightweight and is reference free (Rolland et al., 2001).

c) Optical sensors

Optical sensors, such as cameras, use light to measure a target's position and orientation with at least four tracking points. The amount of light they receive from the environment is converted into voltage levels, stored as different pixel values. The signal emitter in an optical device typically consists of a set of infrared light-emitting diodes (LEDs), which light up consecutively. The camera receives the signals and sends data to the system's processing unit. The position and the orientation of each camera is calculated using the epipolar geometry between two planes of the images

(Ullah, 2011). The major advantage of these sensors is that they can identify users and provide information about the position and orientation of the target. Moreover, no additional device is needed for the user to be equipped with. Optical tracking is inexpensive and allows for a more accurate and robust tracking in controlled environment, whereas these sensors are sensitive to optical noise, occlusion and require heavy computation that makes the system relatively slow (Yang, Wu, Moniri & Chibelushi, 2008). The system's main drawback is that the line of vision between a camera and an LED may be interrupted, interfering with the tracking process. Furthermore, dim light or infrared radiation can also cause the system to be less reliable. Optical sensor systems also require a significant amount of computations to process information about the color, depth and pose to adequately identify targets.

d) Acoustic sensors

Acoustic sensor systems consist of acoustic sensors and ultrasound transmitters (Ullah, 2011). They utilize ultrasonic sound waves to determine the position and orientation of a target based on the time needed for the sound to reach the sensors. The sound has a frequency above 20 kHz – higher than the frequency range of the human ear.

Generally, acoustic tracking is considered reliable against distortion by magnetic interference. It is also a compact and affordable tracking solution. However due to the slow speed of sound waves or environmental conditions instability such as temperature, humidity or air pressure, the refresh rate on a target's position can be affected (Ullah, 2011). Acoustic interference and echoing of waves may cause distortion which also influences the ultrasonic receivers. The necessity for an available line of vision decreases the reliability of tracking.

e) Global positioning system (GPS)

One of principal systems for outdoors tracking is the Global Positioning System (GPS). This is a space measurement based system for navigation and detects the location in earth coordinates (latitude, longitude and altitude) and can be applied almost everywhere outdoors. The GPS network consists of at least 24 satellites (with room for six further satellites) orbiting the Earth in nearly circular orbits with a mean radius of about 26,560 km (Noureldin, Karamat & Georgy, 2013). The precision of the

localization can vary between 3 and 7,8 meters. The accuracy can be increased by so called augmentation systems by ground-based stations to an accuracy of a few centimeters.

Other ways of localization of targets include the multilateration of radio signals between radio towers of the GSM network and a mobile phone, or through Universal Mobile Telecommunications System, an evolution of the GSM mobile phone standard. In gaming, AR technologies, use mobile phone's GPS to determine the participant's current real-world location and provide players with additional layers of informational discovered through exploration of the physical place. Disadvantages of GPS systems may be associated with poor accuracy and resolution, and the failure of the technology if the direct lines of sight to the satellites are occluded (Rolland et al., 2001).

2.3.1.3 Hybrid tracking

The above described tracking approaches have their own disadvantages and benefits. In order to develop a better approach, methods for tracking can be used together in a more complex system (Rolland et al., 2001). This way, a more accurate and robust tracking approach can be achieved. Generally, hybrid tracking approaches combine vision and sensor based tracking techniques. Sensor-based tracking can provide the required speed at lower cost, without the need for independent support, while vision-based tracking is more accurate in recognition but integrates a complex computing system. Therefore, more assuring results can be achieved by applying sensors for pose estimation and vision-based techniques for improvement of the registration process.

Hybrid tracking techniques are also utilized often in unprepared environments (such as in outdoor conditions) and can combine vision-based tracking with GPS data (Azuma, Lee, Jiang, Park, You, & Neumann, 1999). GPS signal can be detected with enough accessible satellites, but in some cases additional devices can assist in localizing a target. In order for the GPS signal to be amplified to indoor environments the use of dedicated ground-based radio transmitters or "pseudolites" can be instrumental. Other available positioning systems for locating a target are infrared beacons, which transmit a light beam in the infrared spectrum, bluetooth and wireless local area networks. Inertial trackers, gyroscopes and compasses represent the

global 3D orientation coordinates, while the magnetic sensors detect local coordinates. In indoor tracking applications, local coordinates are often easily accessible, but outdoor tracking applications usually rely on the global coordinate system. Hence, hybrid tracking systems are a promising way to deal with the difficulties posed by general indoor and outdoor mobile AR environments (Höllerer & Feiner, 2004) since they combine the best features of both methods.

2.3.2 Registration

Image registration for AR has been a subject of much research due to its relevance to various application areas as well as because of its complicated nature (Azuma et al., 2001; West, Fitzpatrik, Wang, Dawant, Maurer, Kessler, Maciunas, 1999; Zitova & Flusser, 2003). Registration evens up spatially two images of a setting so that corresponding points adopt the same coordinates. Every point in the first image, or the reference image, should find a matching point in the second (sensed) image. No alterations are made to the reference image while the sensed image is modified to take the geometry and spatial coordinates of the reference image. In cases where the images constitute of different 3D views, or if there is a movement in the setting, it is very unlikely that an exact match of all points in the images can be achieved. Image registration only targets correspondence between points that are present in both images.

The visual aspect of augmented reality is crucial in a representation of a realistic scene, and therefore the registration process is of high importance. In AR registration, issues are mainly related to visual alignment between computer-generated and real world elements and errors are much more critical than other registration errors (such as the visual-auditory or visual-haptic errors) (Azuma, 1997). However, human visual system is capable of detecting very small differences. Delays between tracking and the conclusive overlap of the corresponding images are also problematic in such applications. The real-time registration process must also be accurate enough for the augmentation of the virtual objects which should not appear “floating” (Ohshima, Sato, Yamamoto, Tamura, 1998), as well as must be cost effective in terms of used hardware.

There is a vast amount of image registration algorithms classified on different principles. Intensity-based and feature-based algorithms compare intensity patterns

in images via correlation metrics or correspondences between image features such as points, lines, and contours respectively (Goshtasby, 2005). Rotation and scaling fall under the category of linear transformation algorithms while those that allow radial basis functions are considered as “nonrigid” transformation methods. Other classification include spatial (matching of image intensity patterns and features); frequency-domain (translation, rotation, and scaling in transformation); single or multi-modality (register images in the same or multiple sensor types) and manual or automatic methods, which depend on the level of user involvement in the process of image aligning.

The consecutive steps involved in the registration process, consist of (1) feature detection, (2) feature matching, (3) transform model estimation and (4) image resampling and transformation (Zitova & Flusser, 2003). In the first two steps salient objects like edges, closed-boundary regions or contours are detected in a paired (reference and sensed) image to find correspondence features. In the transform model estimation the type and parameters of mapping functions, which align the sensed image with the reference image, are assessed. In the last step, or image resampling and transformation, the sensed image is transformed according to the mapping functions.

2.3.3 Calibration

An early definition of camera calibration is given in (Tsai, 1987). The author states that in the context of three-dimensional computer vision camera calibration is the process of determining the internal camera geometric and optical characteristics (intrinsic parameters) and the 3D position and orientation of the camera frame relative to a certain world coordinate system (extrinsic parameters). The general performance of the computer vision system greatly depends on the accuracy of the camera calibration.

Several ways exist to perform a camera calibration. Often, a manual manipulation is necessary in order to change simulation parameters and adjust the simulation output to match the observed values. This task, often continuous, requires specific skills and can be quite challenging. Therefore, other methods such as calibration-free (Kutulakos & Vallino, 1998) and autocalibration AR (Luong & Faugeras, 1997; Hartley & Zisserman, 2000) have been developed. Furthermore,

there are also tools and libraries which can provide calibration functions e.g. ALVAR[4] and ARToolkit[5]. Matlab[6] and OpenCV[7] also have a calibration toolkit and can be used in addition in AR systems.

2.3.3.1 Manual calibration

Naturally, the first AR developed algorithms in camera calibration have been performed by hand (Ballard & Brown, 1982; Tsai, 1987; Tuceryan, Greer, Whitaker, Breen, Crampton, Rose & Ahlers, 1995) Various methods for *camera calibration* can be found from the literature but generally the process in manual calibration consists of three consecutive steps: detecting the 3D coordinates of calibration points in the world coordinate system; defining of the corresponding 2D points in the image plane and constructing of the transformation matrix from the data obtained.

The calibration methods for the various devices in AR may differ significantly. For example, a typical AR system for enhanced vision may use a head-mounted display (HMD): either an optical or a video see-through. Calibration of video see-through HMDs can be done using image processing techniques, where real world points are located visually in the image. Optical see-through HMDs are less commonly used due to difficulties in achieving accuracy of the calibration (Tang, Zhou & Owen, 2003).

2.3.3.2 Calibration-free AR

Implementing calibration-free AR excludes the need for a manual calibration. This method uses affine mapping (rotation, scaling and translation) which originates from the positions of tracked fiducial points. An early example of such methods demonstrate an approach which does not require camera calibration and uses several fiducial points so that the system can perform accuracy within 15 pixels for 640x480 images (Kutulakos and Vallino, 1998). However, the disadvantages of the algorithm are concerned with constraints of the affine space and the visibility of fiducial points. A later study demonstrates an algorithm for augmenting a real video

[4] ALVAR: http://virtual.vtt.fi/virtual/proj2/multimedia/alvar/. Retrieved Sep. 5, 2014.
[5] ARToolKit: http://www.hitl.washington.edu/artoolkit/ Retrieved Sep. 5, 2014.
[6] Matlab: http://www.mathworks.com/products/matlab/ Retrieved Sep. 5, 2014.
[7] OpenCV: http://opencv.org/ Retrieved Sep. 5, 2014.

sequence with views of graphics also without camera calibration and represents the motion of the video camera in perspective (Seo & Hong, 2000).

2.3.3.3 Auto-calibration

Auto-calibration is a technique which defines a camera's intrinsic parameters (internal camera geometry and optical characteristics) from a series of images based on rigid motion (Luong & Faugeras, 1997; Hartley & Zisserman, 2000). After specific points and their correspondences from the images are marked, a distorted 3D reconstruction, linked to the real one by a spacial homography is obtained. The next step in the process is the development of a geometric transformation which restores the 3D structure from the distorted version. This leads to the obtaining of the camera positions and their internal parameters. Different camera autocalibration algorithms are applicable in various situations and can considerably reduce the configuration requirements for AR systems. However, for applications demanding high accuracy the autocalibration may not be always satisfactory and may require Marker-based calibration.

2.3.4 Display technologies

Image generation methods and physical layout are the most important criteria to be identified when categorising AR display technologies (Azuma, 1997; Azuma et al., 2001; Raskar & Bimber, 2004). The display technologies that support image generation have been described in literature as video-mixing, see-through or projector-based. For each imaging generation method the imaging display can be arranged in three main groups including (1) head-attached, (2) handheld and (3) spatial displays. Depending on optical technology used they represent the augmented image to the user through either planar images (handheld and spatial) or curved images (retinal and projector based). While head-mounted devices are attached to the head of the user, hand-held devices such as PDAs or mobile phones are usually held by the user. Spatial devices are detached from the user and positioned at any place in the environment.

2.3.4.1 Head-attached displays

The image-generating technology allows for the implementation of three different types head-attached displays. One way to achieve augmented visualization is to attach mini displays in front the eyes of the user. Another technology, the head-mounted projector, uses small LCD panels or projectors. In the third method low power lasers generate the images on retinal displays.

a) Head-mounted displays

HMD resembles a helmet (and more recently glasses), worn on the head, which display to the user simultaneously images of the real and virtual environment. There are two types of HMD: video-see-through or optical see-through and can have a monocular or binocular display optic (Bimber & Raskar, 2005; Macchiarella, Liu, & Vincenzi, 2009). Video-see-through systems are generally more complicated since the user must operate with two cameras that simultaneously process the real and the virtual objects. This type of appliance can be useful when applied in remote views of objects or with an image enhancement system (thermal imagery or night-vision devices). The mixed view of the real and virtual is handled by the computer allowing control over the final result. In video see-through it is easy to match the video latency with the computer graphics latency, because motion trackers are not instantaneous as well as computer graphic generation is not immediate and even when refreshing images at 60, 70, even 120 Hz, there is a delay from sensing to imaging.

The optical-see-through system uses a halfsilver mirror technology and transforms views of the physical world that pass through the lens and displays them reflected in the user's eyes. These devices have the advantage of allowing the user to have the peripheral vision around the display and natural vision of the real world at the same time (Livingston, Rosenblum, Brown, Schmidt, Julier, Baillot & Maassel, 2011). In this technology there is no latency but exists a lack of synchronization between what the user sees and the displayed graphics. On the contrary, video see-through allows synchronization of delay so that the video and graphics are always synchronized. Tha advantage of this type of display is that of having more control over the occlusions between real and virtual images, however the vision is limited to the geometric and colour resolution of the camera that captures the real world

(Livingston, 2011). The two types of systems can be used for different application depending on requirement.

The most important advantage of both systems is the fact that they allow the user to move freely, without the need to hold the device, while simultaneously displaying content only to a single viewer. On the other hand, the Field Of View (FOV) of the computer-generated and real world images is restrained to the limit of the resolution of the used video optics. However, some recent developments, such as OLED displays, may soon be able to solve these issues.

b) Retinal displays

The above discussed head-mounted display technology presents the images on screens to the user. Retinal displays use low-power lasers to scan modulated light directly onto the retina of the human eye, achieving a much brighter and higher-resolution image with a comparatively wider field of view than a screen-based display (Bimber & Raskar, 2005). In order for the lasers not to damage the eye they use low power and simultaneously are capable of producing a bright and contrast images with greater FOV compared to screen-based displays. Those features make them well-adapted for mobile usage.

c) Head-mounted projectors

Head mounted projectors are divided into two types: head-mounted projective displays (HMPD) and projective head-mounted displays (PHMD). Generally, HMPD use retro-reflective screens, which reflect the light back towards its occurring direction and are mounted in front of the eyes of the user (Hua, Brown & Gao, 2004). Micro corner cubes overlay a retro-reflective surface (Bimber & Raskar, 2005). Compared to other light-diffusing surfaces, micro corner cubes are capable of reflecting the light back along its incident direction, thus reflecting much brighter images. A projective lens together with a beam-splitter send an image from a mini LCD display onto these surfaces.

d) AR eyewear

Emerging wearable computing devices attract extensive attention worldwide (Zhang, Li, Huang, Liu, Zong, Jian, Feng, Jung, Liu, 2014). See-through “smart” eyewear can currently deliver augmented experiences and enhance data processing functionality.

The lightweight head-worn device is built like a normal pair of eyeglasses, however in order to allow for real-time AR overlays, they are equipped with various sensors, such as gyroscope, accelerometer and GPS. Compared to video glasses, which provide only a virtual experience, this type of technology provides a more natural environment for the user. The cameras embedded in the frames or on the lenses have the ability to recognise locations or real world objects from the point of view of the user. The sensors detect the position of the user and track different environmental objects while an immediate search for relevant information is performed. Tracking eye movements provides insights about the context of the user, from recognizing what documents a user is reading, over recognizing memory recall to assessing expertise level (Ishimaru, Uema, Kunze, Kise, Tanaka & Inami, 2014). The data is downloaded and overlayed accurately onto the real world in real time and consecutively projected through micro projectors on the lens.

Examples of current marketed models are the monocular Google Glass[8] and Vuzix Smart Glasses[9], and the binocular Meta Pro[10]. The devices have the properties of a smartphone hands free accessory, allowing for camera and display functionality of augmented reality. The Vuzix Smart glasses allow for 3-degrees of freedom head tracking, have an integrated compass, GPS and 4GB of memory. The enabled applications include a visual address book, text messages and email, visual navigation, video recording, and AR applications. Google Glass can respond to natural voice commands and instead of using the traditional earphone and speaker applies bone conduction to generate sound. In Meta Pro both right and left eyes are able to see a 3D holographic interface, with a 40 degree binocular field of view, compared to Google Glass's 14 degree monocular field of view. The Meta Pro model also has the ability to recognize hand gesture interactions.

Possible next stage in the evolution of augmented reality eyewear may be the development of bionic contact lenses capable of displaying text and images, triggered just by blinking of the eye and containing semi-transparent LEDs, integrated circuitry, and antennas for wireless communication (Lingley, Ali, Liao, Mirjalili, Klonner, Sopanen, Suihkonen, Shen, Otis, Lipsanen & Parviz, 2011; Parviz, 2009).

[8] Google Glass: https://www.google.com/glass/start/Internet. Retrieved September 5, 2014
[9] Vuzix Smart Glasses: http://www.vuzix.com/consumer/products_m100/. Retrieved September 5, 2014
[10] Meta Spaceglasses: https://www.spaceglasses.com/products. Retrieved September 5, 2014

2.3.4.2 Handheld displays

Handheld displays represent hand-held video or optical see-through displays as well as hand-held projectors. They are small, lightweight computing devices such as smart-phones, PDAs and tablet PCs (Wagner & Schmalstieg, 2006). The technology here blends graphics with real environment and implements sensors, such as a digital compas and GPS unit for the six degree of freedom tracking sensor, fiducial marker system or computer vision methods, such as Simultaneous Localisation and Mapping (SLAM)[11]. Handheld AR relies on the spatial relation between the physical surrounding and the on-screen content (Vincent, Nigay & Kurata, 2013). This approach is currently used as the fastest and easiest way to introduce AR to a mass market due to low production costs and ease of use. Disadvantages to the technology are limited memory and computational capability, as well as limited graphics capability, limited input and output options, especially in the case of nonprojection environments (Craig, 2013).

2.3.4.3 Spatial displays

Spatial Augmented Reality (SAR) places image information directly on physical objects and combines video-projectors, optical elements, radio frequency tags, and tracking technologies. This technology has better display resolution compared to head mounted displays or portable devices. It does not engage the user with the wearing of any type of display and the process of application can be done with video-see-through, optical-see-through and direct augmentation, as classified in Bimber & Raskar, 2005) below:

a) Screen-based video-see-through displays

In SAR, video-see-through displays are screen based and used in fixed systems which include only standard PC equipment. The visible area is limited to the screen size and its spatial alignment and distance are relative to the observer. This type of display is less immersive with a smaller field of view due to screen size limitation. The generally low resolution of merged images is a disadvantage common to video see-through.

[11] OpenSLAM: http://www.openslam.org/. Retrieved September 5, 2014

b) Optical-see-through displays

Spatial optical-see-through displays produce images that are blended with the physical environment naturally. Spatial optical combiners, such as planar or curved mirror beam splitters, transparent screens, or optical holograms are substantial components of this type of displays. However, a lot like screen-based video see-through, spatial optical-see-through does not support mobile applications due to spatially aligned optics and display technology. Another disadvantage is an existing effect, known as window violation which cuts out virtual object out of the display area. One positive side of this type of display systems is that the human eye adapts easily; they also allow higher resolution, larger and scalable field of view, better calibration and control of the setting.

c) Projector-based spatial displays

Projector-based spatial displays work with smooth front-projection on physical objects' surfaces. Multiple projection techniques can be applied to enhance characteristics of the display perception. It can be applied on 2D or 3D perspective environment. It combines the characteristics of the traditional spatially immersive displays and augmented reality displays. Some of the limitations of this method include shadow-casting, restriction of the display area to size, shape and color of the physical object's surfaces, solvable by multi-projector configurations. Projector-based spatial displays have an advantage in comparison to head-attached displays in unlimited field of view, a scalable resolution, and an easier eye accommodation.

2.3.5 Computers and inputs

Until now, the keyboard and the mouse have been the dominant data input devices for controlling personal computers, however their problematic use in an outdoor environment has called for the development of alternative input devices. Mobile technology progress has allowed for wireless hand-held devices to become suitable for AR. Nowadays smart-phones are used as application pointing input devices (e.g. Google Sky Map[12]) and late-model tablet PCs are able to cope with heavy graphics and computational work.

Traditionally, computer systems require powerful CPU, graphic card and sufficient amount of RAM to process camera images in AR. As processing power

[12] Google Sky Map http://www.google.com/mobile/skymap/ Retrieved September 5, 2014

has improved in recent years, various types of input devices for AR systems have become available: glove-based systems (Bowman, Wingrave, Campbell & Ly, 2001; Thomas & Piekarski, 2002; Reitmayr & Schmalstieg, 2003), combination of ultrasonic sensors and gloves (Hoefer, 2011, see Figure 8a; Han, Na & Lee, 2012), wireless wristband (Feldman, Tapia, Sadi, Maes, and Schmandt, 2005) or AR glasses (GoogleGlass[13], GlassUp[14], Telepathy One[15] - figure 8b).

The input devices depend greatly upon the type of application the system is being developed for as well as and the destined display. In a system with a handheld display a touch screen input device is often utilized. Figure 8a and 8b show examples of recent input devices.

Figure 8

a)Tacit glove (Hoefer, 2011); b) Telepathy One glasses prototype

b)

2.3.6 Areas of application of AR

Through the realistical addition of computer generated images to the view one perceives from the real world, AR enhances user's perception and can create interactive experiences. The technology provides information that the user's senses are incapable of detecting directly. It is also referred to as an Intelligence Amplification (IA), or using the computer as a tool to make a task easier for a human to perform (Brooks, 1996 as cited in Azuma, 1997, p.3). The technology's primal application has been in aiding the user in performing of specific tasks.

Since the early 1990's, utilization of AR has been investigated in various industries including medicine, manufacturing, aeronautics, robotics, entertainment, tourism and more recently, social networking education and marketing (Azuma, 1997; Billinghurst, 2002; Hincapie, Caponio, Rios, & Mendivil, 2011; Shelton, 2002; Shin,

[13] Google Glass http://www.google.com/glass/start/ Retrieved September 5, 2014
[14] GlassUp http://www.glassup.net/ Retrieved September 5, 2014
[15] TelepathyOne http://tele-pathy.org/ Retrieved September 5, 2014

Kim, Kang, Jang, Choi, & Woo, 2010; Shuhaiber, 2004). The following examples give a short overview of the development of the technology for the application of AR in different fields.

It is not unusual to see the first real practical applications for a technology used in military purposes, and AR technology does not make an exception. For many years AR has been used for military training where head-attached displays served to superimpose vector graphics upon the view of the real world providing drivers and pilots with basic navigation for particular tasks. The first specific application of AR technology was for fighter pilots, The Super Cockpit, developed at Wright-Patterson Air Force Base beginning in the late 1960s (Furness, 1969). Other examples for military training and equipment included The Aspen Movie Map (Naimark, 1979), where user could trace or specify a chosen route for the system to follow and the Battlefield Augmented Reality System^{TM} (BARS) - a wearable device incorporated into a soldier's personal equipment, allowing for networking the mobile users together with a command center (Julier, 2000).

Significant efforts have been made to implement AR in medical imaging and tools to complement doctors' knowledge and skills. Various examples can be found in the field of neurosurgery (Grimson, Lozano-Perez, Wells, Ettinger, White & Kikinis, 1996; Masutani, Dohi, Yamane, Iseki & Takakura, 1998), general surgery (Soler, Delingette, Malandain, Ayache, Koehl, Clément, Dourthe & Marescaux, 2000; Satava, 1998; Sato, Nakamoto, Tamaki, Sasama, Sakita, Nakajima & Tamura, 1998), medical diagnosis (Gallo, Minutolo & De Pietro, 2010) or rehabilitation (Luo, Kline, Fischer, Stubblefield, Kenyon & Kamper, 2005).

AR plays an important role in assembly and repair of complex machinery (Feiner, MacIntyre & Seligmann, 1993) as well as in construction, where a system can equip users with "X-ray vision" inside a building, allowing them to see where the pipes, electric ducting, and structural supports are inside walls and above ceilings (Webster, Feiner, MacIntyre, Massie, Krueger, 1996). Furthermore, AR has been implemented in the teleoperation of robots, where it serves as a tool to aid the telerobotic exploration and characterization of remote environments (Azuma, 1997).

AR can also improve the effectiveness of navigation devices by displaying additional information on the windshield of a car such as destination directions and weather conditions, terrain, road and traffic information as well as alerts for potential hazards on the road. One example is the system for longitudinal and lateral driver

assistance which visually conforms to the road's surface (Tonnis, Lange & Klinker, 2007). A hybrid system that smoothly transitiones between egocentric route information and a 2D overhead map was simulated by Kim and Dey (2009).

Another application of AR that has received wide interest is in the field of education. AR has been implemented as an additional tool for learning in various domains, such as chemistry, history, mathematics, etc. An early example, the Magic Book, implemented simple AR technology on the pages of the book to make the reading more entertaining (Billinghurst, Kato & Poupyrev, 2001). Similar approach was used for geometry (Kaufmann & Schmaltieg, 2002) and biochemistry books (Medina, Chen & Weghorst, 2007). More recent studies have shown a way to apply AR in the classroom through games (Annetta, Burton, Cheng, Chmiel, & Frazier, 2012; Campos, & Freitas, 2008). By using mobile device based on geolocalisation and AR technology, Martín, Díaz, Cáceres, Gago and Gibert (2012) presented an educational application called EnredaMadrid for teaching the history of the city of Madrid in the 17th century to students.

The recent improvements in mobile computing power and functionality have led to the development of mobile AR systems (Johnson, Smith, Levine & Haywood, 2010), bringing the technology closer to everyday consumers as opposed to laboratory research and industry. A new type of AR applications has made its entrance into the market with mobile devices allowing users to view augmented images of their immediate surroundings, right on the screen of their phone. Using the video stream captured with the camera as the background, AR applications place content and information layers in the physical reference system of the user. In addition, these devices allow ubiquitous access to contextual information.

Various applications for mobile devices have become accessible in the past several years designated for different uses. For instance, in location-based AR Wikitude[16] is a platform which allows information about restaurants, metro stations, shops, special offers and museums to display in a text layer on top of the camera viewport. Worksnug[17] discovers free wifi in a given area, superimposing the direction and distance of the wifi service over the camera view. Some of the AR travel applications are Lonely Planet City Guides[18] and Trip Advisor Augmented Reality

[16] Wikitude App: http://www.wikitude.com/app/. Retrieved Sep. 10, 2014
[17] Worksnug App: http://worksnug.com/apps.Retrieved Sep. 10, 2014
[18] Lonely Planet City Guides: http://www.lonelyplanet.com/apps-and-ebooks/android. Retrieved Sep. 10, 2014

App[19]. Other location-based messaging applications, such as Traces[20] lets users share secret videos, pictures and music through the real world. Available to users in the UK, messages can be received only if a user is in the right place at the right time. The app was conceived as an experiment to see how the principles of neurodesign can be harnessed to create more meaningful, human digital experiences.

2.3.7 AR experiences

Aside from academic research, there have been hundreds of world examples of AR being used to enhance promotion of brand names. The implementation of AR in physical advertisement has grown rapidly and is being implemented in various industries such as automobile, food, game, engineering and many more. Big brands such as Coca cola, McDonald, Nike and Kellogg have embraced the technology as their marketing tool.

The first AR advertising campaign took place in 2007 and was created for the Wellington Zoo by the HIT Lab NZ, Saatchi & Saatchi[21] and MXM Hyperfactory[22] (Schmalstieg, Langlotz & Billinghurst, 2011). After sending a text message to a published number in a local newspaper, readers received a small application which they could run on their mobile phone. When they pointed the phone at a printed advertisement, users saw a virtual zoo animal, popping out of the newspaper page. The mobile AR application was written using the Symbian port of ARToolKit[23], which combined a 3D model loader with Marker-based tracking (Schmalstieg et al., 2011).

For years, AR advertisements were mainly based on markers, however with the evolution of the technology the more sophisticated markerless approach has naturally been put forward. Examples of mature marker based approaches have been implementated for brands like Doritos Sweet Chili[24], featuring markers on the product packaging, the Mini Cabrio convertible car[25] promotions having markers printed on a magazine cover or Volkswagen 2012 Beetle billboard advertisements[26]. Nowadays, markers are gradually becoming obsolete, and examples like Nike

[19] Trip Advisor Augmented Reality App: http://www.wikitude.com/wikitude-launches-tripadvisor-augmented-reality-app/. Retrieved Sep. 10, 2014
[20] Traces App: http://www.stylus.com/qkxcwq. Retrieved Sep. 10, 2014.
[21] Saatchi & Saatchi: http://saatchi.com/en-us/. Retrieved Sep. 10, 2014.
[22] MXM Hyperfactory: http://www.mxmhyperfactory.com/. Retrieved Sep. 10, 2014.
[23] ARToolKit Library: http://www.hitl.washington.edu/artoolkit/ Retrieved Sep. 10, 2014.
[24] Doritos Sweet Chili video: http://www.youtube.com/watch?v=k5ggMKsdkJc&NR=1. Retrieved Sep. 10, 2014.
[25] Mini Cabrio convertible video: http://www.youtube.com/watch?v=HTYeuo6pIjY. Retrieved Sep. 10, 2014.
[26] Volkswagen 2012 Beetle video: http://www.youtube.com/watch?v=KRA0SZhKNyo. Retrieved Sep. 10, 2014.

Lunarglide[27], a shoe that is directly recognized by the Augmented Reality system to trigger advertising content, become reality.

An illustration of markerless Augmented Reality platform is the one created for Ford C-MAX cars[28], at shopping centers in the UK, which allowed passersby to play with an interactive product advert without markers or other symbols. It permitted customers to use their natural movements to toggle virtual buttons and rotate virtual model vehicles. Another demonstration for markerless system, also in the automobile sector was the Configurator advertising campaign for Volvo brand in Portugal exhibited at several shopping malls in 2012. The Portuguese interactive system development company Edigma[29] launched an interactive videowall, controlled by intuitive human gestures, allowing users to customize their own Volvo V40 car by choosing its exterior color, alloy wheel and background scenery. Other functionalities included opening the front doors, trunk, hood, turning on the headlines and wiper blades as well as rotating the car itself. Subsequently, customers had the option of sharing their "configurations" through Facebook, or getting a printed photo of themselves next to the car.

Retail stores have also embraced the opportunity to display fashion interactively in an augmented manner. The technology is often used in a creative way in these applications, and typically, user experience is a major priority. For instance, interactive shopping windows, such as the one at a Hugo Boss store in London[30] allowed customers to hold up a brochure with a marker in front of a window while the screen displayed visuals such as a fashion show. Other AR applications have the capability to add virtual clothing or apparel onto consumers' reflection, which they seem to "wear". Examples of this approach are "virtual dressing rooms" and "virtual mirrors" of brand names selling accessories such as sun-glasses, jewelry or watches. The purpose of these applications is to enrich customer shopping experiences, both in real-world and online. Shoppers are able to share their choices, or 'likes' through social media, and are often able to make their final purchase directly through the AR interface.

A recent trend in the beauty industry, made possible through AR, is the real time video enhancement and modification of facial images. Such is the example of

[27] Nike Lunarglide video: http://www.youtube.com/watch?v=SxdWkgZXizI. Retrieved Sep. 10, 2014.
[28] Ford C-MAX billboard video: http://www.youtube.com/watch?v=bl8T9oYO5vY Retrieved Sep. 10, 2014.
[29] Edigma: http://www.edigma.com/. Internet. Retrieved Sep. 10, 2014.
[30] Hugo Boss video: http://www.youtube.com/watch?v=4q4Aew-zx3w Retrieved Sep. 10, 2014.

Beauty Mirror[31], which takes less than a second to find and track the facial features of a user with the 3D facial tracking and calibration techniques. The technology applies photo-realistic 3D effects and changes the face in real-time through pre-defined looks and customisable effects such as weight loss and skin perfection. The altered video can be recorded, saved and shared online through the app.

A similar concept, shown at the IFA tech show in Berlin 2014 combined facial recognition technologies from Lumix camera line of Panasonic[32] and a projection of an image onto a display in real-time. The platform's main idea was to give various recommendations on how to apply makeup virtually to eyelashes, eye shadows and lips. Additional feature of the system is the face wrinkle and spots detection, which show how each makeup combination could look in different lighting conditions with the help of the camera-based face-tracking software. Currently, Panasonic is planning to sell these mirrors to cosmetic retailers where users will be able to try on different shades of make-up virtually.

Over the past several years 4D projection mapping, also sometimes referred to as video mapping or spatial augmented reality (Raskar, Welch, Cutts, Lake, Stesin & Fuchs, 1998), has been implemented in the campaigns of a number of leading brands. The projection technology is used to turn objects of sizes and shapes (e.g. buildings) into display screens for video projection, where advertisers have used the technology to create immersive experiences for the audience. Video mapping requires a specialized projector to fit an image onto the surface of an object, and adds extra dimensions and optical illusions to as if the objects are moving.

In the corporate world, dozens of brands — Nokia, Samsung, Peugot and New Balance to name a few — have used video projections to launch products in different cities across the world. For the launch of their Motion & Emotion Campaign in Brazil, Peugeot organized a 4D video-mapping show[33] in Rio de Janeiro, using a unique a Kinect-based gesture-controlled tracking system and real-time 3D projection mapping. The audience witnessed the large-scale production being controlled by a mystery man in white as though it was a video game. A fourth dimension was added in the form of direct interaction with the public: in the course of the show, spectators were given a chance to bring the "Let Your Body Drive" signature to life by

[31] Beauty Mirror: http://beutify.com/. Retrieved Sep. 10, 2014.
[32] Panasonic Corporation: http://ch.panasonic.net/contents/13979/#r=s. Retrieved Sep. 10, 2014.
[33] Peugeot Motion & Emotion video: http://www.youtube.com/watch?v=cPgL5RhPvFE. Retrieved Sep.11, 2014.

collectively interacting with the rhythms and pulsations of the event while it incorporated real-life wind, rain and headlight effects.

One of the most recent examples for spatial AR experiential event took place in Central Park NY in September 2014. To announce their new Polo for Women Spring'15 collection, Ralph Lauren retail brand[34] and MPC Creative New York[35] introduced a holographic 4D experience[36], launching a new type of fashion show. During New York Fashion Week, a runway event was revealed to hundreds of spectators: 4D images were projected on a nearly twenty meter tall water-screen in Manhattan's Central Park, creating a multi-sensory effect. Ralph Lauren has used similar 4D projection technology before. In 2010, for example, it was used to celebrate an e-commerce expansion by projecting visuals onto brand's locations on New York's Madison Avenue and London's New Bond Street. In line with the 4D concept of the show, spectators experienced the scent of the brand's latestt perfume in synch with the visual projection.

While projection mapping is currently only used for spectacular campaigns, as the technology becomes more dominant it might become a standard part of outdoor advertising, where spaces and buildings are regularly used for advertising. Simultaneously, design of consumer experiences is emerging as one of the most important research domains for business practitioners. A compelling design of virtual experiences must be functional and purposeful, thus helping the participants to engage, memorize and enjoy the process (McLellan, 2000). This is because the participants' total experience is the key for success (Chittaro & Ranon, 2000).

[34] Ralph Lauren Corporation: http://www.ralphlauren.com. Internet. Retrieved Sep. 11, 2014.
[35] MPC Creative New York: http://www.moving-picture.com/. Internet. Retrieved Sep. 11, 2014.
[36] Ralph Lauren Polo video: http://www.youtube.com/watch?v=ugBbTiBmZ2g. Internet. Retrieved Sep. 11, 2014.

Literature review, part II

An essential decision to be made in research design is whether an emphasis should be placed on the theory or the data. More specifically, the debate in literature has been concerned with whether a researcher should use a deductive or an inductive approach. The deductive approach is characterized with using theory about a topic of interest as a starting point and consecutively defines hypotheses in order to test the theory. This process seeks to prove or disprove the original theory and its main advantage is the existing initial clarity on the study topic. Theory and hypothesis direct the process of gathering the data in the following manner: Theory → Hypothesis → Data collection → Findings → Confirmation or rejection of hypothesis → Revision of theory (Bryman, 2008, p.10). While this approach may grant a relatively rapid and efficient mechanism, a concern exists that the results may be incidental.

In contrast, inductive research is organized in the opposite direction as the researcher infers the implications of the findings for the theory in the beginning of the process: Observation → Patterns → Tentative hypothesis → Theory . Also, unlike deductive arguments, inductive approach recognizes that the conclusion might be false, even if all of the premises are true (Vickers, 2014). Based on previous observations, it determines given relationships and formulates general statements. Many authors differ in their positions towards deductive and inductive research with respect to research methodological foundations (Burrell & Morgan, 1979; Daft &

Wiginton, 1979; Gill & Johnson, 1991; Saunders, Lewis & Thornhill, 2009). On one hand, deductive research can be explained as a research mechanism that has incorporated the practices of the natural scientific model and specifically positivism. Concepts need to be operationalized in a way that enables facts to be measured in a quantitative manner. In contrast, inductive research can be understood as one that places an emphasis on the ways in which individuals interpret the social environment. This approach is more frequently applied in qualitative studies. In this view, the study uses primarily a deductive approach and to a lesser degree an inductive approach.

In the following sections, the review is focused on a more in depth understanding of relevant psychological concepts which are applicable to this research and also provide a contextual framework for the progress of the research.

2.4 Consumer psychology

The process of decision-making is highly complex in nature and consists of mutually connected mechanisms rather challenging to examine. According to Futrell (2011), buyers should be viewed also as decision makers. Generally, in considering purchasing of products, consumers pass through five steps of consumer decision making process namely need recognition, information search, evaluation of alternatives, purchase decision, and post purchase behavior (Kotler & Armstrong, 2014). Specifically, one of the stages in consumer decision making is central to the objectives of this study: the formation of consumer purchase intention. Laroche, Kim and Zhou (1996) suggest that factors such as customers' consideration in buying a brand and expectation to buy a brand can be used to measure consumer purchase intention. These can include the customer's interest, attending, information and evaluation as part of the overall process in determining intention.

2.4.1 Purchase intention

According to the definition given in Theory of Reasoned action (TRA), intention refers to a subjective probability for an individual to engage in a certain behavior (Fishbein & Ajzen, 1975). Intention is the cognitive representation of a person's willingness to perform that behavior, and is considered to be its immediate antecedent. A person's attitude toward a behavior consists of a belief that that particular behavior leads to a

certain outcome and an evaluation of the outcome of that behavior. The existence of a positive association between attitudes and intention in TRA has been also confirmed elsewhere (Lee & Green, 1991; Netemeyer & Bearden, 1992).

Forasmuch as the main topic of this study, the same view can be applied to purchase intentions and consumers' readiness to exercise purchase behavior. Purchase intention is considered a function of cognitive and affective evaluations (Fishbein & Ajzen, 1975) and serves as a link between consumers' attitudes toward products and their purchase or use of the products. Purchase intention is preceded by a general product evaluation and an emotional reaction reflecting consumers' attitude towards an object. Furthermore, consumer attitudes have been shown to have positive influence on purchase intention (Dubé, Cervellon & Jingyuan, 2003; Morris, Woo, Geason, & Kim, 2002; Voss, Spangenberg, & Grohmann, 2003). Subjective norms and perceived behavioral control are inseparable concepts, in the overall process of transition from belief to behavior.

The concept of consumer purchase intention is commonly applied in measuring marketing effectiveness (Andrews, Akhter, Durvasula & Muehling, 1992; Beerli & Santana 1999, Li, Daugherty & Biocca, 2002) and as metric for prediction of consumer purchasing behavior (Bonnie, Teresa, Yingjiao, & Raul, 2007). Literature in the field has indicated that attitude (Laroche, Kim & Zhou, 1996; Pope & Voges 2000; Prendergast & Hwa 2003), knowledge (Anand, Holbrook & Stephens, 1988; Heath 1990; Laroche et al., 1996; Chang, 2004), innovativeness (Bopeng Zhang & Jung-Hwan Kim, 2013) and demographics (Prendergast et al., 2003) have a significant impact on consumer purchase intentions. The consumer's intention to buy a specific brand is also determined by attitudes toward alternative available brands (Simonson & Tversky 1992; Malhotra 1986; Nantel 1986). Furthermore, with the increasing popularity of online shopping, businesses now try to expand their competitive advantages by focusing their resources on the virtual business environment. Currently, the line between the virtuality and reality is increasingly becoming more obscure due to continual progress in computing. The extent to which users can clearly and easily see themselves using a product affects their expectations to purchase it especially when object interactivity leads to higher purchase intentions (Schlosser, 2003).

A closely related extension of TRA but specifically applied to human technology adoption behavior is the Technology Acceptance Model (TAM) (Davis,

1989). The model is concerned with understanding users' technology acceptance decision factors in order to explain users' behavior. Davis (1989) and Davis et al. (1989) suggested that users will produce a spontaneous decision to accept a new information technology based on the replaced TRA's attitude measures with the two technology acceptance measures - ease of use and usefulness. Perceived usefulness refers to the subjective probability that using a specific application system will increase a given task performance while perceived ease of use is concerned with the degree to which a prospective user expects that interacting with a given system will be free of effort. For example, Koufaris (2012) applied TAM to examine how emotional and cognitive responses to visiting a virtual store can influence the likelihood to make unplanned purchases. The findings indicate that since consumers are also computer users, and businesses are now virtual stores there are two significant variables to be considered to assure customer retention: experience and enjoyment. Furthermore, in the context of virtual shopping, other studies' application of TAM indicate that attitude exerts a positive effect on behavioral intention (Bruner & Kumar, 2005). In a study by Al-Rafee and Cronan (2006), attitude was found to be the most significant construct in influencing behavioral intention. Therefore, the more positive a consumers' attitude towards online shopping, the higher the intention he or she has to engage in making a purchase (Ahn, et al., 2004). Forming attitudes and behaviors in marketing contexts along with purchase intentions, has been shown to be influenced also by arousal (Lee, Suh & Whang, 2003), pleasure (Holbrook & Hirschman, 1982; Hartman, Shim, Barber, & O'Brien, 2006), usability and perceived interface aesthetics (Vidgen & Barnes, 2006, Tractinsky, 1997, Kurosu & Kashimura (1995), brand personality (Aaker, 1997; Freling & Forbes (2005) and perceived risk (Li & Huang, 2009; Tan, 1999). Therefore, the current study attempts to develop a research strategy to explore the effects of several major factors which are identified by prior studies on purchase intention in virtual contexts. Accordingly, the research hypotheses are discussed in the following sections.

2.4.1.1 Consumer product experience

Designing memorable consumer experiences has become a key objective in today's retailing environments. The importance of consumer experience was highlighted by Morris Holbrook and Elizabeth Hirschman's in an article where they discussed how

emotional experiences are linked to products and services (Holbrook et al., 1982). Throughout the years consumer research expanded its view from the prevailing belief of considering customers just as rational decision makers. Simultaneously, the concept of experience became an essential part in understanding consumer behavior in disciplines such as economy (Pine & Gilmore, 1999), where experience was seen as the forth economic offering after commodities, goods and services, and marketing, where consumers were considered emotional human beings, concerned with achieving pleasurable experiences (Schmitt, 1999). Experiences are extraordinary (LaSalle & Britton, 2003), memorable (Pine et al., 1999) or holistic, integrating individual experiences such as sense, feel, think, act or relate (Schmitt, 1999).

More recent research has discussed how consumers obtain information about a product through either direct or indirect experiences (Meyer & Schwager 2007, Daugherty, Li & Biocca, 2008). A direct product experience has been described as “an experience that stems out of an unmediated interaction between the consumer and the product, with a person's full sensory capacity, including visual, auditory, taste-smell, haptic and orienting” (Gibson, 1966) and is believed to provoke greater confidence in consumers’ product choices (Hoch & Deighton, 1989). Direct experience is the primary way of forming attitudes towards products due to the fact that it provides information which cannot be accessed otherwise, generally occuring “in the course of purchase, use, and service and is usually initiated by the customer (Meyer et al., 2007, p. 118). Inspecting a product directly also allows consumers to obtain more believable information than indirect experiences, for example as in product trials. Product trials have demonstrated greater consistency between consumers’ attitudes and behavior (Smith & Swinyard, 1983) as well as greater belief confidence (Smith & Swinyard, 1988) than exposure to indirect experiences (e.g. advertising). Indirect experience, on the other hand, is described as “unplanned encounters with representatives of a company’s products, service or brands and takes the form of word-of-mouth recommendations or criticisms, advertising, news reports, reviews and so forth” (Meyer & Schwager, 2007, p. 118). Although indirect experiences communicate mainly verbal information, it should be acknowledged they are useful in reducing perceived risks.

Currently, computer simulations have allowed for a new type of experience – the virtual one, or the "psychological and emotional states that consumers undergo while interacting with products in a 3D environment" (Li, Daugherty & Biocca, 2001,

p.1). Virtual experiences are computer-generated experiences that try to mimic physical experiences and generate a lifelike impression that the consumer is actually present in the virtual environment. It has been suggested that the more authentic the virtual product or brand experience appears to be - the more likely users are to experience feeling of presence in a virtual environment (Li et al., 2001; Chin & Swatman, 2005).

Besides its common factor of interactivity in virtual experiences both direct and indirect experiences can take place (Hoch et al., 1989). Also novelty of 3D products visualization is found to heighten situational interest, increase involvement, and result in a favorable attitude toward the experience (Li et al., 2001). In addition, research has argued that interaction with 3D technology used in websites for products and brands has the capacity to affect product knowledge, purchase intentions, and brand attitudes (Li et al. 2001, 2002; Suh & Chang, 2006). Specifically, Daugherty et al., (2008) tested empirically the impact of consumer exposure to indirect, direct, and virtual experiences on brand attitude, product knowledge, and purchase intention when evaluating a physical product. The results reported a higher level of product knowledge after subjects were engaged in a virtual experience, than they did after an indirect or direct experience separately. Considering these findings, the authors argued that the higher level of product knowledge led to a significantly positive effect on attitude and purchase intent. In other words, virtual experiences created by 3D environments are noted to show better result in tests than indirect experience created by traditional media. Moreover, in 3D product demonstrations, as opposed to still images, buyers are predisposed to spend more time viewing the products, with bigger probability of purchase (Daugherty et al., 2008).

Often the terms virtual experience and virtual reality experiences are used interchangeably, however the first term addresses a much broader concept. As explained above, a virtual experience has the properties of an imitation of a real-world experience which occurs within a computer-mediated environment, and has been described to be located between direct and indirect experience along the spectrum of consumer learning (Li et al., 2001). However, virtual reality experiences create a sense of full immersion to the user where he or she cannot perceive the real world anymore. Contrarily, Augmented Reality experiences allow the user to perceive the real environment, which is enhanced with virtual objects. Thus, AR supports reality instead of replacing it by a virtual one. In this sense AR is closer in properties

to a virtual experience in that it combines the features of a direct and indirect experience together, however it differs in that the user is present in real time in a real world. Allowing consumers to interact with a product in an AR experience virtually may demonstrate higher effectiveness towards purchase intention. In this study, the two experiential conditions (AR Marker-based and AR Markerless) are compared with the control condition in order to evaluate possible differences among groups.

The following subsections provide overview of relevant constructs to be explored in the study for the purpose of assessment of the experiential event. For this thesis, participants are divided in low and high segments, according to their score on each variable under investigation. More specifically, the variable is dichotomized into "high" and "low" values through a split at the level of the median. Participants with values below the median fall into the "low" consumer profile segment, while the participants with values above the median – into the "high" consumer profile segment. By doing so, consumers are described categorically, grouped according to a given condition according to participants' domain specific innovativeness, emotions, information seeking, arousal levels, system usability evaluation, perceived interface aesthetics and brand personality.

2.4.1.2 Innovativeness

The concept of innovativeness refers to "interindividual differences that characterize people's responses to new things" and is constituted by least three realms: Global innovativeness, Consumer Innovativeness and Domain-specific Innovativeness (Goldsmith & Foxall, 2003, p. 324). Global innovativeness is a personality trait which manages consumers' judgment and willingness to try new things. Having a high degree of Global innovativeness increases the likeliness of being more receptive towards new experiences and novel stimuli (Goldsmith, 1984). Two courses of measurement of Global innovativeness has been commonly adopted in literature: cognitive innovativeness and sensory innovativeness. Cognitive innovativeness represents either internal or external thinking, stimulated by pleasurable new experiences while sensory innovativeness is a tendency that encourages pleasure through internal experiences like wishful thinking, dreaming or risky activities (Venkatraman & Price, 1990).

Consumer innovativeness is defined as being the first to buy new products and is related to characteristics such as marketplace knowledge, opinion leadership or price insensitivity (Goldsmith & Foxall, 2003). It explores how consumers embrace innovation. Adoption of innovations depends on consumer innovativeness because innovativeness introduces the innovation to the social system (Grewal, Mehta & Kardes, 2000, p. 234). Adoption of new products can be explained through the concepts of Domain Specific Innovativeness (DSI) since consumers evaluate new products based on a specific domain of interest (Goldsmith & Hofacker, 1991). DSI is defined as "the tendency to learn about and adopt innovations (new products) within a specific domain of interest" (Goldsmith & Hofacker, 1991). DSI is found to be the most useful scale to measure consumer innovativeness in a specific product category (Citrin, Sprott, Silverman, & Stem, 2000; Hynes & Lo, 2006). Further, Roehrich (2004) considers DSI as "intermediary" between innate innovativeness and the adoption of new products while Goldsmith, d'Hauterville, and Flynn (1997) note that the DSI scale is appropriate to measure the relationship between consumer innovativeness and new product adoption. The positive effect of personal innovativeness on the intention to use has also been confirmed within the context of AR (Yussof, Ibrahim, Zaman, Ahmad, & Suhaifi, 2011).

2.4.1.3 Emotions

Emotions communicate self-relevant changes in the environment (Lazarus, 1991), facilitate rational decision-making (Damasio, 1994), provide internal cues about the goodness or badness of the environment (Schwartz & Clore, 1983), and coordinate thoughts (Oatley & Johnson-Laird, 1987) and behavioral responses (Frijda, 1987) to self-relevant events.

The impact of emotions on judgments and decisions has long been important to consumer psychology and behavior. The study of consumption related emotions has received increased attention from consumer-behavior researchers. Previous studies have concentrated on human emotions (Niemic, 2002), the effect of emotions on consumer behaviour (Laros & Steenkamp 2005; Watson & Spence, 2007) and behavioural intentions (Smith & Reynolds, 2009), emotional response to advertising (Hill, 2010) and to product evaluation (Howard & Gengler, 2001).

When feelings are discussed, inseparable constructs in consumer psychology are those of affect, emotions and moods (Kidwell, 2004). Emotions experienced before, during and after interaction with a product or service are equally important and have an impact on the whole shopping experience. Emotions are critical predictors of satisfaction, word of mouth intentions, and service-quality perceptions (White, 2010). Researchers have also demonstrated that different emotions with similar valence and levels of arousal can lead to very different consumption-related behaviours (Watson at al., 2007). Mattila and Wirtz (2000) argue that when a customer enters into the core delivery of the service in a positive affective state, they will tend to perceive the entire service experience in a more positive manner. This is due to feelings and moods being linked to positive memory associations. Individuals who are in a positive emotional state have been shown to evaluate products more favourably than individuals who feel neutral or negative emotions (Smith & Bolton, 2002). Conversely, negative affective states are also related to negatively toned cognitions, the result of which is that the consumer is more likely to evaluate the experience as poorer than expected (Mattila et al., 2000).

Moods can also affect judgments and, in turn, influence consumer behavior. People are assumed to use their mood as a basis for making judgments. Prior research in marketing has established that also consumers' mood state influences their immediate product evaluations (Mattila et al., 2000). Positive mood can increase consumers' preferences for products – the positive affect of one person can have an effect on the product attitudes of others (Howard et al., 2001; Loken, 2006). A positive mood state may increase motivation to engage in relational elaboration. Some researchers also suggest that consumers might be willing to make decision errors in order to maintain a positive mood. Other research shows that if the stakes are high, consumers will forego short-term mood maintenance for longer-term gains or will even maintain a negative mood if it will improve task performance (Loken, 2006).

With the competitiveness in the market today, industries are seeking in-depth understanding of the factors influencing consumers at the emotional level. Identifying the emotional elements that consumers experience and expect in a product provides a complete perspective on consumer affective behaviors. Researchers attempted to define terminologies associated with emotions and developed comprehensive lists of emotions involved in an overall consumption experience. One of the most commonly

used concepts to describe the experience of emotions is affect intensity. Affect intensity is defined as “stable individual differences in the strength with which individuals experience their emotions” and is considered to be an important predictor of mood experience (Larsen & Diener, 1987, p. 2). Affect intensity is usually measured by means of the 40-item Affect Intensity Measure (AIM) (Larsen, 1984) but has been criticized to measure intensity frequency of emotions simultaneously (Bachorowski & Braaten, 1994). To overcome the problem of frequency and intensity of emotions being confounded in one scale, Braaten and Bachorowski (1993) and Bachorowski and Braaten (1994) presented a new scale with different items, the Emotional intensity Scale (EIS). This scale is explicitly meant to provide a measure of affect or emotional intensity independent of the frequency of occurrence of emotions.

In Consumer psychology emotions are considered a central component towards customer loyalty, which decreases price sensitiveness and the threat of conversion to competitors (Kotri, 2011) as opposed to negative emotions which are usually the result of an unfavorable service experience. Customers who have positive emotional responses are more likely to develop committed relationships with the service provider (Tronvoll, 2011). Company owners need to focus on developing the aspects of their offerings that stimulate positive emotions, as customers are highly likely to say positive things about a company, have increased willingness to pay more for the services they receive, and be less likely to turn to competitors (White & Yi-Ting, 2005).

2.4.1.4 Arousal

Arousal is essential in all mental functions, contributing to attention, perception, memory, emotion and problem-solving. A generally accepted definition of arousal has not been yet been agreed upon but it has been outlined as “a condition conceived to vary in a continuum from a low point in sleep to a high point in extreme effort or intense excitement" (Duffy, 1962, p.5). Arousal is associated with both a physiological response (e.g., an automatic reaction to a stimulus) and cognitive processes (e.g., judgment), and it has been described as a non-specific component of motivation which reflects intensity rather than direction of motivation (Humphreys & Revelle, 1984) or the valence of affect (Whissell, Fournier, Pelland, Weir, & Makarec, 1986). It is possible that heightened arousal will lead to an increase in motivation in

a range of behaviours, as directed by environmental context (Antelman & Caggiula, 1980; Brehm & Self, 1989; Katz, 1978).

Researchers have been interested in pleasure and arousal in order to capture the emotional reactions to stimuli. In marketing theory, it is suggested that every process of decision making starts with the arousal of a specific need, which a person subsequently intends to satisfy by a particular purchase (Assael, 1995). Previous studies have shown that arousal and pleasure are causal factors explaining variations in consumer's behavior and their decision making (Holbrook & Garderner, 1993; Hui & Bateson, 1991). In terms of innovative technology, pleasure refers to the degree to which a user feels good or happy with the usage of an object while arousal concerns the degree to which a user feels excited, stimulated, or active from using it (Kim et al., 2004; Lee, Ha & Widdows, 2011). Lesser and Kamal (1991) found that heightened positive arousal was a crucial mediating variable in consumers' motivations to purchase. From a psychophysiological point of view, arousal is a fundamental feature of behavior and an integral part of the emotional process. It is also a feeling of activation, varying from drowsiness to excitement (Mehrabian & Russell, 1974). Excitement, alternatively, is described as one of the specific affective states associated with impulsive buying (Rook & Gardner, 1993). In addition, it has been argued that dynamic design features are also related to increases in arousal. For example, testing of the effects of moving and still images reported that image motion was associated with raise in both self-reported and physiological arousal (Detenber, Simons & Bennett, 1998; Simons, Detenber, Roedema & Reiss, 1999). Also, the number of physiological and psychological responses were significantly affected by the animation speed of dynamic banners in websites, with faster ads resulting in higher arousal levels (Sundar & Kalyanaraman, 2004). Raney, Arpan, Pashupati & Brill (2003) showed that increasing the entertainment value of a website leads to more arousal, a more positive site evaluation and a greater intent to return to the website. Therefore, it is hypothesized that:

H_{1a}: Within the high Innovativeness adoption consumer profile segment, the participants in AR the Markerless condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions.

H_{1b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions.

H_{1c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions.

H_{1d}: Within the low Perceived Risk consumer profile segment, the participants in the AR Markerless condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions.

2.4.1.5 Responsiveness

Sales is arguably the key measure of success of advertising and predicting behavioral measures of success from responses is crucial. Besides their intensity, responses can be characterized by their polarity (i.e., pleasure versus displeasure). For example, Goldberg and Gorn (1987) found that commercials were better remembered when placed in a happy TV program than when placed in a sad program. Isen (1984) argued that positive affective states produce changes in cognitive organization that enable a more efficient processing. Specifically, people in a happy state categorize material in fewer but broader categories. This use of broader categories allows them to organize the material more efficiently and consequently to memorize it better. It is believed that event-induced pleasure will have a positive effect on the recognition of interface stimuli.

Responsiveness in this study refers to how participants evaluate visual stimuli from an interface. Design visuals are of major importance for a system and are "…the conscious design of web environments to create positive effects in consumers in order to increase a favorable response" (Daily, 2004, p. 795). However, as it has been explained previously, consumers' intention to purchase is also influenced by the level of arousal produced by merchandising aspects, e.g. product information and consumer reviews and opinions (Jayawardhena & Wright, 2009). The hypothese derived are:

H_{2a}: Within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.

H_{2b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.

H_{2c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.

H_{2d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.

2.4.1.6 Perceived interface aesthetics and usability

A core and an inseparable part in every system is its interface design or its aesthetics. Users' perceptions of interface aesthetics are closely related to the usability of that interface. Perceived usability of a system relies heavily on the role aesthetics plays in the perceived usefulness of the system (Tractinsky, 1997). Research has suggested that aesthetics may significantly increase the acceptance of a system. Specifically, in their study Kurosu and Kashimura (1995) investigated the relationship between users' aesthetic perceptions and their initial perceptions of a system's usability to find that apparent usability has a greater correlation with aesthetics than inherent usability. This indicated that users tend to expect what they perceive as beautiful to naturally perform better. What this means is that it is important to acknowledge role aesthetics plays in interactive systems. On the other hand, in order for a system to provide a successful user experience, Dumas and Redish (1994), argue that there are certain principles to be followed by designers (p. 300). Identifying final users by initially studying their cognitive, behavioral, anthropometric and attitudinal characteristics is the first phase before actually designing a system. The second phase involves observing, recording and analyzing reactions of intended users after testing a given prototype. The final phase in achieving a robust system is concerned with a repeated cycle of designing, testing and measuring. Those guidelines stress the importance of investigating the

aesthetics aspect of user interface design and its relationship to other aspects of a system, including usability. Furthermore, it has been argued that visual aesthetics of user interfaces is a strong determinant of users' satisfaction and pleasure (Tractinsky, 2004). User satisfaction and pleasure become strong predictors of the intention to purchase products online. Therefore is it hypothesized that:

H_{3a}: Within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, account for higher Perceived interface aesthetics evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{3b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, account for higher Perceived interface aesthetics evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{3c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, account for higher Perceived interface aesthetics evaluation, compared to AR Marker-based and purely interactive conditions.

H_{3d}: Within the low Perceived Risk consumer profile segment, the participants in the AR Markerless condition, account for higher Perceived interface aesthetics evaluation, compared to AR Marker-based and purely Interactive conditions.

Usability, also refered to as "ease of use" is an inseparable part of any designed interactive user experience and incorporates user navigation, information search and actual site interaction (Goto & Cotler, 2002; Wood, 1998). One common definition explains that "usability means that people who use the product can do so quickly and easily to accomplish their own tasks" (Dumas & Redish, 1994, p. 4). Furthermore, Nielsen (2002), states that ease of use is the first priority of interface design. He defines usability in terms of five characteristics, namely (1) learnability; (2) efficiency; (3) memorability; (4) errors, and (5) satisfaction (Nielsen, 1993, p. 26). Learnability refers to the initial ease of accomplishing basic tasks. Efficiency and memorability are concerned with the speed of performing tasks after first use and after period of time respectively. Errors give information on how easy users can recover actual errors they make and satisfaction is concerned with design pleasantness. Similarly, Rosson

and Carroll (2002) identify three perspectives that contribute to the general concept of usability such as (a) the human performance, time, and errors (b) the human cognition, mental models of plans and actions and (c) the collaboration, group dynamics, and workplace context (p.10).

Apart from technological properties, research has shown that purchase intention has a strong relation with interface usability. Perceived ease of use for online purchasing refers to the degree to which the prospective consumer expects the online purchases to be free of effort (Vidgen & Barnes, 2006). The Technology Acceptance Model (TAM) considers a user's attitude toward a technology to be determined by the perception of usefulness and ease of use of that technology and that this attitude influences the intention to use the technology (Smith, 2004). In line with this research, Olsson, Kärkkäinen, Lagerstam & Ventä-Olkkonen, 2012) studied the perception of early adopters of AR systems and stated that "the most valuable mobile AR services were those demonstrating pragmatic usefulness for the user, e.g. by saving time and effort" (p. 43). The authors inferred that in order for AR adoption to occur, users need to see rich and high quality information that is contextually relevant to them. Olsson et al. (2012) concluded that the importance of information quality is critical for users' acceptance of AR.

Creating systems with high usability features that encourage purchasing and repeat visits is an important objective for interactive environments (Vassilopoulou, Keeling, Macaulay & McGoldrick, 2001). Furthermore, contemporary view on usability has changed from the early days of HCI, in the sense that the rise of networked digital media (e.g., web, mobile, interactive TV, public installations) has added novel emotional concerns for HCI, translating usability in to an overall user experience (Cockton, 2013). Therefore, the following hypotheses have been derived:

H_{4a}: Within the low Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{4b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{4c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{4d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.

2.4.1.7 Organization

Organizational issues are at least as important as technical issues for a system interface. The user interface is the central point of user interaction with the application. Users rate the credibility of the medium they explore based on visual characteristics such as appearance, interface design and organization of information (Wathen & Burkell, 2002). Consistent interfaces allow users to develop usage patterns, for example what the different buttons, tabs, icons and other interface elements look like and will recognize them and realize what they do in different contexts. Users also learn about functionality and are able to operate new features quicker, extrapolating from the previous experiences. Organization of an interface has major influence on system evaluation, therefore:

H_{5a}: Within the low Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{5b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{5c}: Within the high Information seeking information consumer profile segment, the participants in the AR Markerless condition account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{5d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions

2.4.1.8 Interface evaluation

A crucial aspect in achieving success in implementing systems for experience is acceptance. In this scope, the system's user interface is critical, as even minor problems will demotivate users, thus undermining the use and success of the system. Humans have poor short-term memory, i.e. they have a limited ability to search and interpret textual and or tabular data (Miller, 1994). On the other hand, humans can interpret a visual scene in a matter of milliseconds. If the visual scene is pleasant and the content is fun users will enjoy the experience more, as opposed to having a hardship with a boring time. Fun is an "absolutely primary category of life, familiar to everybody at a glance" (Daniels, 1995). Research has revealed that fun has an effect on the perception of time, which often seems shortened when one is having enjoyable experience. In an experiment by Sackett et al. (2010) participants were exposed to a boring task while let believe that it had lasted half an hour - as long as it really had. They thought it was more enjoyable than those who had been doing exactly the same task but who hadn't been told about how much time had passed. Evaluation of an interface is especially important in pre-testing stages of an interface system. For this experiment two aspects will be observed: "fun" and "boring".

H_{6a}: Within the low Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{6b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{6c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{6d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.

H_{7a}: Within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, exhibit lower level of Boredom compared to AR Marker-based and purely Interactive conditions.

H_{7b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, exhibit lower level of Boredom compared to Marker-based and purely Interactive conditions.

H_{7c}: Within the high Information seek consumer profile segment, the participants in the AR Markerless condition, exhibit lower level of Boredom compared to Marker-based and purely Interactive conditions.

2.4.1.9 Brand personality

Consumers are capable of establishing symbolic relationships with brands in a way similar to the one they develop among each other in a social setting. Aaker (1997) defined brand personality as a “set of human characteristics associated with a brand” (p. 347). A broader definition of brand personality was suggested by Allen and Olson (1995) who illustrated brand personality as “the specific set of meanings which describe the ‘inner’ characteristics of a brand. These meanings are constructed by a consumer on the basis of behaviour exhibited by personified brands or brand characters” (p. 393). The authors argued that consumers attach personality characteristics to brands through inferences based on observations of “brand behaviour”, with brand behaviour linked to everyday life situations. Accordingly, brand personality appears to be a mirrored human personality (Azoulay & Kapferer, 2003). Often various personality qualities are assigned to brands such as that the brand can be extrovert, friendly, conscientious, old-fashioned, modern, exotic, etc. (Pantin-Sohier, 2009).

Moreover, brand personality offers consumers the means of constructing and maintaining social identity (Fiske, 1989). It allows the consumer to express his own

self (Belk, 1988) or his ideal self (Malhotra, 1988). Freling et al., (2005) argue that brand personality is established in consumers' perceptions as well as experiences (p.158). By assigning human characteristics to non-human objects, brand personality provides consumers with emotional fulfilment, thereby increasing purchase intention (Freling et al., 2005, p.155). Generally, powerful brand images enhance perceptions of quality, reduce perceived risk and moderate the consumer inclination to make decisions solely based on price. Also, a rationale for studying brand personality for this thesis is the evidence of an existing significant link between brand personality and outcome variables, such as preference (Aaker, 1999), emotions (Biel, 1993), and attitude (Guthrie & Kim, 2009). Experiences can be positively but indirectly associated with relational benefits where brand familiarity, brand image and brand personality can serve as mediators in the brand experience (Xu, Zhang & Tang, 2011). Taken together, these factors all improve consumer purchase intentions. For this study the constructs of "daring" and "contemporary" will be studied. Accordingly, the following hypotheses are proposed:

H_{8a}: Within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, exhibit higher Daring levels compared to AR Marker-based and purely Interactive conditions.

H_{8b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, exhibit higher Daring level compared to AR Marker-based and purely Interactive conditions.

H_{8c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, exhibit higher Daring level compared to AR Marker-based and purely Interactive conditions.

H_{8d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, exhibit higher Daring level compared to AR Marker-based and purely Interactive conditions.

H_{9a}: Within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.

H_{9b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.

H_{9c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.

H_{9d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.

2.4.1.10 Perceived risk

Perceived risk refers to the degree of ambiguity about the nature and extent of loss and was first discussed by Cox and Rich (1964) as the overall amount of uncertainty and consequence perceived by a consumer in a particular purchase situation. Uncertainty comes from the difficulty of identifying buying goals and matching these goals with product or brand offerings. Uncertainty may result from factors inherent in the product, the place of purchase or the mode of purchase. The consequence, on the other hand is associated with: a) functional or performance goals, b) psychosocial goals and c) the means such as money, time, and effort invested to achieve those goals (Cox, 1967).

Jacoby and Kaplan (1972) classified consumers' perceived risk into the following five types of risk: financial, performance, physical, psychological, and social risk. Chaudhuri (1998) stated that low levels of perceived risk in products are related to high levels of positive emotional experiences during consumption. Perceived risk has been found to be one factor which could affect users' adoption of online services. Previous research has merged perceived risk as a variable with technology predicting models, such as TAM, and found that perceived risk could be one of the predictor

variables which can forecast technology adoption (Dowling & Staelin, 1994; Kim, Ferrin & Rao, 2009; Lu, Hsu & Hsu, 2005).

As the sense of touch is absent in electronic environments and as in most cases inspection of products is done in two dimensions, products received by consumers may not function as expected initially. Also, handling and shipping expenses are often paid by the buyer warranty issues may also be present, as well as upon completion of purchase consumers may encounter better offerings for the same product. These types of risks, perceived by consumers are categorized in two dimensions of uncertainty, namely behavioral and environmental (Bensaou & Venkataman, 1996; Pavlou, 2003). Those dimensions encompass economic risk, personal risk, seller performance risk and privacy risk. Therefore, consumers will be willing to make a purchase online only if they are convinced of the low effect of the risks involved (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975).

Previous studies have attempted to explain how moods affect consumers' cognitive judgment and decisions (Chebat & Michon, 2003; Michon, Chebat & Turley, 2005). People in a positive emotional state would usually perceive a lower extent of loss or risks (Fedorikhin & Cole, 2004). Therefore, it is believed that having a pleasant and engaging experience would amplify customers' shopping desires, compliment the quality and images perceived, and heighten the pleasure and arousal they receive in mind.

Chapter 3

Research methodology

Methodology is the framework associated with a particular set of paradigmatic assumptions that one uses to conduct research, such as scientific method, ethnography and action research (O'Leary, 2004, p.85), that reflect the research question and suit the researcher purpose. This section provides justification for the selection of research design, the system of methods and procedures derived to interpret and solve different problems within the scope of the study.

Section 3.2 discusses qualitative, quantitative and multi method research; section 3.3 focuses on the methods; sections 3.4, 3.5 and 3.6 discuss the selection of research design, the variables used and the design's construction; section 3.7 discusses the use of a Focus Group; section 3.8 talks about the group design; section 3.9 is concerned with the questionnaire pre-test; section 3.10 focuses on the selection of the participants in terms of population and sampling; section 3.11 outlines the experimental procedure including the setting, instruments and technology used in the study; section 3.12 discusses the validity of the study; section 3.13 discusses how the data was processed and analysed; in sections 3.14 and 3.15 ethical considerations and study limitations are summarized.

3.1 Introduction

An extensive amount of research in advertising and marketing has distinguished the importance of emotions in decision making and consumer behaviour (e.g., Ambler, Ioannides & Rose, 2000; Ambler & Burne, 1999; Du Plessis, 2005; Hall, 2002; Haimerl, 2008). Emotions elicited by advertising play a crucial role in brand associations and determine vastly the chances of a brand being selected. Advertising that produces a strong emotional response remodel brand perceptions and help generate engagement and recall. With over half of the human cerebral cortex devoted to visual processing (Michelon & Koenig, 2002), representing visually objects, thoughts or ideas is the most powerful way of generating emotions.

An attention-capturing and innovative approach to have visual representations displayed realistically in a 3D form and in real-time was the recent advent of AR technology for commercial use. The implementation of AR as an alternative advertising format has been recognized to provide captivating and entertaining experiences due to the capacity of the technology to link virtual information to user's sensory perceptions. AR can effectively contribute towards winning customers on an emotional level, as it may strengthen the positive customer-brand relationship (Owyang, 2010) and increase satisfaction through the creation of perceived experiential value (Yuan & Wu, 2008). However, the effect of advertising on consumers' emotions and feelings, rather complicated to measure, is often left unidentified. To attain on this matter and to produce a more accurate metric to study consumer's emotional reactions to a brand, this study explored results gathered from conscious and unconscious engagement tests where participants were exposed to key facets of the brand (e.g. logo).

The complexity of the research problem at hand is explained partly by the participation of different disciplines such as psychology, sociology, marketing or economics and partly by the necessity to explore the topic from various angles. In order to reach a decision on how to approach this intricate matter multiple perspectives of consumer behavior had to be intercrossed - antecedents of consumer purchase intention, impact of new technology in advertising, the various aspects of consumer psychology, such as emotions, arousal, consumer involvement, memory as well as knowledge. Evaluating the effectiveness of models of advertising in AR

compared to simpler platforms, selecting specific test instruments for the development of new consumer psychological profile and assessing which characteristics best explain participants' cognitive and emotional reactions to AR required a robust methodological approach to cover all aims and objectives of the study.

The subsequent part of this chapter outlines the methodology of the research project, used to develop an evaluation framework to measure the effectiveness of three different systems of advertising from an array of perspectives. The intention is to layout the structure of the research project and to describe how the major parts of the study address the central research questions by introducing the aims and objectives of the research, selecting the research design, describing the research methods, introducing the procedure of designing the instrument, collecting the data, and providing arguments on its' internal and external validity. The chapter also defines on whether qualitative, quantitative, or a synthesis of both methods was found to be a better approach for achieving the research aims. Argumentation about the type of data, design techniques (focus group, observation, study instrument and experiment), sampling method and procedures is provided in the course of gradually unfolding the overall process.

3.2 Qualitative and quantitative and multimethod research

After the research aims and objectives have been stated (Chapter 1), central task in a research project is to identify and use suitable tools and techniques (O'Connor, 2001). These tools may be either qualitative, quantitative or may use a mixed-method. Qualitative research presents findings in textual form (Baxter & Babbie, 2004), while quantitative research is characterized by the use of larger samples, standardized measures, a deductive approach, and highly structured interview instruments to collect data for hypothesis testing (Marlow, 1993). Hence, both types of research have distinct features, but their employment depends largely on the particular priorities and aims of the research project.

Malhotra et al., (2012) define qualitative research as primarily exploratory design based on small samples, intended to provide insight and understanding and seeking to uncover the behavior, experiences and feelings of respondents. In investigating processes of complex human systems, such as in communities,

qualitative methodology may often be an appropriate research strategy (Reid, 1987). Commonly used together with other approaches like field research, qualitative inquiry describes the systematic observations of social behavior with no preconceived hypotheses to be tested (Rubin & Babbie, 1993) but observing and analyzing human behavior lead to the their generation. Principally, qualitative research is effective in obtaining culturally specific information about the values, opinions, behaviors, and social contexts of particular populations (Mack, Woodsong, MacQueen, Guest & Namey, 2005). Qualitative research is based on the constructivist view which conceptualizes that researchers and participants construct their own social realities in relation to one another. Reality is seen as subjective and experiential and does not engage in determining a connection between cause and effect. Qualitative research employs inductive reasoning by building theories from units of data. Accounts on reality are restricted to the time frame and context of the study, so generalizability is limited to transferability of results from one context to another (Teddlie & Tashakkori, 2009).

Quantitative techniques, on the other hand, are normally concerned with determining the relationship between an independent and a dependent variable in a population. Quantitative research is derived from the positivist paradigm where objective, hypothesis driven, and measurable research is supported. This process pursues to uncover causality where a given effect is a consequence of a cause. Bryman (2004) describes quantitative research as exhibiting a view of the relationship between theory and research as deductive, a predilection for a natural science approach, and as having an objectivist conception of social reality. Quantitative research explains a phenomenon by collecting numerical data that are analyzed using mathematically based methods, like statistics (Aliaga & Gunderson, 2002).

In order to preserve the strengths and reduce the weaknesses in each of qualitative and quantitative approaches a mixed method can be applied (Bergman, 2009). Problems most suitable for mixed methods are those in which the quantitative approach or the qualitative approach, by itself, is inadequate to develop multiple perspectives and a complete understanding about a research problem or question (Creswell, Klassen, Plano Clark, & Smith, 2011a). However, Cronholm & Hjalmarsson (2011) argue that a study of this type might require a research team instead of one researcher due to the fact that qualitative and quantitative research

are used concurrently. Even though mixed methods can be more beneficial for the overall outcome of a study they are more time consuming and more expensive to execute. An appropriate procedure to answer the questions positioned in this study, involving measurements of controlled experiment against a control sample and a test of hypothesis in a feasible manner, implied the adoption of a more straightforward approach.

The choice between research methods fundamentally depends on the array of decisions about the research questions in the study and collecting the appropriate kind of data that will answer them. Considering the above recommendations, this study holds the understanding that a qualitative research is useful during the early stages of the investigation process in order to gain more detailed and rich information in the form of comprehensive descriptions and observable attestation. Obtaining a more adequate understanding of the topic under study required that information is collected in context through a closer, immersive approach, e.g. empirically. Focus group interviews, participant observation and self-reports of knowledge and attitudes were adopted as sources of data collection in qualitative research. This approach helped to explore affect on participants by considering social meaning and context. As it assists in preliminary insights into building models and scale measurements (Hair, Bush & Ortinau, 2006), qualitative research was useful in developing an approach for profound investigation.

Although qualitative methods are generally rich in narrative and description, they tend to discuss the overall process instead of providing an outcome. Their strong points are in describing individual experiences or group norms in a flexible manner, allowing the researcher to be absorbed during a session. However, for this study, an immersive approach with a heavy involvement on the side of the researcher was not insured by a biased view of the situation, such as in the focus group test. Also the acknowledged lack of generalizability, reliability and validity in qualitative research required the use of other determinable techniques to vindicate the initial findings of the study. Incorporating quantitative instruments allowed detailed measurement and analysis of data as well as a comprehensive study of the relationship between an independent and dependent variables. Also, the main aspects under investigation such as young consumers' emotional self-assessment, top of mind awareness, brand comparison and attitudes required quantitative tools to project results to a bigger population. According to Morse (2003), "by using more

than one method within a research, we are able to obtain a more complete picture of human behaviour and experience which enables us to broaden the dimensions and hence the scope of the research project".

Objectivity in the findings of the research, ability to test hypotheses and measure data statistically, are the main advantages of quantitative research. Yet, quantitative research tends to ignore the context of the experiment and does not review the different meanings items have for participants in the same way as qualitative research does. Thus, it was considered that a combination of methods, such as in a multimethod manner may provide means of improving research process and findings. Multimethod research is a paradigm already established in science which combines together rather "independent" qualitative and quantitative parts to unite the main components of one research program (Mingers, 2001; Morse, 2003; Hunter & Brewer, 2003). Specifically, multimethod design "is the conduct of two or more research methods, each conducted rigorously and complete in itself, in one project" (Morse, 2003, p. 190). It is a strategy to deliberately combine different types of methods by overcoming each method's weaknesses (Hunter & Brewer, 2003, p. 578). Multimethod research uses different approaches or methods in simultaneously or sequentially but they are not integrated until inferences are made. It is not to be confused with Mixed methods research, which integrates more than one approach or method during the program of study, and not just at its concluding point. Mixed methods research is sometimes used as a generic term to include both mixed and multimethod research.

While different research design taxonomies (Morse, 2003; Creswell & Plano Clark, 2010; Teddlie & Tashakkori, 2009) can be useful in delineating a spectrum of possibilities, no model can completely capture the degree of variation which occurs in "real world" research. Morse (2003) argues that research projects may have complex designs containing combinations of qualitative and quantitative characteristics, with one serving as a theoretical drive for the project, depending on the scope and complexity of the research program. Combining qualitative and quantitative data in this study was considered appropriate as it would improve the overall interpretation by ensuring that the limitations of one type of data are compensated by the strengths of another while understanding is bonded by integrating different ways of learning. Following the above recommendations, each part of the project has been planned

and conducted to answer the research questions, while the results were subsequently triangulated to form a broader and more complete perspective.

3.3 Methods

The prime goal of this study was to identify the degree of consumer involvement within an AR application and to compare it with an exposure to more conventional platforms, while investigating the relationship among independent variables (advertising means) and the outcome dependent variable (purchase intention). A combination of both qualitative and quantitative techniques was agreed upon, however gathering information on consumer's experiences of the different treatments required conducting of laboratory tests and pretesting. An experimental approach was found appropriate due to its established capacity to test the effect of an experimental stimulus on a dependent variable through the random assignment of participants to experimental and control groups (Baxter & Babbie, 2004; Hair at al., 2006). The Pretest-Posttest with Control Group design included two separate experimental groups exposed to a treatment condition and a control group not subjected to the treatment conditions under study. The groups were matched in order to be interchangeable for the purposes of the test as well as a supplement to randomization (Hair at al., 2006). Conclusions were drawn from between-subjects experiments by making comparisons among the behaviors of different groups of subjects.

An outset of the research process was a focus group experiment, which was sought to be beneficial to the qualitative part of the research in terms of observation, emerging ideas, attitudes, free debates and knowledge. Focus groups are a well-established tool in providing information simultaneously on how groups of people think, interpret or feel about a given subject while data is collected in a short period of time. The obtained input was carefully studied while various ideas were discussed and some were considered.

As advised in (Smith & Albaum, 2010), the next stage in the research procedure was a questionnaire pretest, performed to assist in the development of the questions and the study measurement instrument. This step assured fine-tuning, learning new insights and adjusting the questionnaire for the main experiment. A questionnaire is the main means of collecting quantitative primary data (Malhotra,

2006) and conducting a pretest helped identify whether the questionnaire measured adequately answers from real survey respondents and if it worked technically well in practice. An independent group of participants was asked to fill the questionnaire about domain-specific innovativeness, attitudes towards the brand, perceived risk, involvement and buying choices regarding sportswear, technologies and brand names. The purpose of the pretest was to determine whether respondents are interpreting questions as intended and whether the order of questions could have influenced responses in any way. As advised in Malhotra (2006) question content, difficulty, wording, form, layout, and instructions were pretested, while the pretest group was similar to the respondents in terms of background characteristics, familiarity with the topic, attitudes and behaviors of interest. The pretest was conducted using the same protocol and setting as the actual experiment.

In the third stage three more groups (two Pretest-Posttest groups and a Control group) of randomly assigned subjects were exposed to three separate conditions to measure the outcomes of different treatments on consumer behavior. The groups were observed and examined under the same controlled conditions. For the analysis of the data, since there were two or more measurements for each of the elements, and variables were analyzed simultaneously, multivariate techniques were adopted (Malhotra et al., 2012). All elements and consecutive procedures for the study were attentively identified and structured together in a system, namely the research design.

3.4 Research design

A research design specifies the details of the procedures necessary for obtaining the information needed to structure or solve marketing research problems (Malhotra et al., 2012). It is a carefully designed process to obtain evidence which addresses the research question and objectives of the study. There are multiple ways to achieve this purpose since the topic of research designs is well established in literature. Research designs are organized in two main categories as exploratory (involving qualitative or quantitative research) or conclusive (involving descriptive or causal research). Often, research objectives can be fulfilled by using conclusive designs, chosen depending on the structure of the research problem (Ghauri & Grønhaug, 2010).

As Churchill (1991, p.127) advises, a marketing research design should be “the framework or plan for a study used as a guide in collecting and analyzing data” and that it should serve as a “blueprint that is followed in completing a study”. Therefore, in this study the research design serves as structured network of all parts and phases of the research project. Failure to develop a solidly structured design might result in providing incorrect answers to the research question under investigation. A research design must ensure that the study is relevant to the research context and employs appropriate procedures (Churchill, 1991; Frankfort-Nachmias & Nachmias, 1992). Reducing personal, procedural, or methodological bias in research design is vital for the entire research process. Hence, developing a sound research design is essential for the overall realization of the study. The following subsections describe briefly the common types of research designs and provide an argumentation about the final choice of design.

3.4.1 Exploratory research design

Exploratory research is not engaged in producing conclusive reports from which a specific course of action can be determined. Instead, it maintains a certain level of flexibility by collecting either secondary (research reports, reference books, articles) or primary data (focus group interviews, experience inquiries, and pilot studies) and uses an unstructured format or informal procedures to interpret them (Hair at al., 2006). Its main purpose is to grasp the nature of given marketing phenomena or define a problem more precisely, especially in cases where the issue of investigation cannot be measured in a quantitative manner (Malhotra et al., 2012).

Exploratory research serves often as foundation for generating of hypothesis about key aspects of a situation and is linked with the conceptual framework networking hypothesis (Shields & Tajalli, 2006).

3.4.2 Descriptive research design

A descriptive research design is suitable for research in which the research problem and the procedures for data and information gathering are structured. What differentiates exploratory and descriptive research is the fact that descriptive research formulates specific research questions and hypotheses beforehand

(Malhotra et al., 2012). This type of research works with raw data and allows for drawing inferences about specific phenomena of concern (Hair et al., 2006).

A wide variety of research objectives can be answered with studies of descriptive type, but the collected descriptive data will only become useful for problem solving when the process of the research is guided by one or more clearly defined specific research problems. The decision of whether a research design should be of a descriptive character is based on the combination of three factors: (1) the nature of the initial decision problem/opportunity situation, (2) the set of redefined information research questions, and (3) the expressed research objectives (Hair et al., 2006). The means of collecting quantitative data are techniques such as surveys and quantitative observation (Malhotra et al., 2012). As opposed to exploratory design, descriptive research design defines who, what, when, where, why and how of the research (Boyd, Westfall & Stasch, 1989).

Although descriptive designs are often used as foundation for marketing decisions, they do not produce direct cause and effect relationships. As these kinds of decisions cannot be made solely by instinct, causal designs are the only ones that provide a reasonable confidence whether one type of variable is affected by another. Independent variables are manipulated in a controlled environment and the main mechanism employed is experimentation (Malhotra et al., 2012).

3.4.3 Causal research design

Causal research is intended especially to address cause and effect relationships among variables while the researcher has control and ability to manipulate an experiment in controlled conditions. It is considered the most scientifically valid research method (Kotler & Keller, 2006) and due to its experimental character allows the researcher to observe the degree to which the dependent variables change (Churchill, Brown & Suter, 2010).

Causal research is appropriate in situations when the research objectives require explanation of the reasons why a given market phenomena occurs (Hair et al., 2006). Advanced correlation strategy, used to explore how and why variables are related to one another (Leary, 2001), causal designs allow researchers to develop equations that allow the prediction of a variable from one or more variables. According to Black (1999), causal designs extend even beyond establishing a

relationship and strength between variables allowing predictions by extrapolation and interpolation based upon a “best-fit line”.

Referring to philosopher John Stuart Mill, Cook and Campbell (1979) discuss causal designs and define three major principles for inferring a cause and effect relationship: (a) manipulation of the presumed cause and observation of the outcome; (b) observing whether variation in the cause is related to variation in the effect; and (c) elimination of alternative interpretation for cause and effect relationships. Often in social science research, the third condition appears the hardest to achieve (Trochim, 2000). Similarly, later research has added two more requirements for causality, namely (1) timing (to ensure the cause occurs before the effect), and (2) association (to ensure two variables occur together in a patterned way) (Malhotra et al., 2012; Neuman, 2006).

Besides obtaining understanding on which variables are the cause and which variables are the effect of marketing phenomena, a causal research is appropriate for determining the type of relationship between the causal variables, as well as the testing of hypotheses (Malhotra et al., 2012). Research methods for causal design are deductive in nature and it is the positivists who seek to establish causality to explain phenomena and predict the reoccurrence of what has been observed in other contexts. Main methods of causal research include randomized experimentation, quasi-experimentation (or action research), and ethnography. These methods require field environment (e.g., actual market conditions), participants (e.g. consumers), and a researcher (which may observe and/or acts on the research). However, due to these demands, causal research design can be restrained in time, cost and administration (Malhotra et al., 2012). In addition, field experiments do not allow for high control of experimental conditions. Instead, experiments can be conducted in a laboratory setting, where the effect of the manipulation of the independent on the dependent variable is observed and measured while the impact of other extraneous factors is significantly minimized. Even though both techniques provide a level of control and manipulation, the major distinction between them is the environment (Sawyer, Worthing & Sendak, 1979). Laboratory experiments provide more control, however they are not able to mirror the natural setting entirely and might bias overall study results. Despite of being conducted in a laboratory or a field setting, experiments are seen to improve causal descriptions (consequences attributable to deliberately varying a treatment) but are considered less useful at explaining causal

relationships (or clarifying the mechanisms and conditions under which that causal relationship holds) (Shadish, Cook & Campbell, 2002).

In the case of this study, by employing randomized experiments, allowing the various treatments to compare (including a no treatment condition) and be assigned to experimental units by chance (Shadish et.al, 2002), causal design can provide answer to the research questions by exploring which variables are the cause and which are the effect. A single independent variable with two levels (AR Marker-based and AR Markerless treatment) can define the experimental conditions, while random assignment can regulate control of extraneous variables. Collection of data is done under controlled conditions and the effect of all other variables but the causation one is minimized.

Laboratory experiments are generally not concerned with the problems that arise in field experiments and permit the employment of facilities for collection of high-quality data (Baillie, 2003; Kjeldskov & Stage, 2004). Since the nature of this research requires testing of the effect of AR technology on different groups of participants, causal design implies the most suitable guidelines in designing a laboratory experiment. Setting up a locale with the specific conditions and then manipulating, observing and measuring the effect of the treatment on some variables while controlling others, is vital for the objectives of this research. The strong points of experimentation, and also reasons to select causal design for this study, are scientific rigour, the ability to control internal and external validity, and the ability to isolate the experimental variable, which allows for causality to be inferred (Christensen, 1997). In addition, the generalisability required by this research can only be achieved through larger-scale quantitative research. Causal relationships between consumers' attitude, recall, arousal or knowledge and consumer background variables (gender and age) as well as the effect of consumers' emotional responses on advertising effectiveness, can only be established through statistical testing. Since the advantage of the method is its ability to investigate the causal link between variables and thus to measure the association between them, it is expected that valid predictions about the effects of marketing decisions are also provided (Aaker et al., 2006).

Despite its advantages, it must be acknowledged that causal research designs can be complex and time-consuming and not exempt from inconsistencies. For example, human responses can be difficult to measure and group comparison can be

challenging. To ensure rigor and better quality of findings the experiment integrated qualitative research methods such as focus groups (as a precondition).

3.5 Variables

The objective of this study is to explore the effectiveness of three digital shopping platforms on the impressions and purchase intention of consumers. The project is mainly interested in whether AR advertisement provides any added advantage to advertised product in the form of relatively greater recall, favorable attitude, or a stronger purchase impulse. It is important to understand whether interaction with a different system influences the relationship of AR advertising and advertising effectiveness. Also it is essential to register whether attitude towards a brand affects evaluation of the effectiveness of an advertisement. The comparison of three types of user experiences with three different systems requires the manipulation and measurement of different variables, however this process is complex in nature and consists of mutually connected mechanisms rather challenging to examine.

Since the systems used in this study represent shopping platforms and allow for purchase of a product, potential buyers are viewed as decision makers (Futrell, 2011). The consumer decision-making process relates to advertising effectiveness and is concerned with how people perceive, process, respond to, and use advertising information in making purchase decisions about certain product or service (Jeong, Kim, & Park, 2004). As human psychology is quite complicated, various aspects of the decision-making process, crucial for the objectives of this study are described and investigated. When doing so, every observable and measurable element is considered a variable, including where it is, how it is used, and what surrounds it (Hair et al., 2006). Four types of variables, critical for the designing of causal research experiments (Hair et al., 2006) are considered for this study: independent, dependent, control, and extraneous.

The independent variable for this study are the advertising means (AR Marker-based and AR markerless), which also represent the treatment. This variable was directly manipulated by the researcher and is assumed to be the causal factor of a functional relationship with the dependent variables. Furthermore Innovativeness adoption, Emotional intensity, Information seeking and Perceived risk are also considered as measurable variables.

The dependent variables or the effect change on test subjects, derived oring from manipulating the independent variable, are cognitive aspects such as consumer Arousal, Resposiveness, Perceived interface aesthetics, Attitude, interface Organization, aspects of Fun, Boredom, Daring, Contemporary as well as Recall. Furthermore, advertising effectiveness (e.g. interface usability) and an outcome purchase intention were considered.

Control variables were controled in order not to affect the functional relationship between the independent and dependent variables in the experiment. Age, gender, educational level, group size and lab setting were matched and controlled for, to be as similar as possible for each of the manipulations.

Extraneous variables, such as participants' fatigue were accounted for and measures were taken to lessen the confounding impact on the dependent variable of the experiment. Randomized experimentation was employed to control for extraneous factors. Table 2 summarizes the variable types.

Table 2

Study variable types and items

Variable type	*Item*
Independent (manipulated)	AR Marker-based treatment, AR Markerless treatment
Independent (measured)	Innovativeness adoption, Emotional intensity, Information seeking, Perceived risk
Dependent	Arousal,Responsiveness, Perceived interface aesthetics, Attitude, Usability, Organization, Fun, Boring, Daring, Contemporary, Recall, Purchase intention
Control	Age, Gender, Educational level, Group size
Extraneous	Fatigue

3.6 Construction of the research design

Prerequisites for constructing a strategy to achieve the objectives of the study were to decide upon robust data collection techniques and to establish a likelihood of method replication. Proper comparison of groups and obtaining knowledge in participants' experiences were also crucial in determining an accurate research approach. The course for selecting the specific research design is described below.

The observed literature indicated that qualitative research helps researchers understand how people make sense of their world and their experiences (Merriam, 2009; Denzin & Lincoln, 2000). Inductive form of reasoning develops concepts, insights and interpretations from patterns in the data. Imperative for this study is to obtain understanding on consumer's feelings, attitudes, memory and knowledge but as those aspects are difficult to quantify, qualitative research appears to be an adequate method of investigating emotional responses. However, assessing the obtained results of this project simply through a qualitative technique would have been problematic when applying conventional standards of reliability and validity. Also, produced knowledge and findings would have been less generalizable to people and settings other than the sample under study. Therefore, the implementation of questionnaires on each of the conditions, gathering instruments to control for procedural bias and selection of a sample with a statistical representation of the population demanded the additional implementation of quantitative techniques.

After examining the objectives and the research questions, the limitations and the scope of the study, adopting both qualitative and quantitative data gathering techniques was considered appropriate. A combination of these strengthens social research (Onwuegbuzie & Leech, 2005), provides more data to work with and subsequently allows for a more accurate evaluation. To justify further this choice and obtain a more complete set of findings, a better understanding of the research problem can be provided by triangulating both numeric trends from quantitative research and the detail of qualitative research (Creswell, 2003).

The priority in this research design is given to the quantitative method, because it represents the major aspect of data collection and analysis in the study, focusing on detailed explanations of quantitative results by exploring three separate conditions. The quantitative and qualitative methods are integrated together at different phases of the research. At the beginning, a qualitative phase (focus group) was adopted followed by a group pre-test with questions based on the insights obtained. The third phase was experiment-based and included three matched groups of participants exposed to three different (two plus control) treatment conditions. The results of the three phases are integrated in the discussion of the outcomes of the whole study.

To summarize, both qualitative and quantitative research methods are designed to build knowledge and they can be beneficial to a researcher if used as

complementary strategies as opposed to strictly adhere to a single method. The objectives of the research, to gain rich data from understanding the feelings and emotions of participants through focus groups, open-ended responses, participant observations and reflections, required qualitative approach on one hand and quantitative approach on the other to provide measurement and analysis in a statistical form to determine and generalize results to a bigger population. Following the above guidelines, referring to the main questions and evaluating the requirements for collecting qualitative and quantitative data, it was considered that the design that would most adequately fit the research project would be the Causal Research Design with Experimentation.

3.7 Focus groups

The first qualitative research technique to collect information for the main research project was a focus group test. This procedure involves a discussion conducted by a trained moderator among a group of respondents in an unstructured and natural manner (Malhotra et al., 2012). The obtained information provides an insight for identifying specific attitudes and behaviours, and has been a long established method for collecting consumer responses to marketing communications (Daymon & Holloway, 2002). Focus groups can provide information simultaneously on how groups of people think, interpret or feel about a given subject while data is collected in a short period of time. Compared to individual interviews, this method has a clear advantage (Madriz, 2000) and can be beneficial to a qualitative research in terms of emerging ideas, attitudes, debates and knowledge. Nonetheless, when reporting the findings of qualitative examination, it is critical for the researcher to find the most adequate way of registering the expressions of the participants and their meanings (Janesick, 2000).

Focus group theorists differ in approaches of choosing the most pertinent method of analysis for focus group data - individual, group, or interaction (Duggleby, 2005). A more recent study suggests that researchers should document and provide information about the level of consensus and dissension among participants (Onwuegbuzie, Dickinson, Leech, & Zoran, 2009). In addition, the authors suggest that the researcher might also consider presenting material to which the participants

can respond such as video, articles, pictures, etc. The above recommendations were considered for carrying out the focus group test.

The purpose of this procedure was to examine the knowledge, experience, motivations and emotions of AR-based advertising in potential young consumers. The trial was conducted with a total of 26 participants, all university students under 22 years old. The pilot examination used Blippar AR-based interactive technology, as well as a short movie ad presentation for Volkswagen Beetle. The main objective was to extract qualitative information and advance on the deeper understanding of possible influence of mobile AR on potential consumers.

3.7.1 Participants

The size of a focus group directly affects the group dynamics and may vary between 6 and 10 participants (Imms & Ereaut, 2002; Lunt & Livingstone, 1996). However, according to other studies a group size can be between 8 and 12 subjects (Byers, & Wilcox, 1991; Quible, 1998) but is ultimately dependent on researcher's decision (Morgan, 1996). For the purpose of this study three focus groups were conducted, consisting in total of 26 full-time undergraduate students from University of Porto. The first group consisted of six subjects - four male and two female. The second and third group included ten subjects each, with two and one males and eight and nine females respectively. The focus group call was distributed via email and used an e-mail sign-up procedure. The students were representative to the larger undergraduate student population in terms of age, gender, and race. In terms of reliability and effectiveness of the data collected, and according to the purpose of the research to understand young consumer's perceptions of multiple aspects of innovative advertising application, the number of participants was considered adequate.

3.7.2 Procedure

The focus group test took place at University of Porto on December 5th, 2012. The sessions were held in one of UP's room facilities and lasted approximately 45 minutes each. The test was conducted with a dual-moderator group where one moderator ensured that specific issues were discussed and the other was responsible for the smooth flow of the session, as advised in Malhotra et al., (2012).

Throughout the duration of the test all conversations were recorded with a digital audio device, positioned on the table of the room and surrounded by the participants. Each session followed the same structure with nine identical open-ended questions addressed to the group. An advertising production movie for *Volkswagen Beetle*, showing AR in use was demonstrated to the participants. Following the movie, three advertising printouts (*Nike*, *ASOS* and *Domino's Pizza*) were consecutively shown to each group and participants were asked to comment on the impressions ads originate. The next step in the session was the introduction of *Blippar* mobile AR application and two smartphones were provided for testing purposes. Subjects were allowed to freely examine the application, while their reactions were noted and documented. Throughout the empirical study the emotional state of participants was observed, since as an affective response, it forms an integral part of the user experience.

The conversations followed the pre-defined protocol, although occasionally participants deviated slightly in their answers. They were always let to explain their point of view, when of interest to other aspects of the study but also attentively directed to adhere to the topic of discussion. The format of the presented materials was the same regardless of the degree of technological sophistication - sceneries, colors, characters, visual elements and messages remained unchanged for all the three groups. Following each focus group, the proceedings were transcribed word-for-word from the digital audio recording.

3.7.3 Technology

Blippar is a free image recognition mobile phone application for brands, which brings various content and interactive options to consumers and is designed to work on any printed media such as newspapers, magazines and posters with Augmented Reality experiences. These materials are scanned through the application previously installed on the phone. The computer algorithm recognizes an image through the camera on a mobile device and returns a response which creates a layer over the primary image. This response can be a representation of an interactive 3D graphic, a video or a web page superimposing the content over the camera's view of the real world. Three printed Blippar examples and an ad movie were shown at the focus group tests.

3.7.3.1 Domino's

The pizza chain, Domino's launched a poster campaign to engage with smartphone users by offering options such as information about locating their nearest store, downloading the Domino's mobile ordering application, becoming a Facebook fan and observing their menu. The experience was designed to reach customers while they were already out on the street so that they can be reminded of the sales promotion and either walk into a restaurant to get a pizza or have it delivered to their homes.

3.7.3.2 ASOS

ASOS clothing retail magazine offered consumers to purchase directly from their catalogue page through special "click-to-buy" icons by using their smartphones. Through an interactive display the models could be rotated and specific pieces of clothing could be purchased. The application enabled a smartphone to interact with the printed page without visible codes while the screen displayed a digital replica of the page.

3.7.3.3 Nike

In January 2012, Nike launched the #makeItcount campaign with famous UK athletes, who stated their pledges for the forthcoming year on multiple out-of-home formats and sport newspapers. The campaign used black and white photography with a written powerful message and a call to action for the audience. The campaign delivered interactive content (a trailer) and brand experience, activated through the Blippar application.

3.7.3.4 Volkswagen Beetle movie

Volkswagen Canada created a large-scale outdoor Augmented Reality campaign to reintroduce its Beetle model to the market. The campaign consisted of large-scale billboards and posters and implemented an AR experience through the use of a smartphone. The movie aimed at presenting an example of current possibilities of AR utilization and demonstrated how with the help of technology the information about the surrounding real world of a user can become interactive and digitally usable.

3.8 Group design

Since this project is interested in the profile of a target audience (young consumers) and their purchase intentions, attitudes, and knowledge related to online shopping and technology, quantitative techniques were considered fundamental for predicting behaviors at a statistically significant level. The quantitative approaches decided upon in this study were questionnaires and controlled treatments. The need to compare groups and obtain measurements resulting from experimental treatments required true experimental design with a Pretest-Posttest with a Control Group implementation.

The main advantage of the Pretest-Posttest Control Group design is the randomization of participants to experimental conditions, as any changes that would appear in the Posttest should be the result of the experimental variable rather than possible difference between the groups. Compared to studies using either quasi-experimental or non-experimental designs, those that use randomized experimental designs have higher levels of internal validity (Shadish, Cook & Campbell, 2002; Stone-Romero, 2002).

The experimental design employed in the project allowed for multiple configurations of comparison in evaluating the effect of the treatments: $O_3 – O_2$, $O_5 – O_4$, $O_5 – O_3$, $O_3 – O_1$, $O_5 – O_1$. The consistency of the results of each of the evaluations represents a substantially increased strength of the inferences about the effect of the experimental treatment (Smith & Albaum, 2010). Table 3 illustrates the group division according to the adopted design:

Table 3
X - exposure of test group to an experimental treatment, the effect of which is to be observed and measured; O - measurement or observation taken; R - random assignment of subjects to differing treatments (adapted from Malhotra et al., 2012)

Experimental design			
Group	Pre-test	Treatment	Post-test
Control Group = C (R)	O_1		
Experimental group I = E (R)	O_2	X_1	O_3
Experimental group II = E (R)	O_4	X_2	O_5

3.9 Questionnaire pretest

After specifying the research problem, the research design and obtaining qualitative insight for identifying specific attitudes and behaviours from the focus group, the main instrument of the research needed to be developed. At this stage, the research objectives had to be transformed into a questionnaire, the answers of which would provide the data for testing the research hypothesis. Pretesting is the first “live” test of the instrument, as well as the last step in the finalization of the questions (Iraossi, 2006).

Although, no scientific approaches can guarantee ideal questionnaire design, guidelines offered in literature can generally help develop a pertinent instrument. All aspects of the questionnaire, including question content, wording, sequence, form, layout, question difficulty, and instructions needed to be tested (Malhotra, 2006). Pretesting of the questionnaire was also used to analyze the information provided to clarify directions and response categories where necessary. Since the used questionnaire was self-administered, previous research suggests that question design, format and wording are especially important to reduce response error (Bradburn, Sudman & Wansink, 2004). Therefore, difficult and improper language, contradictory phrasing and unclear words were avoided. Only questions related to the main topic of research were included, most of which in a closed format with specified response options. Pretesting helped to identify any poorly defined questions or problems with the sampling method, the result of which would have reflected subsequently in the data analysis. The logical order was sought to be another important factor to prevent the possibility for bias and order effects (Malhotra et al., 2012). Opening questions were easy to understand and increased in difficulty so as to prevent fatigue. Instructions and survey format (including length, spacing and the appearance of text) were also assessed as they play an important role in maximising the accuracy of information and completion rates (Hair et al., 2006). Finally, it was sought that the pretest group be similar to the potential respondents in terms of their background characteristics, familiarity with the topic, attitudes and behaviors of interest (Malhotra, 2006).

Participants (n=198) consisting of 62% female and 38% male, were drawn from the population of interest, namely UP students and were recruited in exchange to a course credit. The questionnaire was paper-based, written in Portuguese

language and contained questions grouped in sections according to the various aspects of interest to the study. Three basic goals of the pretest stated in Iraossi (2006, p.89) were followed: a) to evaluate the competency of the questionnaire; b) to estimate the length of the survey or time to take the survey, and c) to determine the quality of the surveyor.

The pretest questionnaire contained six separate elements: demographic profile; information about online buying habits; domain specific innovativeness; attitude towards preferred brand; emotional intensity; opinion leadership and information seeking. The questions collected data through a multi-item Likert-type scaling with 5 and 7 point disagree - agree formats. A separate section with an open-ended question collected information on participants' top of mind awareness for brands, online purchase history and familiarity with AR. Given the above discussion on the concerns of developing an efficient questionnaire, the instrument used to collect information for the current research was designed using pre-existing scales. Adapting questions, successfully employed in other surveys is regarded as to enhance instrument validity (Bradburn, et al., 2004; Fink, 2006; Fowler, 2002).

Following completion of the pretest several changes of the instrument were made. As the current study adopted a Pretest/Posttest with Control Group design, the questionnaire used in the pretest had to be adjusted to fit the needs of the main experiment. Firstly, the questionnaire was split into two separate parts with the questions following a logical flow. Both questionnaires were equal for all three groups. Then, two questions were discarded from the original pretest: the first one, about discontinued habits of online purchasing was considered inoperative, and the second regarding AR technology was removed due to lack of knowledge on the side of participants. The term "Augmented Reality" seemed to be often confused with more abstract concepts with only two of the subjects giving an accurate description and demonstrating knowledge about the technology. It was considered that, in situations where respondents are uninformed, even if answers are provided they might be misleading (Malhotra, 2006). The second, Posttest questionnaire included new questions regarding the different systems participants had just interacted with as well as user's evaluation and emotional state. The specific questionnaire design considerations for this research are described at section 3.11.4.

3.10 Population and sampling

3.10.1 Population and sample frame

Population is the “collection of elements about which we wish to make an inference” (Scheaffer, Mendenhall & Ott, 1996). To generalize the findings of the study, the target population consisted of elements that possess equal characteristics which are of interest to the study. This project’s objectives are concerned with exploring the effectiveness of different types of advertising treatments on young consumers and therefore a population of University of Porto students was pertinent. The largest faculty at UP is The Faculty of Engineering with more than 8500 students enrolled[37] and these represented all units in the sampling frame - the list of all eligible elements in the population (Scheaffer et al., 1996). Due to the large size of the population, high cost and time consumption, not every individual in the population could be tested. Therefore, a simple random sampling technique was applied from a list of all enrolled students. After defining the population, the next steps included listing the population, assigning numbers to the units, finding random numbers and selecting the sample.

3.10.2 Sample and size

A sample is a set of elements selected from a particular population of interest, based on specified rules and operations (Pedhazur & Schmelkin, 1991), where an element is “an object on which a measurement is taken” (Scheaffer et al., 1996, p. 42). As stated above, not all elements of the population could participate in the experiment and therefore the drawn sampling frame consisted of a student database, with units possessing equal characteristics. A simple probability sampling technique (R) was appropriate for the study due to its simplicity, relatively low cost and its ability to allow statistical projection of the results to the target population, in contrast with other methods (e.g. non-probability sampling). Accordingly, “every element of the population of interest has a known nonzero probability of being selected into the sample” (Pedhazur & Schmelkin, 1991, p. 321). Due to the experimental design nature of this research fifty (n=50) subjects per treatment effect were organized in 3 experimental groups with participants aged 18-30 years of age. A total number of 150 subjects provided the necessary amount of data. Subjects were organized in homogenous groups of students (e.g. age, instructional level, native language).

[37] FEUP http://sigarra.up.pt/feup/pt/web_base.gera_pagina?p_pagina=247026 . Retrieved, September 10, 2014

Sample size was determined based on combinations of commonly used criteria, such as estimate of variance, precision confidence levels, and acceptable margin of error.

3.11 Procedure

3.11.1 Experimental setting

The experimental sessions took place at Faculty of Engineering in October and November 2013. The sessions were held in a laboratory setting, equipped with three computers, a 42-inch screen, a web camera and a Kinect for Windows SDK device. Participants were tested consecutively in three treatment conditions for the purely Interactive, AR Marker-based and AR Markerless platforms with fifty subjects each (n=50). Prior to the participants' admittance to the laboratory, efforts were made to minimize disturbance and noise and avoid distraction. The test platform was separated from the computer area by a removable panel in order to prevent newcomers from viewing what was displayed on the screen.

3.11.2 Subjects testing

The procedure for participant testing took three steps to complete. Firstly, each group of students was given a briefing about the research project and instructions on how to proceed with the system. A Letter of Consent for Participation in Research (see Appendix) was distributed to all participants to obtain assurance that they clearly understood what they were agreeing to do, that they were free to decline involvement or withdraw from the study at any time. To keep track on consecutiveness of survey completion and data collection in a database, each participant was assigned an unique number (ID) which was the same for each of the three steps of the process.

As one of the most important aspects of this study was to observe participants' emotions before and after a treatment, the process of completing the required steps was explained in a way that would not influence in any way subjects' attitudes or expectations. In a separate area, students were free to serve themselves with refreshments and snacks along the whole duration of the test.

The first step for every participant was a computer-based survey with questions regarding basic demographic data, online shopping habits, preference of brands for sport shoes, innovativeness, attitude towards the brand, emotion intensity, information seeking, evaluations and perceived risk. Upon completion of the survey

each participant was shown to the testing platform and was asked to interact with the system freely. Each separate case was recorded via web camera. The final step included a second computer-based survey with questions about the experience in terms of arousal, system satisfaction and usability, attitude towards advertised brand, interface evaluation and purchase intention. The overall time spent on all three steps varied between 20 to 30 minutes per subject. The completed questionnaires were collected in a database and participants were debriefed, thanked and politely sent away.

3.11.3 The experience

The user experience was designed in a way that participants could apply their common sense to interact with the system. Three separate experiences took place in three consecutive sessions, namely a plain web-based, a Marker-based and an AR gesture based system. It was important to maintain consistency among all the interfaces, making them as similar as possible. All of the platforms were equal in terms of containing the same visual elements and differed only in the level of user interaction with a system. Before activation of any of the systems, a black screen with a brand logo was displayed on the screen. This measure was taken in order to prevent users from realizing immediately what they were about to experience and to record their expressions upon activation. Each start of the experience was done manually from a remote computer depending on moderator decision. The common features of the three systems were: 1) three interactive screen buttons for color preference, 2) an “ADD TO CART” purchase button, 3) a “BUY” button, and 4) a “CLEAR” button. Users were also able to choose their shoe size by selecting the “SIZE” button. The purchase button’s main objective was to store information on the amount of users who chose to buy the sneakers and to register the selected color. For a product prototype a highly detailed 3D model of a pair of sneakers was chosen.

In the purely Interactive platform participants were not exposed to an augmented reality experience of any kind. This case was without treatment and served as a control condition. The system was mouse and keyboard operated and allowed for basic functionality such as inspection of the product, selection of color and size, add to cart and purchase.

The second system used AR Marker-based and required a special paper printed symbol (a black and white fiducial image) to be pointed and recognized by the application. The marker served as a spatial reference to place a model in the scene, on top of the marker, following and rotating accordingly. In this condition the user was exposed to a mixed method of interaction by the combined use of the 3D image from the marker and the mouse and keyboard for navigation among the menu.

Immediately after activation, the third system (AR Markerless) showed a screen, composed by a 2D plane background with a live, real time streaming of the Kinect captured video. This condition was entirely gesture based and did not involve the use of any additional hardware. The three interfaces, with which a user could interact, were: (1) double hand activator, which required both hands to trigger the application; (2) the six buttons, which only required one hand to hover and (3) a rotator, activated by moving a hand from down to up or from left to right. For the execution of the first two interfaces the user could position the hand over for detection for two seconds while the buttons start to glow around increasingly until they are activated. To reactivate the same interface the hand would first be removed and placed over the selected interface once again. A steps sticker sealed to the floor of the lab assisted with subjects' position before the system. All three conditions were video recorded in order to collect information on participants' facial expressions and gesture movements.

3.11.4 Instruments

3.11.4.1 Questionnaire

As illustrated in section 3.9, the main instrument used in the experiment was a self-completion, computer-based questionnaire. Analytical examination of all elements of data collection instrument is critical in minimizing measurement errors. Failure to adopt appropriate and systematic procedures in questionnaire development, testing, and evaluation may threaten the quality and utilization of data (Esposito, 2002).

After the pretest, the instrument was refined to help gather information about potential consumer purchase intention and preferences. The nature of this study required an experimental Pretest-Posttest group design which led to the transformation of the initial questionnaire in two parts. The first aimed at obtaining pre-treatment information on basic demographic data, online shopping habits,

preference of brands for sport shoes, innovativeness, attitude towards the brand, emotion intensity, information seeking, evaluations and perceived risk. The second, post-treatment part was concerned with participant arousal, system satisfaction and usability, attitude towards advertised brand, interface evaluation, recall and purchase intention.

The number of survey questions was kept to a minimum, and only those directly relevant for the research were incorporated to prevent the experience from becoming too lengthy. This was important because the experimental groups had to fill in a survey and interact with the system prior to second questionnaire completion. Evidence in research has shown that increasing survey length could reduce response rates in web surveys (Crawford, Couper, & Lamias, 2001; Galesic & Bosnjak, 2009).

The first questionnaire contained 10 questions and was distributed before the treatment, while the second contained 6 questions and participants were asked to fill it in last. The questions contained between six and ten sub-questions, except the part on emotional intensity which contained 30. The Likert scale model used in the present study was chosen due to its advantage of being easy for the researcher to construct, and that of being easy for the respondent to understand (Malhotra, 2006). Therefore multi-item Likert-type scaling format with 5 and 7 point disagree - agree formats was kept for majority of the items on both questionnaires also including a middle alternative, or point of indifference. It was anticipated that an attitude of indifference may be valid.

In terms of types of questions, the two questionnaires implemented series of closed-ended questions, equally formatted for ease of completion. Respondents were asked to indicate their opinion on a number of statements relating to each of the questionnaire parts. Giving priority to closed-ended, structured questions for the questionnaire is justified by the fact that they are most appropriate for self-administered surveys (de Vaus, 2002; Fowler, 2002). Inclusion of structured questions also provides an opportunity for more advanced and less time consuming data analysis (Malhotra et al., 2004). Four open-ended sub-questions regarding top of mind awareness, brands and online purchase were part of the first questionnaire, while only one open-ended question was employed in the second questionnaire pertaining to unaided brand recall.

Since a self-administered questionnaire was used, it was particularly important to minimize the potential for response error. The presence of the researcher granted

the opportunity to respondents to seek clarification if necessary. In addition, to serve its purpose a measurement instrument must be simultaneously valid and reliable. Validity refers to the amount of systematic or built-in error in measurement, while reliability deals with the accuracy or precision of the measuring instrument (Norland, 1990). An instrument that is valid in content must draw representative questions from a universal pool (Cronbach, 1971; Kerlinger, 1978). Several sources of data were used for the development of the instrument, including previous instruments established by other researchers; a research framework developed from the relevant literature and feedback from the pre-test on the representativeness of questions. The survey obtained expert evaluation in terms of content, construct, criterion, and face validity to determine whether the content of the instrument was appropriate.

The pretest helped to establish reliability by collecting data from subjects not included in the sample. Data collected from the test was analyzed using IBM SPSS Statistics[38], version 22. Cronbach's alpha is the most common measure of reliability and all items with higher value than .90 were discarded as this score suggests redundancies (Streiner, 2003).

3.11.4.2 Google Forms[39]

Web-based surveys have significant advantages over paper-based surveys in terms of response rate and costs. Google Forms was the chosen platform to create a survey online since it is a free service and unlimited number of people can participate in a survey via a web browser. Google Forms supports a wide range of question types including scale (e.g semantic differential) and grid (e.g. Likert scale) that are generally not available in other free web polling services. Compared to the paper-based pre-test of the survey, in the web-based survey all responses were automatically collected in an Excel spreadsheet which made it easier to analyze large sets of data using charts and other complex spreadsheet functions. When the survey was complete and online, it could be easily distributed in other platforms such as Doodle scheduling platform[40] which facilitated announcement through the webmail service of Faculty of Engineering. Students could then choose available dates and sign up for a session.

[38] IBM SPSS Statistics http://www-01.ibm.com/software/analytics/spss/ Retrieved October 1, 2014
[39] Google Forms http://www.google.com/google-d-s/createforms.html Retrieved October 1, 2014
[40] Doodle http://doodle.com/en/ Retrieved October 1, 2014

3.11.4.3 Technology

The demo platform, developed for the aims of the study, was created to assist in studying the reflections and cognitive effects on consumers through an AR Markerless shopping application in comparison to the two other systems: an AR Marker-based interactive application and a purely Interactive platform.

In order to identify which approach would provide the desired conditions and perform with as little limitations as possible, several marker-based and marker-less approaches were examined. For the AR Markerless platform Microsoft Kinect sensor was chosen. One reason for this choice was that the developed tracking system performed with great accuracy, even when part of the body was occluded from the sensor visibility cone. Also, this tracking setup allowed any user to interact with the application without an additional tracking object, such as a marker. Through the combination of the Unity3D[41] game engine and the Kinect for Windows SDK[42], the general application implementation was eased, allowing more time to focus on the user experience it was meant to provide. One of the key features of the SDK is the access to the whole user's skeleton map (hands, arms, head, etc.) which provides its elements a relative 3D position to one another. The hands' position was mapped to a 2D plane, streaming the video from the Kinect camera. This allowed the application to activate the correct button when a user hovered one of their hands over the interface. Data were stored in a SQLite database which could be accessed later for statistical information.

In addition to the Kinect system, two other applications (a purely Interactive and a AR Marker-based system) were created to establish a line of comparison and obtain information on how users interact with each of them. All three applications used the same game engine with the second AR application using a marker based approach, powered by the NyArToolkit[43] computer tracking library. The programming language used was Microsoft .NET C# 2.0. The developed applications were meant to assist in exploring the antecedents of consumer purchase intention and in defining the metrics that can be applied to measure advertising effectiveness with AR.

3.11.4.4 Measures

The project applied measures for the following variables:

[41] Unity 3D http://unity3d.com/ Retrieved October 1, 2014
[42] Microsoft Kinect http://www.microsoft.com/en-us/kinectforwindows/ Retrieved October 1, 2014

[43] Nyartoolkit http://nyatla.jp/nyartoolkit/wp/ Retrieved October 1, 2014

a) Demographic: Basic demographic analysis were used to identify population characteristics in order to determine potential customer profile. The statistical characteristics of interest to this study were those of subjects' gender and age (ranging from 18 to 30 years old).

b) Behavioral: the aspects of interest to the study are knowledge, use and responses of consumers. The study measured the degree of familiarity with AR (pre-test), online shopping habits for sport shoes and brand preference, opinion leadership and information seeking as well as need to evaluate.

c) Psychographic: The measures in this category are concerned with lifestyle preferences or interests, the attitudes and values of consumers, or their actions. The study measured attitudes toward the brand, the ad and the technology; emotional intensity, arousal (calm/excited), valence (negative/positive), dimensionality (Pleasure-Displeasure); recall (ad message details and intention to purchase) and consumer profile: ad involvement and sportswear product involvement, technological expertise (self-evaluation).

3.11.4.5 Laboratory observation

Laboratory observation is a research method in which all participants or objects, are observed and examined under the same controlled conditions. Due to the qualitative nature of this method the information obtained relied on narrative records such as video footage and field notes. All controlled conditions were live video recorded through a web camera while interacting with a system, resulting in 150 video clips, collected in a database for further evaluation. All subjects were informed beforehand that participation in the experiment would involve video recording. However, in order to reduce the effect of the observer's presence on subjects and avoid bias, there was no direct intervention during the process and video recording was done automatically on start of each experience. Field notes were collected additionally to support collection of findings. Since this study is interested in a naturally occurring behavior, the combination of observational technique together with a questionnaire was considered appropriate for the exploration of an experimental setting in a relatively unexplored field and lack of formally developed hypotheses.

3.12 Validity

Two major aspects have been reckoned as crucial for the quality of an experimental study in terms of credibility and transferability: internal and external validity. The purpose of this subsection is to demonstrate that 1) the observed effects of the independent variable on the dependent variable are true and valid, and not caused by any extraneous variable and 2) the capacity to generalize the study results to groups beyond the ones used in the experiment itself.

3.12.1 Internal validity

Several are the factors to be considered for examining internal validity, as stated in Malhotra et al., (2012): selection bias, mortality, instrumentation, history, testing effects, statistical regression and maturation. In all three procedures, participants were assigned randomly to the experimental conditions, making each group on average similar in all extraneous variables. This way, threat of selection bias was ruled out by randomization of subjects. Mortality did not occur during the experimental session since no subject dropped out of the tests. During the sequel of the tests no changes in the measuring instrument or the process were made preventing instrumentation from affecting the results. Pre-testing and post testing were done in a relatively short interval of time, hence excluding the effect of history. The two test surveys contained different questions in order to cover various aspects of interest to the study, thus suspending statistical regression and testing from influencing the prior measurement in having an impact on the later measurement. Maturation affected participants to some degree due to the length of the experiment in testing every subject (between 20 and 30 minutes). However, within each experiment participants had a similar pattern of maturation across the manipulations resulting in a relatively even distribution, not held as a consequential threat to internal validity. Chapter 5 is dedicated to a comprehensive presentation of the obtained results.

3.12.2 External validity

External validity deals with the question about to what extent the findings of the study can be generalized to a bigger population. Naturally, the external validity of an

experiment depends on the experimental design and more precisely the survey sample. There are four common threats of external validity, namely reactive effects of testing, interaction effects of selection bias, reactive effects of experimental arrangements and multiple treatment interference (Tuckman, 1999).

3.12.2.1 Reactive Effects of Testing

Tuckman (1999) argues that the reactive effects of testing factor result from participants' becoming aware that they are involved in a research, exposed to a treatment or involved in pretest activities. The reactive effects of testing factor will not be a threat to this study due to several reasons. First, the rigorous approach of the Pretest-Posttest Group Design implemented in this study required randomly identified subjects to be randomly assigned to the experimental and control groups, allowing no chances of the experimental group to be aware of the control group. Furthermore, the research design controlled for this effect with a satisfactory number of sample subjects and participants were not exposed to a brand's advertising or product until the actual treatment took place.

3.12.2.2 Interaction effects of selection bias

According to Tuckman (1999), the interaction effects of selection bias factor occurs when the samples that are selected for the research do not entirely represent the population. In the context of this study, subjects were randomly selected from the UP student list, thus representing the population. The subjects were then randomly assigned to the experimental and control groups. However, although the subjects reflect the variety of characteristics of young consumers in Porto, Portugal, 18-30 years of age, the findings are only valid for the population in this area. Furthermore, gender distribution showed that male participants dominated with 74% over 26% female.

3.12.2.3 Reactive effects of experimental arrangements

The reactive effects of experimental arrangements factor appears when the experiments are conducted using contrived conditions which are rarely duplicated outside of the laboratory setting and which "limits the generalizability of the results to

a non-experimental test of the treatment" (Tuckman, 1999, p. 140). This applies to the Hawthorne Effect (Tuckman, 1999) where subjects' performance is increased above average due to "inclusion in an experiment" (Tuckman, 1999, p. 140). However, the Hawthorne Effect will not be a threat to the external validity of the research because although subjects were aware of their participation in a research study, no details (e.g. study hypothesis, objectives) were exposed to them in order to avoid unintentional bias. Experiment moderators were also cautious not to be involved in the participation and adhere to the guidelines specified in the study.

3.12.2.4 Multiple-treatment interference

Multiple-treatment interference occurs when the participants are subjected to a number of other treatments in addition to the research treatment which may affect their performance that was intended for the actual research treatment (Tuckman, 1999). In the context of this research, the multiple-treatment interference factor does not pose a threat to the external validity due to the fact that subjects were only exposed to a single treatment per group.

Overall, the external validity of experimental results depends upon whether participants or settings are maintained in a similar manner during the stages of an experiment. Cook & Campbell (1979, p. 73) argue that the threats to external validity should be resumed as "Interaction of setting and treatment" - referring to whether a causal relationship obtained in a lab environment could be found in a real world environment, and "Interaction of selection and treatment" – referring to whether the observed effects can be generalized beyond the groups used to establish the relationships in the experiment. This study's aim was to generalize the findings from the lab experiments to a "real" environment although in general, lab experiments are reported to have more limitations in terms of threats to external validity than threats to internal validity (Kerlinger, 1973, p. 398). Therefore, efforts have been made to achieve resemblance between the lab and a given field setting of an environment. According to Locke, (1986, p. 7) only essential features of the field settings need to be replicated in the lab and not a reproduction of the total field situation. This would mean to extract the minimum required elements for the phenomenon to occur. Adding authenticity in the task in order to encourage participants' interest rather than detachment from it helped minimize inequalities. Furthermore, the experiments were

conducted with students and the purpose was to generalize the causal findings on the “consumer behavior” of students to the “consumer behavior” of “real buyers”. However this study regards to students as potential buyers. Also, the main product used in the advertising platforms was a pair of sneaker shoes while the age of target consumers of Converse brand are between 14 to 25 years old.

3.13 Data processing

Subsequent to the experiment all data were coded and exported for analysis into the IBM SPSS Statistics, version 22. The scores were computed and screened thoroughly for mistakes. Descriptive statistics were computed for each group. Choosing upon analysis for the Pretest-Posttest Control Group Design with random assignment called for One-Way Analysis of Variance and Two-Way Analysis of Variance. ANOVA can be used in cases where multiple independent variables are considered, and it allows the analyst to estimate both their individual and their joint effects on the dependent variable (Hair et al., 2006). To identify patterns, which can then be used for prediction Logistic Regression was applied.

3.13.1 Descriptive statistics

Before computing any inferential statistics, data was coded, entered into SPSS and exploratory data analysis (EDA) was performed. The process included various descriptive statistics and graphs, and was done to obtain better understanding of data, and to define whether it met basic assumptions for the subsequent statistical analysis. Descriptive statistics summarize the data and describe each variable as well as provide information about the sample (Hayes, 2005). Furthermore using EDA helped identify issues in the data set such as outliers, non-normal distributions, coding errors and missing values. Relationships between variables were also observed in order to decide upon how to conduct the hypothesis-testing analyses. Mean, standard deviation, skewness, minimum, and maximum values for all cases on all ordinal or scale variables under measure were computed. Since questionnaires were computer-based and allowed for only one answer of each question, no duplicates were present.

The sample consisted of 74% males and 26% females. The average age of participants was 21,61 (*M* = 21.61, *SD* = 3,345). The median, or middle number in the data set was 21 (*Med* = 21), with the most commonly occurring age of 22. The biggest part of the participants (29%) reported buying their last pair of sport shoes in the last six months. Twenty six percent of the participants bought shoes less than three months ago, while the rest made a purchase between the last six months and one year (20%) or more than a year ago (24%). Descriptive statistics also showed that 68% of participants have already made a purchase online.

3.13.2 Missing data, outliers and normality

For ordinal variables, missing values were imputed with the median. Median imputation was used due to the fact that items were measured using a Likert scale. Missing values represented less than 10% of the sample size. Only one case was removed from posttest analysis due to incompletion of questionnaire. Nonmetric variables were not considered for imputation due to lack of availability of comparable measures (Hair, Black, Babin & Anderson, 2010); instead an estimate of a value was calculated rather than an estimate on a continuous scale.

The procedure of identifying outliers was done though boxplot inspection. Ordinal scales consisted of either five or seven intervals, and since the questionnaires were computer-based abnormal value outliers were nonexistent. In cases where graphical visualization detected exceptionally high values it was unreasonable to believe these were incorrect, therefore there was no theoretical basis for removing them. Thus, they remained simply as highest/lowest responses.

To determine whether a variable was normally distributed, the skewness and kurtosis index was computed to evaluate how much a variable's distribution deviated from a normal curve. It is advised that both values should fall in the range from +2 to –2 if data are normally distributed (Lewis-Beck, Bryman & Liao, 2004). However, since most variables were based on Likert-type scales, it was unjustifiable to exclude variables based solely on skewness results, unless they exhibited no variance. Also, kurtosis values outside of the acceptable range would indicate a potentially problematic case (and therefore, lack of sufficient variance). Items with borderline skewness and kurtosis issues (value between 2 and 3) were simply flagged for potential future issues in subsequent analyses. Aside from skewness and kurtosis indexes, normal distribution was explored graphically through histograms and Q-Q

plots. Normal probability displays the pairing of observed value of each score against its expected value from the normal distribution . Observation of a reasonably straight line indicates a normal distribution of scores. Subsequent to the normal probability plots - the detrended normal plots, outline the actual deviation of scores from the straight line. The plot should illustrate clustering of scores around the zero line (horizontal line) without an apparent pattern. Furthermore, if the obtained mean, median, and mode values were approximately equal, it was assumed that the distribution was approximately normally distributed (Leech, Barrett & Morgan, 2012). Since assessing whether data from tests are normally distributed to an acceptable degree is ultimately a researcher's decision, all variables in question were kept under observation for future analysis. Since in social sciences it is rather common to find variables that are not normally distributed (Pallant, 2013), normality (versus non-normality) is seen here as a matter of degrees, not a strict cut-off point.

3.13.3 Factor analysis

The use of factor analysis has several aims: firstly, it examines whether the items used to measure the constructs fall into the same factors. Secondly, it reduces the information obtained from the questionnaire into a small set of newly merged dimensions which make the data more manageable in order to offer a more parsimonious description of the data. Furthermore, categorising the data into specific factors allows a simpler interpretation and also enables these factors to be included in regression models (Hutcheson & Moutinho, 2008). Factor analysis helps remove multicollinearity, e.g in cases where two or more variables that are highly correlated.

The selected factor extraction model was Principal Component Analysis (PCA) due to its ability to reduce the number of variables by creating linear combinations that retain as much of the original measures'variance as possible (Conway & Huffcutt, 2003). The process consisted of several steps including initial extraction of the components; determining the number of components to retain; rotation to a final solution; interpreting the rotated solution and computing component-based scores.

3.13.4 Cluster analysis

Cluster analysis (Jain & Dubes, 1988; Kaufman & Rousseeuw, 1990) divides data into groups (clusters) for the purposes of summarization or better understanding. One

of the most widely used and efficient clustering methods is the K-means method (Hartigan & Wang, 1979; Lloyd, 1957) which uses prototypes (centroids) to represent clusters by optimizing the squared error function. K-means operates a non-hierarchical divisive cluster analysis on input data. The analysis allows for the degree of clustering in the data to be evaluated. K-means allows one to compare the degree of clustering observed in the actual data with clustering observed with comparable randomized data (Kintigh & Blankholm, 1987).

A k-means cluster analysis (IBM SPSS Statistics version 22) was applied on all cases for Innovativeness adoption, Emotional intensity, Brand attributes evaluation, Information seeking, Perceived risk, Arousal, Usability, Perceived interface aesthetics and Brand personality. A pre-defined two cluster segmentation resulted in high and low profiles where the variables were significantly different in the mean. ANOVA was applied to compare clusters and define for which variables the clusters are significantly different from one another.

3.14 Ethical considerations

As this study required the participation of human subjects, ethical issues were addressed to protect the privacy and safety of all participants. The most significant matters considered during this study were informed consent and confidentiality. Prior to participation, each subject was fully informed of all important aspects of the study. Furthermore, participants were advised of their right to withdraw from the study at any time. Subject confidentiality was ensured by not disclosing their names or personal Information in the research. Only relevant data pertinent to answering the research questions were included.

3.15 Limitations

Although the experimental design makes it possible to determine a cause and effect relationship by manipulating the independent variable to observe the effect on the dependent variable, the experimental situation may not always completely relate to the real world. The experimentation took place in a university laboratory and subjects for the study were drawn from a student population which does not fully represent the real world environment, neither the real world buyer. However, the technology used encompassed the basic input requirements for any kind of online transactions (e.g.

monitor, computer, keyboard and mouse). Young consumers have familiarity on this level which helps them establish and apply their shopping habits, at home or in another setting.

Identification and elimination of extraneous variables in an experiment is not always possible. Exploring consumer's emotions and attitudes required profound examination with different techniques resulting in a lengthy procedure causing a slight maturation effect to take place. Furthermore, the study was restricted to the use and investigation of one type of product. The prototype should be tested with a number of products that are purchased on a regular basis (e.g various sneaker models).

3.16 Summary

This chapter discussed the research methodology employed in the study. The project employed a Causal Pretest-Posttest Group Design implementing both qualitative and quantitative data gathering techniques to answer the research questions, and provide a structured design strategy for obtaining data and hypothesis testing approach. The importance of emotions in the mechanism of building consumer preference and choice required carefully selected and adequate measurement tools. Justification was provided in terms of the choices made to obtain the necessary data, design techniques (focus group, observation, survey and experiment), sampling method and procedures. Participants were randomly assigned to the various experimental groups since representativeness of survey samples is essential for estimating the predominance of various characteristics of the population under study. The statistical generalizability of the study's results depended largely on the sampling procedure chosen – in this case enhanced by randomization of subjects. In terms of Internal validity the aspects of history, maturation, testing, instrumentation, regression, selection, mortality, and selection/maturation interaction are controlled given the presence of random selection and assignment. Any influence of experimenter effects, reactive or interactive effect of testing and reactive effects of the experimental arrangements on External Validity is greatly reduced given the presence of random selection and assignment. Extraneous variables, if any, produced in the experimental group were most likely to produce similar differences in the control group, hence balancing each other. Although the sample is representative of the population and

the treatment is uncomplicated, generalizability may be reduced. Replication of the study by others may confirm findings, thus demonstrating that the possible threats to external validity do not operate.

Chapter 4

Data analysis

This chapter presents an analysis of the data that was collected using a Pretest-Post-test with Control group experiment. The objective of this study was to explore the effectiveness of three digital shopping platforms on the impressions and purchase intention of young consumers. The data was analyzed to obtain insight on whether AR advertisement provides any added advantage to advertised product in the form of relatively greater recall, favorable attitude or a stronger purchase impulse. Furthermore, the analysis provides an understanding on whether interplay with a different interactive system influences the relationship of AR advertising and advertising effectiveness. Data analysis and results are organized and presented according to the main research question. The findings of the study are presented based on 44 hypotheses. Section 4.1 presents the results of the qualitative part of the study; section 4.2 is concerned with preliminary data analysis; section 4.3 reports on the actual data analysis; section 4.4 summarizes the findings.

4.1 Qualitative results: focus group

Focus group interviews, participant observation and self-reports of knowledge and attitudes were adopted as sources of data collection as a qualitative part of the research. This approach assisted in obtaining preliminary insights in developing an approach for thorough investigation. The procedure examined the familiarity, experience, motivations and emotions of AR-based advertising in potential young

consumers. The trial was conducted with a total of 26 participants, all university students under 22 years old. The focus group utilized a *Blippar* AR-based interactive technology, as well as a short movie ad presentation for *Volkswagen Beetle*. Each of the focus groups consisted of six to ten members (Morgan, 1997), a moderate size not difficult to lead and direct. The sample chosen for the pilot included undergraduate University of Porto students, since young adults are commonly targeted by AR applications (Owyang, 2010). The questions asked emerged into three major themes related to (1) general advertising knowledge and awareness (2) level of experience in mobile technology usage (3) AR knowledge motivations and emotions. The ideas which originated during the process of the focus group trial were applied and tested with the advancement of the research process.

4.1.1 Advertising knowledge and awareness

Each focus group began with a more general question that asked each participant to describe whether they were accustomed to look at advertising in magazines, journals or outdoor. Open-ended questions are most appropriate at the start of the discussion because they allow participants to give answers, coming from different perspectives. These questions give the participants an opportunity to express their thoughts and feelings based on the specific situations, allowing for unrestrained and free responses. This ensured a chance for each participant to communicate their first thoughts out loud in front of the group, and consequently to feel comfortable in the setting. Students were encouraged to recall examples of recent advertising or brand names that they have memorized. Generally, a brand is considered memorable once it has gained recognition and is commonly measured by unaided awareness. Therefore, suggestions were not given with these questions as to prevent any possible bias. A few of the participants named some of the distinctive characteristics of particular ads such as slogans, characterizing them with words like “creativity”, “repetitiveness”, and “objectivity”. The attractiveness in advertising was evaluated as having elements of humor, originality, bright colors or interactivity.

P1: “If an ad is unusual we will remember it particularly, otherwise it will be one of the many...”

P2: “Has to be original, different, bright colors, conspicuous...”

P3: "It is not only the slogan, the statement is a question...makes us think more often of advertisements…"

Top-of-mind awareness on advertising showed a sense of the perceived importance of memorable ads, as well as suggested on what are the most important elements for consideration. The participants, who took part in the discussion more often, seemed to have paid more attention to ads in general and had better attitudes toward advertising. It is likely that the ones who paid attention to and had positive attitudes toward ads demonstrated higher recall. This indicated that the ads that were brought up in the discussions were more repetitive or more distinctive in a way, to be remembered in an unaided recall inquiry. Those arguments correspond to the aim of the study to gain deeper comprehension on what are the attributes that would make an ad more effective and engaging to the audience. Seemingly, when an ad lacks originality it tends to lose its newness and may be left undistinguished from the rest. In fact, originality and familiarity have been found to be two of the most important factors in making an ad memorable and to subsequently promote brand memory directly (Pieters, Warlop & Wedel, 2002).

Next, some of the participants commented on the importance of having a famous figure in advertising:

P1:"The thing that marks the announcement is who will use it, for example…soccer shoes, many people buy them because of the player…"

P2:"Perfumes also, sometimes having a particular actor in advertising makes us buy it for that actor or for the wish to be that actor…"

P:3"There's a trailer to promote a game in which enters Robert Downey Jr. and that shows the youtube channel…It was not on TV but was available on the Internet…"

P:4"I remember one of an English school ... with Zezé Camarinha, it is a fun way to look at learning ... and if it comes with a question instead of a statement, makes you think…"

According to the statements participants made, using celebrities in advertising helped them remember the ad. A desire to imitate celebrity lifestyle may be of high importance in purchase decisions. Compared to older audiences, younger

consumers have a greater ability to recall brands using celebrities (Biswas, Hussain & O'Donnell, 2009), due to the fact that celebrity campaigns focus mainly on the feeling and apprehension of a consumer. Other age groups are generally interested in obtaining more detailed information about products or services and therefore not influenced to that extent. Formation of positive attitude and emotional response toward an ad is seen here as a beneficial measure of effective advertising. In addition, using celebrities for advertising in web-based channels (e.g. youtube), where most users are relatively younger and internet-proficient, allows for a non-traditional campaign medium usage (Biswas et al., 2009).

4.1.2 Mobile technology usage

In the questions related to this theme, at first, participants were encouraged to explain in their own words what a smartphone and tablet devices are. None of the participants in the three focus groups owned a smartphone. For tablets two of the participants said that they have access to a device at home, owned by their family members. Although students possessed general good understanding of what a smartphone is, as a main reason for still not owning one they pointed out the high cost of the devices. When asked about functionality of a smartphone, students denoted advantages such as ease of access to internet at any location, applications for everyday life, GPS and listening to music. They were encouraged to give their views on how a smartphone is different from a normal phone:

P1: "It is more than a normal mobile phone…applications are intelligent ... it has youtube, facebook...and has a small application that allows you to see new songs ... gives us 30 seconds and then we can buy the music…"

P2: "Photographic camera, GPS, internet applications…"

P3: "QR codes allow access to a lot of information. At bus stops there is an advertising of a watch with a barcode, which takes me to the Swatch website…"

For tablets students identified several main characteristics such as being practical, portable and saw it as a combination between a smartphone and a computer:

P1: "A computer, more portable and can be used in everyday life, a person can open it anywhere, even on the street. It does not replace the PC, but makes documents faster… notes etc,…a book…"

P2: "The aim is to be practical, it is powerful, the nature of its use is more intuitive…"

P3: "More practical, easy to carry…"

P4:"Evolution, it is a mix of a smart phone and a computer…"

Although none of the students owned a smartphone the way they described the devices was satisfactory and demonstrated that they possess basic knowledge about their usage. An important aspect of the research in investigation was following on participants' opinion formation process. The tablets' portability and ease of use explains why the participants see them as optimal devices compared to smartphones or computers. Currently, "smart" mobile device adoption is in an early stage but just as internet shopping has become integrated into everyday lives, it is likely that mobile usage will also transform consumer behavior in the future. Studying smartphone versus tablet knowledge and usage in young consumers not only provides an insight into the level of technology adoption, but also shows what are some factors of influence (for example family members).

4.1.3 Knowledge of AR

The third theme of questions was addressed towards the knowledge of Augmented Reality by the participants. To the question: "Have you heard the term Augmented Reality?" only two out of twenty six of the participants responded that they had some idea about Augmented Reality technology. The term was associated with "technological innovation", "black and white codes" or "film". However, this was the first experience for all the participants to see and use an AR application. They found the application very entertaining and had a good time during the test.

After watching the advertising movie, participants' emotions and feelings were positive, leading to the identification of several descriptive features:

P1: "Very appealing…unique…"

P2: "…draws attention…"

P3: "…original…"

P4: "It is surprising, it is creative and unexpected…"

When asked to describe the technology with only one word, participants saw it as “innovative”, “revolutionary” “amazing”, “interactive”, “unique” and “interesting”.
Following the movie and the *Blippar* AR application test phase the focus group participants were encouraged to share their experiences. For the *Domino’s* ad students felt the ad was practical, accessible and interesting, and allowed for saving time for a pre-order on the way home, get a discount or easily locate the restaurant. The ASOS print ad was seen as one that gave an option to browse different clothing styles and order directly from the catalogue page. Nike’s ad communicated “positive brand messages”, “confidence” and called for more “attention”. Students also suggested that this way of advertising and displaying of a product can change the way they think.

Another observation in regards to the test was participants’ overall evaluation of advertisement with and without AR usage. The participants were asked to compare both the print ads with the augmented ones in terms of their personal preference. A consensus for greater level of interest toward the AR advertising indicated that students had higher affinity towards the augmented ones.
When addressing the AR application in terms of functionality participants stated that this application is easy to use and is practical. However, in terms of their motivation to use the application, there were some controversies regarding its convenience. Two of the participants mentioned that they could not be sure if they would use the phone to access the advertising unless the ad is very appealing and there is enough available information about the technology.

The overall experience of the participants was exciting and joyful. Students expressed interest in the ads and were surprised. They preferred to get involved in the interactive experience not only to learn about the product, but also for entertainment. This signified that AR advertising was more appealing to the participants in contrast with the conventional print format of the ads.

4.1.4 Limitations

The overall observation of the focus group indicated some promising results in regards to AR advertising, such as a very good first impression of interaction with the application and user experience. However, there were ultimately some limitations that were identified during the course of the trial.

Due to the insufficient amount of studies undertaken and the lack of previous focus group testing in the field of AR and advertising there are no direct suggestions on how to carry out a research, mainly because of the novelty of the topic under investigation. Also, because the sample consisted only of young adults who were unfamiliar with the AR technology, the sample is not representative of all consumers as well as the population is limited to users residing in Portugal.

In terms of technological limitations the devices chosen for the study consisted of two smartphones which were relatively insufficient for a group of ten participants. Also, fully testing interactive features and potential distinctiveness of content was constrained to a certain degree due to the display size of the devices. However, the content used in the study, was initially designed to be viewed particularly on a personal smartphone, mainly as outdoor advertisement aimed at consumers already on the street.

Participants' previous inexperience with AR applications and lack of knowledge evidences currently as another obstacle for further implementation of mobile applications for reaching the primary designation of mass adoption. The main response from the participants was that they did not know what AR is, or if they have heard about it before they did not know how to use it. Familiarizing the general consumer with AR technology in the future may prevent failing in reaching target demographics with mobile AR advertising.

4.2 Preliminary data analyses

4.2.1 Exploratory data analysis (EDA)

Prior to computing any inferential statistics, data was coded, entered into IBM SPSS Statistics, version 22, and Exploratory Data Analysis (EDA) was computed. This procedure consisted of obtaining descriptive statistics and graphs, in order to determine whether data met necessary assumptions for the subsequent statistical analysis. Information about the sample and the different variables was obtained while issues in the data such as outliers, non-normal distributions, coding errors and missing values were eliminated. Mean, standard deviation, skewness, minimum, and maximum values for all cases on all ordinal or scale variables under measure were computed. Missing values were imputed with the median for all ordinal variables using a Likert scale. Missing values represented less than 10% of the sample size since only one case was removed from posttest analysis due to incompletion of

questionnaire. Boxplot graphics were used as a method for identifying outliers, however the use of computer-based scales with five or seven intervals allowing for only one answer for each question prevented the existence of non-authentic values. If extreme values were detected they were not considered incorrect, instead they remained simply as genuine highest/lowest responses. Skewness and kurtosis indexes were the main means of inspecting normality by comparing a variable's distribution to a normal curve. If both values fell in the range from +2 to –2 data were considered normally distributed (Lewis-Beck, Bryman & Liao, 2004). Items with problematic skewness and kurtosis values (between 2 and 3) were observed for potential issues in successive analyses. Those steps were necessary for the purposes of providing fidelity and quality assurance of the data.

Overall, the sample consisted of 74% males and 26% females (Table 4). The average age of participants was 21,61 (*M* = 21.61, *SD* = 3,345). The median, or middle number in the data set was 21 (*Med* = 21), with the most commonly occurring age of 22. The biggest part of the participants (29.3%) reported buying their last pair of sport shoes in the last six months (Figure 9). Twenty six percent of the participants bought shoes less than three months ago, while the rest made a purchase between the last six months and one year (20%) or more than a year ago (24%). Descriptive statistics also showed that 68% of participants have already made purchases online.The products mainly purchased online were electronics (32%), books (26%) and clothes (20.7%) with shoes only forming 9.3%. However, the bigger part of the participants confirmed that have already visited a website for sport shoes (57.3 %) (Fifure 10). The most visited websites were the ones for Nike (41.3%), Addidas (36.7%) and Converse (10.7%). A brand leader in sport shoes purchase was Nike (75.3%), followed by Addidas (66.7%), Puma (22%) and Converse (20.7%). The brands participants felt most familiar with were Nike (96.7%), Addidas (96%) and Puma (60.7%).

Table 4

Descriptive Statistics for Sample by Gender

Gender

		Frequency	*Percent*	*Valid Percent*	*Cumulative Percent*
Valid	M	111	74,0	74,0	74,0
	F	39	26,0	26,0	100,0
	Total	150	100,0	100,0	

Figure 9

Last Purchase of Sport Shoes (in Months).

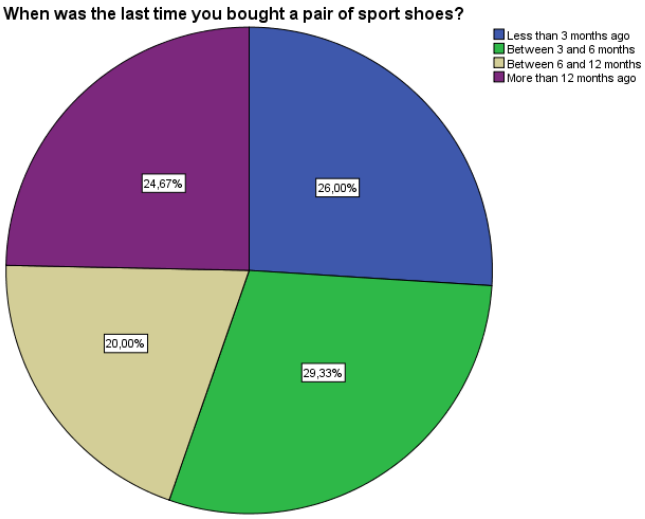
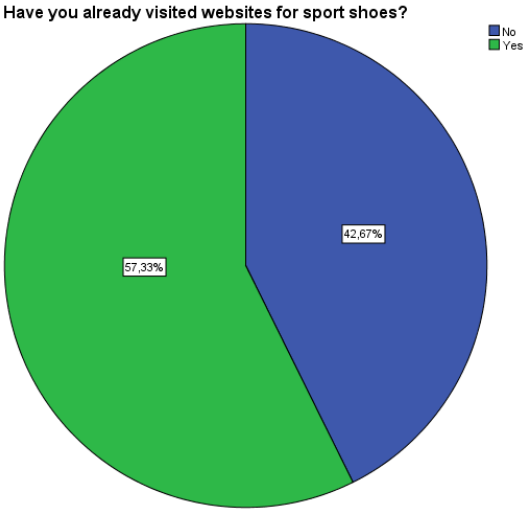


Figure 10

Sport Shoes Website Visits (in %)



4.2.2 Manipulation check

A manipulation check measure was used to determine whether or not the manipulation of the independent variables had its intended effect on the participants. Participants were asked to evaluate the characteristics of the interface they interacted with, relative to usability in terms of ease of use. To investigate whether the manipulation was successful, an a One-way ANOVA with post hoc test was

employed to see whether the means differ significantly. Participants were divided randomly by groups according to their affiliation to a treatment: purely Interactive (n = 49), AR Marker-based (n = 50) and AR Markerless (n = 50). According to results, Levene's test of homogeneity of variance met the assumption, (F = .730, p = .483) and the ANOVA confirmed statistically significant differences between the groups $F(2,146) = 15.001$, $p < .05$). Tukey post-hoc analysis revealed that the mean increase between purely Interactive to AR Marker-based and AR Markerless groups was statistically significant ($p < .05$). As expected, differences among the treatment conditions were present since groups have thus responded significantly different to the question. The test also provided evidence for the construct validity of the manipulation (Cozby, 2009).

4.2.3 Factor analysis

In order to to determine whether the obtained data was suitable for factor analysis two matters were considered: the sample size and the strength of the relationship among the variables. For the first, Tabachnick and Fidell (2001) suggest that although "it is comforting to have at least 300 cases for factor analysis" (p. 588), a smaller sample size (e.g. 150 cases) should be sufficient if solutions have several high loading marker variables (above .80). As for the second matter, it is recommended that an inspection of the correlation matrix for evidence of coefficients is done for results greater than .3 (Tabachnick & Fidell, 2001). To assess factorability of the data two additional measures were performed, namely Bartlett's test of sphericity (Bartlett, 1954) with significance ($p<.05$), and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1970, 1974) index ranges from 0 to 1, with .6 suggested as the minimum value (Tabachnick & Fidell, 2001). Factor analysis was performed to reduce a large number of related variables to a more manageable number, prior to using them in subsequent analysis.

The obtained data was subjected to standard reliability tests utilising a common methodology for survey data reliability testing, otherwise known as the Cronbach's alpha. For the purposes of this study, the recommended minimum threshold of > .6 for reliability was adopted (Malhotra & Birks, 2003) to provide validity and confidence in the acceptance of the data. Items were examined to determine the improvement in the reliability statistic if they were deleted, but care

was taken to ensure that in every case, enough items were retained to ensure validity and adequacy.

4.2.3.1 Domain-specific innovativeness (DSI)

Principal components analysis (PCA) with Varimax rotation was conducted to assess the underlying structure for the six items of the unidimensional Domain-specific innovativeness scale (Goldsmith & Hofacker, 1991). The items were scored on 5-point disagree-agree formats and summed to form an overall DSI score. Most of the coefficients displayed in the correlation matrix scored .3 and above. The Kaiser-Meyer-Oklin value was .768, exceeding the recommended value of .6 (Kaiser, 1970, 1974) and the Barlett's Test of Sphericity (Bartlett, 1954) accounted for statistical significance. PCA revealed the presence of two components with eigenvalues exceeding 1, explaining 34,6 per cent and 29,6 per cent of the variance respectively. The screeplot clearly displayed a break after the second component. The contents of the Rotated Factor Matrix table were examined for items with high loadings from each factor to confirm whether they fit together conceptually and were named accordingly. The interpretation of the two components was consistent with previous research on the DSI scale, with negative affect items constituting on Component 1 (oversight regarding the purchase of new products) and positive affect items (information and willingness to buy) constituting on Component 2. Reliability test was computed only for component one which consisted of 4 out of 6 questions. The obtained Cronbach's alpha value for component 1 was .741 and was considered acceptable. For this scale, since retaining the number of factors is ultimately a researcher's decision depending on study complexity (Cattell, 1966), not the correct number of factors were considered but rather the number of factors worthwhile to retain - in this case one.

4.2.3.2 Emotional Intensity Scale

Similarly, the 30 items of the Emotional Intensity Scale (EIS) were subjected to Principal components analysis. Prior to performing PCA the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The KMO value was .790, with the Barlett's Test of Sphericity (Bartlett, 1954) reaching statistical significance, thus supporting the factorability of the correlation matrix. Principal components analysis computed two components, explaining 16,6 and 14,9 per cent of variance

respectively grouping positive and negative emotional intensity items respectively. The diagonals of the anti-image correlation matrix were all over .5, supporting the inclusion of each item in the factor analysis. Cronbach's alpha scored .820 on the first component and .821 on the second. Thus, the scale reliability was considered satisfactory. Only one factor was retained for clarity in subsequent hypotheis testing.

4.2.3.3 Information seeking

For this scale, composed of five 5-point Likert-type items scored from strongly disagree to strongly agree PCA was also performed. The correlation matrix reported multiple coefficients of values higher than .3. The KMO value was .815, with the Barlett's Test of Sphericity indicating statistical significance. PCA revealed two components with 34,5 percent and 28,5 per cent of variance. The scree plot clearly defined only two components above eigenvalue of 1, explaining 34,5 per cent and 28,5 per cent of the variance. The Rotated Component Matrix also grouped the items with high loadings in two components. The diagonals of the anti-image correlation matrix scored above .7, confirming the addition of each item in the factor analysis. The interpretation of the two components resulted in summing items for opinion leadership in factor 1 and items for information seeking in factor 2. Cronbach's alpha score was.859 for the first component and .697 for the second. While the generally agreed upon lower limit of alpha scores in literature is .7, Hair et al. (2006), suggest that only a value of less than 0.6 would indicate unsatisfactory internal consistency. Therefore, the second factor score was considered valid. Again, only one factor was retained.

4.2.3.4 Perceived risk

PCA with Varimax rotation was again performed on the perceived risk scale, consisting of nine 7-point disagree-agree format items. The correlation matrix revealed sufficient number of scores above the recommended value of .3. KMO test score was .802 and Barlett's Test of Sphericity was statistically significant. All diagonal values of the anti-image correlation matrix were all over .6. Principal component Analysis identified three components with eigenvalues higher than 1, forming 29.2, 26.8 and 19.2 per cent of variance. The scree plot confirmed extraction of 3 components, with the line decreasing after the third component. Rotated component matrix further displayed highest loadings of items to be identified as separate factors. The three components consisted of items which were concerned

with (1) money loss with online purchases, (2) actual functionality of online purchased products and (3) warranties of online purchased products. The results from reliability test and Cronbach's alpha were considered acceptable with scores .847, .842 and .778 for the three factors respectively. Although correct number of factors in this case was three, ultimately only one factor was retained.

4.2.3.5 Arousal

The Arousal scale used in this study was based on Mehrabian and Russell's (1974) original scale. It was composed of the standard six semantic differentials that were intended to measure arousal-related emotional reaction to stimuli plus two additional items (super active/passive and enthusiastic / apathetic). Principal components analysis (PCA) with Varimax rotation was administered to assess the latent structure for the eight items of the scale. The items were scored on 7-point formats and added together to form a total score. The Correlation matrix displayed high correlations of .3 and higher, the KMO value was .821 and Barlett's Test of Sphericity was statistically significant. Items in the anti-image correlation matrix were above .7, while Total variance explained table displayed two components with eigenvalues superior to 1. The two components explained 41,8 and 28, 3 per cent of variance (70, 1 in total). The screeplot graphic also comfirmed the extraction of two factors with the "elbow" appearing after the second component. The items in the Rotated Factor Matrix table with high loadings from each factor were analyzed and grouped accordingly. Reliability tests were conducted for the two components resulting in Cronbach's alpha value of .855 for "responsiveness'' factor and .817 for "arousal" factor respectively confirming a good reliability of the scale.

4.2.3.6 Perceived interface aesthetics

The scale used for this construct was adapted from the original scale developed by Lavie & Tractinsky (2004) with two additional items (response speed and ease of control). PCA with Varimax rotation was the chosen method for factor analysis. The values in the Correlation matrix confirmed multiple correlations of above .3. KMO's test value was .850 and Bartlett's Test of Sphericity was significant. Measures of Sampling Adequacy displayed values of .6 and above confirming applicability to factor analysis. Three components in the Total Variance table surpassed the eigenvalue of 1, with 32,8, 19,5 and 18, 3 per cent of variance. The scree plot supported this result with three components displayed. The Rotated Component

Matrix also showed items with high loadings grouped separately by three components. The items were examined and named accordingly as aesthetics, usability and organization factors. For the aesthetics factor Cronbach's alpha value of .950 was obtained with .804 and .743 for usability and organization. Thus, the scale items were considered satisfactory.

4.2.3.7 Interface evaluation

The eight items comprising the interface evaluation construct were factor analyzed again with a PCA with Varimax rotation. The items were scored on 5-point formats and added together to form a total score. Review of the correlation matrix uncovered the presence of many coefficients of .3 and above. The KMO value was .853 and Barlett's Test of Sphericity was statistically significant. Items in the Anti-image correlation matrix were above .7, while Total variance explained table displayed two components with eigenvalues superior to 1. The two components explained approximately 39,5 and 23, 4 per cent of variance. The scree plot graphic clearly displayed extraction of two factors. The items in the Rotated Factor Matrix table with high loadings from each factor were analyzed and grouped respectively. Reliability tests were conducted for the two components resulting in Cronbach's alpha value of .784 for "fun'' factor and .761 for "boring" factor accordingly confirming a sufficient reliability of the scale.

4.2.3.8 Brand personality

The 11-items scale of the attitude towards preferred brand of sport shoes were subjected to PCA analysis with Varimax rotation.The correlation matrix displayed larger part of coefficients with values above .3. The KMO test reported a value of .874 and Barlett's Test of Sphericity confirmed statistical significance. The Measures of sampling adequacy were all higher than .8 thus validating items for factor analysis inclusion. The Total variance explained table resulted in identification of two components with per cent of variance of 32,1 and 31 respectively. The scree plot identified 2 components with eigenvalue above 1. Varimax rotation grouped items with highest loadings on each of the components and results were used to identify the latent variables represented by each component. The first component encompassed items relating to a brand as "daring" while the second – as "contemporary". Cronbach's alpha coefficient for the first factor was .829 and .871 for the second which confirmed reliability of items.

4.2.4 Cluster analysis

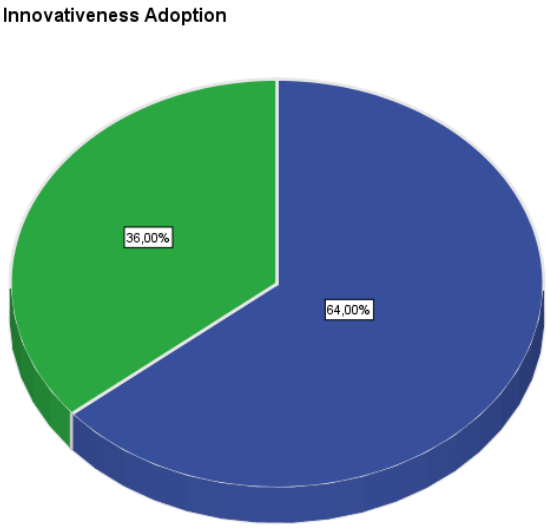
A cluster analysis was run on all cases, each relating to items on corresponding predefined factors (innovativeness, emotional intensity, information seeking, perceived risk, arousal, usability, perceived aesthetics and brand personality). The analysis was performed using IBM SPSS Statistics version 22. A k-means cluster analysis produced two clusters, between which the variables were significantly different in the mean. The purpose of k-means clustering is to create groups of cases with a high degree of similarity within each group and a low degree of similarity between groups (Hastie, Tibshirani & Friedman, 2001). The first cluster was predominant and characterized by high score on each variable under investigation. Participants with values below the mean, fell into the “low” consumer profile segment. By doing so, consumers were described categorically, grouped according to a given condition (e.g low or high Information seeking, etc.) (Figure 11).

First, the Euclidean distance between all the data points for each simulated subject and the initial cluster seeds was calculated, and subjects were assigned to the cluster with the closest cluster centroid. This partitioned the dataset into two clusters with new centroids being computed to update cluster membership. The k-means process of recalculating and reassigning cluster centroids and members continued for 20 iterations until convergence was reached and no further reassignments occurred. Finally, ANOVA was used to compare clusters and define for which variables the clusters are significantly different from one another.

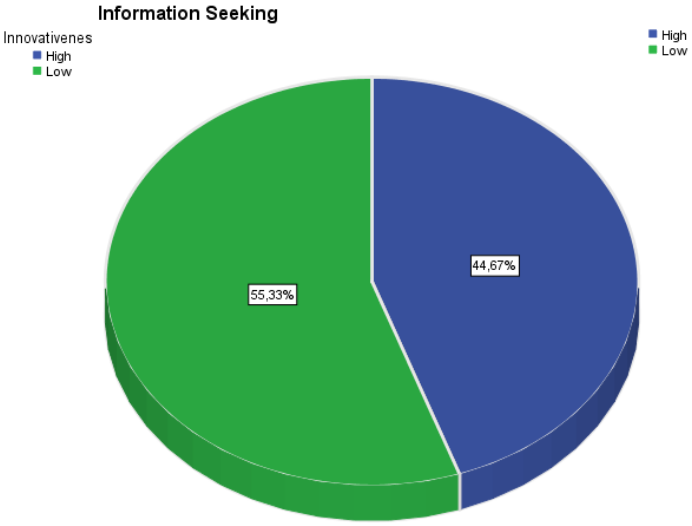
Figure 11

Representation of cluster variables (in %): a) Innovativeness adoption; b) Information seeking; c) Emotional intensity; d) Perceived risk

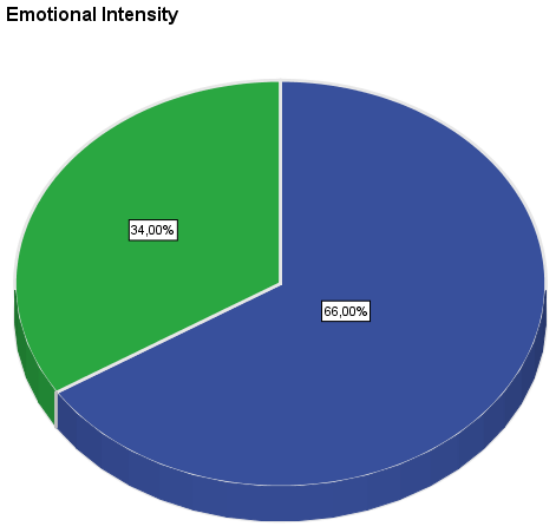
a)



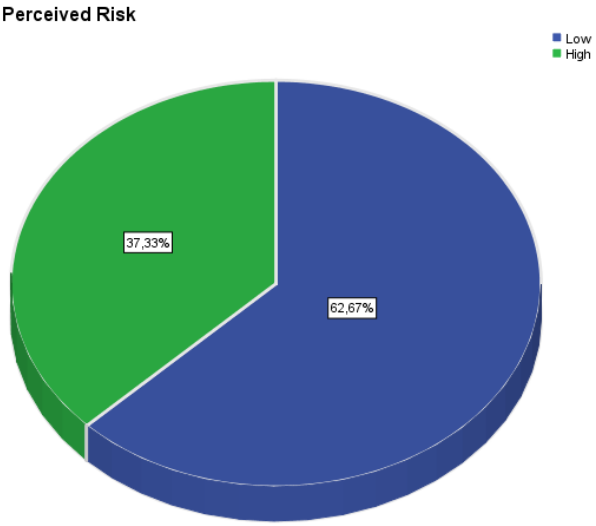
b)



c)



d)



4.3 Data analyses

4.3.1 Differences between groups

Platforms for shopping experiences, using different technologies, may have different impact on consumers' cognitive state and purchase intentions. To determine if levels of Arousal, Responsiveness, Aesthetics, Usability, Organization, Fun, Boring, Daring and Contemporary factors were different for groups in three treatment conditions, a One-way ANOVA with post-hoc tests was conducted. Subjects were divided randomly into three groups according to their affiliation to a treatment: Purely Interactive (or Control group) (n = 49), AR Marker-based (n = 50) and AR Markerless (n = 50). There were no outliers, as assessed by boxplot inspection; data was normally distributed for each group, as assessed by Shapiro-Wilk test ($p > .05$) except AR Marker-based group for Innovation adoption ($p = .045$), AR Markerless group for Emotional Intensity ($p = .047$), AR Markerless group for Opinion leadership ($p = 0.19$), Purely Interactive group ($p = .037$) and AR Marker-based group for Information seeking ($p = .006$), Control group in Arousal ($p = .018$), Purely Interactive group in Aesthetics ($p = .001$), AR Markerless group in Aesthetics ($p = .018$), Control group in Usability ($p = .002$), AR Markerless group in Usability ($p = .048$), AR Markerless group in Organization ($p = .034$), Purely Interactive group in Fun ($p = .010$), AR Markerless group in Fun ($p = .001$), Purely Interactive group in Boring ($p = .040$), AR Markerless group in Boring ($p = .024$) and AR Markerless group in Contemporary ($p=.040$). Although there were deviations from normality, One-way ANOVA is considered robust, particularly if the sample sizes are nearly equal (Liz, Keselman & Keselman, 1996). If sample sizes are not small, fairly skewed distributions are not weighted as problematic (Sawilowsky & Blair, 1992). Furthermore, non-normality does not affect Type I error rate substantially and the One-way ANOVA can be considered robust to non-normality (Maxwell & Delaney, 2004). Even though not all groups were statistically different from each other, inspection of mean values in the levels of Arousal reported to be the highest in the AR Marker-based group, while for Responsiveness the score increased from Purely Interactive to AR Marker-based and to AR Markerless in that order. Highest Aesthetics, Organization, Fun, Daring and Contemporary scores also were reported for AR Markerless group, however for Usability the highest mean value was for the Purely Interactive group. In terms of Boring factor the AR Markerless group also reported highest mean value (Table 5).

Table 5

Descriptive Statistics for dependent variables

Descriptives

Group		*N*	*Mean*	*Std. Deviation*	*Minimum*	*Maximum*
Arousal	Purely Interactive	49	3,527	1,5640	1,0	6,0
	AR Marker-based	50	4,127	1,1145	2,0	6,0
	AR Markerless	50	4,053	1,1534	2,0	6,3
	Total	149	3,905	1,3101	1,0	6,3
Responsiveness	Purely Interactive	49	3,991	1,0061	1,5	6,0
	AR Marker-based	50	4,140	1,0015	2,3	6,3
	AR Markerless	50	4,290	1,1035	1,8	6,5
	Total	149	4,141	1,0385	1,5	6,5
Aesthetics	Purely Interactive	49	3,133	,9154	2,0	5,5
	AR Marker-based	50	3,567	,8234	2,0	5,0
	AR Markerless	50	3,647	,7320	2,2	4,8
	Total	149	3,451	,8513	2,0	5,5
Usability	Purely Interactive	49	4,185	,6320	2,5	5,0
	AR Marker-based	50	3,870	,6333	2,3	5,0
	AR Markerless	50	3,388	,8262	1,8	4,8
	Total	149	3,812	,7722	1,8	5,0
Organization	Purely Interactive	49	3,825	,5866	2,3	5,0
	AR Marker-based	50	3,933	,6801	2,3	5,0
	AR Markerless	50	4,060	,5732	2,7	5,0
	Total	149	3,940	,6187	2,3	5,0
Fun	Purely Interactive	49	3,484	,5775	2,3	5,0
	AR Marker-based	50	3,805	,6046	2,5	5,0
	AR Markerless	50	4,020	,4251	2,8	4,8
	Total	149	3,772	,5811	2,3	5,0
Boring	Purely Interactive	49	3,643	,6595	2,3	5,0
	AR Marker-based	50	4,030	,7083	2,5	5,0
	AR Markerless	50	4,090	,5504	3,0	5,0
	Total	149	3,923	,6684	2,3	5,0
Daring	Purely Interactive	49	3,539	,5512	2,3	4,7
	AR Marker-based	50	3,703	,6652	2,3	5,0
	AR Markerless	50	3,910	,6109	2,3	5,0
	Total	149	3,719	,6259	2,3	5,0
Contemporary	Purely Interactive	49	3,241	,6084	2,0	4,6
	AR Marker-based	50	3,614	,7340	2,0	4,8
	AR Markerless	50	3,704	,7616	1,8	5,0
	Total	149	3,522	,7284	1,8	5,0

The One-way ANOVA assumes that the population variances of the dependent variable are equal for all groups of the independent variable. Therefore, the Levene's test of homogeneity of variance ($p > .05$) was used to determine whether the variance in the scores was the same for each of the three groups. According to the results, the homogeneity of variance assumption was satisfied for Responsiveness, ($F = .137$, $p = .872$), Aesthetics, ($F = .898$, $p = .410$), Organization, ($F = .992$, $p=.373$), Fun, ($F = 2.515$, $p =.084$), Boring, ($F = 1.307$, $p=.274$), Daring, ($F = .344$, $p = .709$) and Contemporary, ($F = .989$, $p = .375$) factors. For Arousal and Usability a Robust Test of Equality of Means, resulted in, Brown-Forsythe's ($F = 3.149$, $df1 = 2$, $df2 = 130.577$, $p = .046$) and ($F = 16.170$, $df1 = 2$, $df2 = 136.664$, $p < .05$) scores respectively.

From the ANOVA report the scores of Arousal, $F(2,146) = 3.163$, $p = .045$), Aesthetics, $F(2,146) = 5.527$, $p < .05$), Usability, $F(2,146) = 16.139$, $p < .05$), Fun, $F(2,146) = 12.284$, $p < .05$), Boring, $F(2,146) = 7.037$, $p < .05$), Daring, $F(2,146) = 4.579$, $p = .012$) and Contemporary, $F(2,146) = 5.968$, $p < .05$) were statistically significantly different between the groups. There were no statistically significant differences in the scores of Responsiveness, $F(2,146) = 1.029$, $p = .360$) and Organization, $F(2,146) = 1.812$, $p = .167$) between the different treatment groups, which showed that participants responded in a similar manner regardless of treatment assignment.

Tukey post-hoc analysis revealed that the mean increase between Purely Interactive and AR Marker-based groups in Aesthetics was statistically significant ($p = .027$) as well as between Purely Interactive and AR Markerless ($p = .007$) groups. For Fun, test groups differed statistically between Purely Interactive and AR Marker-based ($p = .010$) and between Purely Interactive and AR Markerless ($p < .05$). For Boring, according to Tukey post-hoc analysis differences were found between Purely Interactive and AR Marker-based groups ($p = .009$) and Purely Interactive and AR Markerless groups ($p = .002$). For Daring, Tukey post-hoc test showed differences between Purely Interactive and AR Markerless groups ($p = .008$) as well as for Contemporary where there was difference between Purely Interactive and AR Marker-based ($p = .026$) and Purely Interactive and AR Markerless ($p = .004$). For Usability, Games Howell post-hoc analyses showed differences between Purely Interactive and AR Marker-based groups ($p = 0.40$), Purely Interactive group and AR

Markerless group ($p < .05$) and between AR Markerless and AR Marker-based groups ($p = .004$). Summary is shown in Table 6.

Table 6

One-way ANOVA Table of Hypotheses Results

Number	*Hypothesis*	*Analysis*	*Result*
Analysis of differences between groups			
H_A	There are significant differences among groups for Arousal	One-way ANOVA	Accepted
H_B	There are significant differences among groups for Responsiveness	One-way ANOVA	Rejected
H_C	There are significant differences among groups for Perceived Interface Aesthetics	One-way ANOVA	Accepted
H_D	There are significant differences among groups for Usability	One-way ANOVA	Accepted
H_E	There are significant differences among groups for Organization	One-way ANOVA	Rejected
H_F	There are significant differences among groups for Fun	One-way ANOVA	Accepted
H_G	There are significant differences among groups for Boring	One-way ANOVA	Accepted
H_H	There are significant differences among groups for Daring	One-way ANOVA	Accepted
H_I	There are significant differences among groups for Contemporary	One-way ANOVA	Accepted

4.3.2 Differences between clustered segments

Different shopping experiences might influence overall system evaluation along with purchase intentions in the High and Low consumer profile segments. A One-way between-groups Analysis of Variance was conducted also to explore differences between means of High and Low consumer segments of Arousal, Responsiveness, Aesthetics, Usability, Organization, Fun, Boring, Daring and Contemporary variables according to clustered variables of Innovation adoption, Emotional intensity, Information seeking and Perceived risk.

For Innovation adoption the Levene's test homogeneity of variance (p > .05) was confirmed for Arousal, (F = 1.168, p = .282), Aesthetics (F = .452, p = .502), Usability (F = 3.222, p = .075), Organization (F = .153, p = .696), Fun (F = 2.109, p = .149), Boring (F = .743, p = .390), Daring (F = 2.231, p = .137) and Contemporary (F = 1.717, p = .192). Results did not confirm homogeneity of variance for only one variable – Responsiveness (F = 9,459 p = .003).

In ANOVA The variables Organization, $F(1,147) = 5.744$, p = .018 and Daring, $F(1,147) = 6.745$, p = .010, were statistically significantly different between the levels of Innovation adoption. There were no statistically significant differences in the rest of the variables.

For Emotional intensity the assumption of homogeneity of variances was violated for all variables, as assessed by Levene's Test of Homogeneity of Variance (p >.05) however Robust Test of Equality of Means was satisfied for Responsiveness, Welch, (F = 3.928, $df1$ = 1, $df2$ = 119.600, p = .050) and Boring (F = 4.073, $df1$ = 1, $df2$ = 98.456, p = .046). In ANOVA the variable Boring, $F(1,147)$ = 4.162, p = .043 was statistically significantly different between the levels of Emotional intensity. There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p > .05) for all variables in Information seeking: Arousal (F = 2.542, p = .113), Responsiveness (F = .909, p = .342), Aesthetics (F = .78, p = .781), Usability (F = .230, p = .632), Organization (F = .559, p = .456), Fun (F = .090, p = .764), Boring (F = .337, p = .563), Daring (F = 1.383, p = .242) and Contemporary (F = .734, p = .393). ANOVA confirmed that the variables Aesthetics, $F(1,147)$ = 4.609, p = .011, Fun $F(1,147) = 6.866$, p = .010, Daring $F(1,147) = 14.227$, $p < .05$ and Contemporary $F(1,147) = 11.718$, p = .001 were statistically significantly different between the levels of Information seeking. No statistically significant differences were found in the rest of the variables.

There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance ($p > .05$) for all variables in Perceived risk: Arousal ($F = .025$ $p = .875$), Responsiveness ($F = .213$, $p = .645$), Aesthetics ($F = .722$, $p = .397$), Usability ($F = 1.587$, $p = .210$), Organization ($F = .367$, $p = .546$), Boring ($F = 1.259$, $p = .264$), Daring ($F = .228$, $p = .634$) and Contemporary ($F = .176$, $p = .675$) except Fun, where assumption for homogeneity of variance was violated ($p = .032$).

Robust Test of Equality of Means reported violation for all variables. As for ANOVA no statistically significant differences were found in any of the variables ($p < .05$).

4.3.3 Hypotheses testing

Following the analysis of determining if levels of dependent variables were different for groups in the treatment conditions, it was then possible to proceed with analysis of individual hypothesis. To do that a Two-way ANOVA was used in order to compare the mean differences between the different groups that have been split on two independent variables. The primary purpose of a Two-way ANOVA was to understand if there was an interaction between the two independent variables on the dependent variable.

In this study the two independent variables are the group treatment condition and the pre-defined consumer constructs (Innovativeness adoption, Emotional intensity, Information seeking and Perceived risk). The measured dependent variables are the ones for Arousal, Responsiveness, Aesthetics, Usability, Organization, Fun, Boring, Daring and Contemporary. The subsequent hypotheses testing investigates how the independent variables interact to predict the dependent ones. In other words, it is believed that the effect of measured independent variables on the dependent ones would depend on the treatment condition.

4.3.3.1 Arousal

A two-way design was used to test the “main effect” for group treatment and Innovativeness adoption. The possibility of an “interaction effect” was explored to define whether the effect of the treatment on Arousal would depend on Innovativeness adoption.

H_{1a}: Within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions.

The hypothesis was tested through a Two-way between-groups Analysis of Variance to explore the impact of Innovation on levels of Arousal. Homogeneity of variances was violated, as assessed by Levene's Test of Homogeneity of Variance (p > .05). There was a statistically significant difference between the Group score of the three treatment conditions, $F(2, 143) = 3.765$, $p = .026$, partial $\eta^2 = .680$ and Arousal. This signifies that testing the main effect of Group for differences between levels of Arousal was done regardless of Innovativeness adoption. The rest of the results indicated that there was no interaction between Innovativeness and the different groups on Arousal. Tukey post-hoc analysis reported that Arousal's score was not statistically significant in the purely Interactive, AR Marker-based and AR Markerless groups. Therefore, there is no sufficient evidence to reject the null hypothesis.

H_{1b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions.

The next hypothesis was tested to explore whether the effect of the treatment on Arousal would depend on Emotional intensity. Homogeneity of variances was violated, as assessed by Levene's Test of Homogeneity of Variance (p > .05). The results indicated that there was no interaction effect or significant difference in the effect of Emotional intensity in the different groups on Arousal. Tukey post-hoc analysis reported that Arousal's score was not statistically significant in the purely Interactive, AR Marker-based and AR Markerless groups. Thus, hypothesis H_{1b} was rejected.

For the next hypothesis, it was examined whether the effect of the treatment on Arousal would depend on Information seeking:

H_{1c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions.

A Two-way between-groups Analysis of Variance was conducted to explore the impact of Information seeking on levels of Arousal. Homogeneity of variances was violated, as assessed by Levene's Test of Homogeneity of Variance (p > .05). There was a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 3.310$, $p = .039$, partial $\eta^2 = .620$. Results also indicated that there was no interaction effect of Information seeking in the different groups on Arousal. There was also no statistically significant difference between levels of Information seeking, $F(1, 143) = .625$, $p = .430$, partial $\eta^2 = .123$ for Arousal's score. Tukey post-hoc analysis reported that Arousal's score was not statistically significant in the Purely Interactive, AR Marker-based and AR Markerless groups. Hypothesis H_{1c} was rejected.

For the subsequent hypothesis:

> H_{1d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions,

again, a Two-way between-groups Analysis of Variance was conducted to explore the impact of Perceived risk on levels of Arousal. Homogeneity of variances was violated, as assessed by Levene's Test of Homogeneity of Variance (p > .05). For Interaction effects the results indicated that there was no interaction or significant difference in the effect of Perceived risk in the different groups on Arousal. Tukey post-hoc analysis reported that Arousal's score was not statistically significant in the Purely Interactive, AR Marker-based and AR Markerless groups. This signifies that participants in the AR condition were not found to experience higher Arousal levels within the low Perceived risk segment, thus rejecting the hypothesis.

4.3.3.2 Responsiveness

The possibility of "main effect" and "interaction effect" was explored to define whether the effect of the treatment on Responsiveness would depend on Innovativeness adoption:

> H_{2a}: Within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.

The Two-way between-groups ANOVA revealed that homogeneity of variances was violated, as assessed by Levene's Test of Homogeneity of Variance (p > .05). Interaction effects test indicated no iteraction and did not produce statistically significant difference in the effect of Innovativeness Adoption in the different groups on Responsiveness. Tukey post-hoc analysis reported that Responsiveness's score was not statistically significant in the purely Interactive, AR Marker-based and AR Markerless groups. Hypothesis H_{2a} was rejected.

Next, hypothesis H_{2b} was tested:

> H_{2b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.

A two-way between-groups ANOVA was conducted again to explore the impact of Emotional intensity on levels of Responsiveness. There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .384). Tests of Between-Subjects Effects showed that there was a statistically significant difference between Emotional intensity and levels of Responsiveness, $F(1,143)$ = 4.198, p = .042, partial $\eta 2$ = .530. Although there was some evidence for a statistically significant effect on the dependent variable, Tukey post-hoc analysis reported that Responsiveness's score was not statistically significant in any of the groups. Thus, hypothesis H_{2b} was rejected.

Following up with the next hypothesis, again a two-way ANOVA was conducted:

> H_{2c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.

For this hypothesis homogeneity of variances was satisfied, as assessed by Levene's Test of Homogeneity of Variance (p = .868). Interaction effects results did not indicate any significant difference in the effect of Information seeking in the different groups on Responsiveness. Tukey post-hoc analysis reported that Responsiveness's score was not statistically significant in the purely Interactive, AR Marker-based and AR Markerless groups. Hypothesis H_{2c} was also rejected.

The next two-way between-groups analysis of variance was conducted to explore if there was statistically significant effect of Perceived risk on levels of Responsiveness:

> H_{2d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.

For this case, there was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .756), however Interaction effects were not reported and results did not imply significant difference in the effect of Perceived risk in the different groups on Responsiveness. Tukey post-hoc analysis reported that Responsiveness's score was not statistically significant in the purely Interactive, AR Marker-based and AR Markerless groups. The hypothesis was rejected.

4.3.3.3 Perceived interface aesthetics

A two-way between-groups analysis of variance was conducted to explore whether an "interaction effect" might occur and if the effect of the treatment on perceived Interface aesthetics would depend on Innovativeness adoption.

> H_{3a}: Within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, account for higher Perceived interface aesthetics evaluation, compared to AR Marker-based and purely Interactive conditions.

Levene's Test of Homogeneity of Variance confirmed homogeneity of variances (p = .275) and there was a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 5.346$, p = .006, partial η^2 = .834. Tukey post-hoc analysis revealed that the mean increase between purely Interactive and AR Marker-based group in Perceived interface aesthetics was statistically significant (p = .026) as well as between purely Interactive and AR Markerless (p = .006) groups. Thus, hypothesis H_{3a} can be regarded as partially confirmed. This result signifies that differences in the high Innovativeness adoption segment exist between the Purely Interactive group and the other two separately.

To investigate whether interaction effect and statistical significance exist in the Emotional intensity cluster the following hypothesis was tested with a two-way ANOVA:

> H_{3b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, account for higher Perceived interface aesthetics evaluation, compared to AR Marker-based and purely Interactive conditions.

The homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .676) was confirmed. Tests of Between-Subjects Effects reported that there was a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 4.483$, p = .013, partial η^2 = .760. Tukey post-hoc analysis showed that the mean increase between purely Interactive and AR Marker-based group in Aesthetics was statistically significant (p = .027) as well as between purely Interactive and AR Markerless (p = .007) groups. The hypothesis is true for purely Interactive and AR Marker-based and purely Interactive and AR Markerless, but not for Marker-based and AR Markerless groups. Again, this hypothesis was partially confirmed due to existing differences in groups.

The next hypothesis to be tested was concerned with intent to seek information:

> H_{3c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, account for higher Perceived interface aesthetics evaluation, compared to AR Marker-based and purely Interactive conditions.

Homogeneity of variances here was violated, as assessed by Levene's Test of Homogeneity of Variance (p > .05), however there was a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 4.979$, p = .008, partial η^2 = .805 and Information seeking $F(1, 143) = 5.366$, p = .022, partial η^2 = .633. Tukey post-hoc analysis revealed that the mean increase between purely Interactive and AR Marker-based group in Perceived interface aesthetics was statistically significant (p = .023) as well as between purely Interactive and AR Markerless (p = .005) groups. This hypothesis was partially confirmed.

In terms of Perceived risk, the following hypothesis was tested:

H_{3d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition account for higher Perceived interface aesthetics evaluation, compared to AR Marker-based and purely Interactive conditions.

There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .602) a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 6.047$, p = .003, partial η^2 = .879. Tukey post-hoc analysis reported that the mean increase between Purely Interactive Group and AR Marker-based group in Perceived interface aesthetics was statistically significant (p = .028) as well as between Purely Interactive and AR Markerless (p = .007) groups. Therefore, hypothesis H_{3d} can be partially accepted.

4.3.3.4 Usability

For Usability features it was hypothesized that:

H_{4a}: Within the low Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.

A two-way between-groups analysis of variance was conducted to explore the impact of Innovativeness adoption on levels of Usability features. Homogeneity of variances was violated, as assessed by Levene's Test of Homogeneity of Variance (p > .05). Tests of Between-Subjects Effects reported a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 18.193$, p <.05, partial η^2 = 1.000. There was a statistically significant difference between Innovativeness segment and Usability features, $F(2,143) = 3.328$, p = .039, partial η2 = .622. Tukey post-hoc analysis reported that the mean increase between all three groups in Usability was statistically significant: Purely Interactive Group and AR Marker-based group (p = .065), between Purely Interactive and AR Markerless (p <.05) and between AR Marker-based and AR Markerless (p = .002). This hypothesis was partially accepted.

The next hypothesis to be tested was concerned with Emotional intensity:

H_{4b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.

A two-way between-groups analysis of variance was conducted to explore the impact of Emotional intensity on levels of Usability. Homogeneity of variances was not violated, as assessed by Levene's Test of Homogeneity of Variance (p = .106). Tests of Between-Subjects Effects showed a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 16.243$, $p < .05$, partial $\eta^2 = 1.000$. There was a statistically significant difference between the group score, $F(2,143) = 16.243$, $p < .05$, partial $\eta 2 = .1.000$. Also, there was statistically significant difference between Purely Interactive and AR Markerless ($p < .05$), and between AR Marker-based and AR Markerless (p = .002) groups as shown by Tukey post-hoc analysis. This evidence suggests that the H_{4b} hypothesis is true for Purely Interactive and AR Markerless and AR Marker-based and AR Markerless.
To compare the mean differences between the different groups in the next hypothesis a two-way ANOVA analysis was applied:

H_{4c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.

The homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .065) was present. There was also a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 15.682$, $p < .05$, partial $\eta^2 = .999$. The mean increase between Purely Interactive group and AR Markerless group in Usability was statistically significant ($p < .05$) as well as between AR Marker-based and AR Markerless (p = .002) groups, as seen in Tukey post-hoc analysis. Hypothesis H_{4c} was partially confirmed.

The last hypothesis in terms of Usability features was again tested by two-way ANOVA:

H_{4d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.

For this hypothesis homogeneity of variances was violated, as assessed by Levene's Test of Homogeneity of Variance (p > .05). Tests of Between-Subjects Effects reported statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 16.207$, p <.05, partial $\eta^2 = 1.000$. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive group and Markerless AR group in Usability was statistically significant (p <.05) and between AR Marker-based and AR Markerless (p = .002). Hypothesis H_{4d} was partially confirmed.

4.3.3.5 Organization

For Organization the first hypothesis stated that:

H_{5a}: Within the low Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions.

The two-way ANOVA revealed that there was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .415). Tests of Between-Subjects Effects reported that there was a statistically significant difference in Innovativeness score for Organization $F(1, 143) = 6.105$, p = .015, partial η^2 = .689. Tukey post-hoc analysis reported that Organization's score was not statistically significant for any of the groups. Therefore hypothesis H_{5a} was rejected.

The next hypothesis to be tested with two-way ANOVA was formulated as:

H_{5b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions.

There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .135). The results from Tests of Between-Subjects Effects indicated that there was no interaction effect or significant difference in the effect of Emotional intensity in the different groups on Organization. Tukey post-hoc analysis reported that Organization's score was not statistically significant in the

Purely Interactive, AR Marker-based and AR Markerless groups. Therefore H_{5b} hypothesis was rejected.

Subsequently the following hypothesis was examined:

> H_{5c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions.

There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .665). Tests of Between-Subjects Effects reported that there was no significant difference in the effect of Information seeking in the different groups on Organization. Tukey post-hoc analysis confirmed that Organization's score was not statistically significant in the Purely Interactive, AR Marker-based and AR Markerless groups. Thus hypothesis H_{5c} was rejected.

The next hypothesis to be tested:

> H_{5d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions,

revealed that Levene's Test of Homogeneity of Variance (p = .408) was confirmed. Tests of Between-Subjects Effects indicated that there was no significant difference in the effect of Perceived risk in the different groups on Organization. Tukey post-hoc analysis reported that Organization's score was not statistically significant in the Purely Interactive, AR Marker-based and AR Markerless groups. Therefore the hypothesis was rejected.

4.3.3.6 Fun

The first hypothesis to be tested for influence of the independent variables on Fun was stated as:

> H_{6a}: Within the low Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.

There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .238). Tests of Between-Subjects Effects showed a statistically significant difference in Group score for Fun $F(2, 143) = 11.282$, $p < .05$, partial $\eta^2 = .992$. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive group and AR Marker-based group in Fun was statistically significant (p =.011) as well as between purely Interactive and AR Markerless (p < .05) groups. Thus, H_{6a} hypothesis was partially confirmed for Purely Interactive group and AR Marker-based groups.

Following up, it has been hypothesized that:

> H_{6b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.

Two-way ANOVA revealed that there was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .404). Tests of Between-Subjects Effects discovered a statistically significant difference in Group score for Fun $F(2, 143) = 11.014$, $p < .05$, partial $\eta^2 = .990$. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive Group and AR Marker-based group in Fun was statistically significant (p =.011) as well as between Purely Interactive and AR Markerless (p < .05) groups. Although some differences were present, they were minimal and not enough to retain the alternative hypothesis.

In relation to consumer's Intention to seek information it was believed that:

> H_{6c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.

For this case, Levene's Test of Homogeneity of Variance (p = .233) confirmed homogeneity of variances. There was a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 11.540$, $p < .05$, partial $\eta^2 = .993$ and in Information seeking for Fun, $F(1, 143) = 5.691$, $p = .018$, partial $\eta^2 = .659$ as assessed by Tests of Between-Subjects Effects. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive group and AR Marker-based group in Fun was statistically significant (p =.009) as well as between Purely

Interactive and AR Markerless (p < .05) groups. Thus, hypothesis H_{6c} was partially confirmed.

Subsequently, the independent variable of Perceived risk was tested, again with two-way ANOVA:

> H_{6d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.

There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .059). Tests of Between-Subjects Effects reported a statistically significant difference in Group score for Fun $F(2, 143) = 13.848$, p < .05, partial η^2 = .998. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive Group and AR Marker-based group in Fun was statistically significant (p =.010) as well as between Purely Interactive and AR Markerless (p < .05) groups. Thus hypothesis H_{6d} was partially confirmed.

4.3.3.7 Boring

In terms of levels of Boring, it was believed that:

> H_{7a}: Within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, exhibit lower level of Boredom compared to AR Marker-based and purely Interactive conditions.

Homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .730) was confirmed. Tests of Between-Subjects Effects showed statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 7.355$, p = .001, partial η^2 = .935 and between Group and Innovativeness on Boring $F(2, 143) = 3.375$, p = .037, partial η^2 = .629. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive group and AR Marker-based group in Boring was statistically significant (p =.007) as well as between Purely Interactive and AR Markerless (p = .002) groups. Thus, the hypothesis was partially confirmed.

Next, the following hypothesis was assessed:

H_{7b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, exhibit lower level of Boredom compared to AR Marker-based and purely Interactive conditions.

For this hypothesis there was homogeneity of variances, as confirmed by Levene's Test of Homogeneity of Variance (p = .685). Tests of Between-Subjects Effects reported a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 7.149$, p = .001, partial η^2 = .928. Tukey post-hoc analysis affirmed that the mean increase between Purely Interactive group and AR Marker-based group in Boring was statistically significant (p =.009) as well as between Purely Interactive and AR Markerless (p = .002) groups. Thus the hypothesis was partially confirmed.

The last hypothesis to be tested with Two-way ANOVA, concerning the dependent variable of Boredom,

H_{7c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, exhibit lower level of Boredom compared to AR Marker-based and purely Interactive conditions,

confirmed Levene's Test of Homogeneity of Variance (p = .668). In Tests of Between-Subjects Effects there was a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 6.758$, p = .002, partial η^2 = .913. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive group and AR Marker-based group in Boring was statistically significant (p =.008) as well as between Purely Interactive and AR Markerless (p = .002) groups. The hypothesis was partially accepted for those groups.

4.3.3.8 Daring

Whether “main” or “interaction effect” among the treatments on Responsiveness would depend on Innovativeness adoption was assesses by the following:

H_{8a}: Within the high Innovativeness Adoption consumer profile segment, the participants in the AR Markerless condition, exhibit higher Daring level compared to AR Marker-based and purely Interactive conditions.

There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .163). Tests of Between-Subjects Effects reported statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 6.598$, p = .002, partial η^2 = .906 and Innovativeness $F(1, 143) = 8.153$, p = .005, partial η^2 = .810. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive Group and AR Markerless group in Daring was statistically significant (p =.006) Thus, the hypothesis was partially confirmed for those groups.

Next, it has been hypothesized that:

> H_{8b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, exhibit higher Daring level compared to AR Marker-based and purely Interactive conditions.

Two-way ANOVA produced Levene's Test of Homogeneity of Variance (p = .864) confirming homogeneity of variances. The results from Tests of Between-Subjects Effects indicated that there was no significant difference in the effect of Emotional intensity in the different groups on Daring. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive group and AR Markerless group in Daring was statistically significant (p =.008). Due to lack of sufficient evidence for differences among the groups the hypothesis was rejected.

Two-way ANOVA was computed to assess whether:

> H_{8c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, exhibit higher Daring level compared to AR Marker-based and purely Interactive conditions.

For this hypothesis there was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .413). There was a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 4.301$, p = .015, partial η^2 = .741 and Information seeking $F(1, 143) = 13.370$, $p < .05$, partial η^2 = .953 as shown in Tests of Between-Subjects Effects. Tukey post-hoc analysis reported that the mean increase between Purely Interactive group and AR Markerless group in Daring was statistically significant (p =.006). Therefore the hypothesis was partially accepted.

For Perceived Risk it was believed that:

> H_{8d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, exhibit higher Daring level compared to AR Marker-based and purely Interactive conditions.

Homogeneity of variances was confirmed by Levene's Test of Homogeneity of Variance (p = .408). A statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 4.147$, p = .018, partial η^2 = .724 was detected in the Tests of Between-Subjects Effects. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive group and AR Markerless group in Daring was statistically significant (p =.009). Thus, the hypothesis was partially accepted.

4.3.3.9 Contemporary

For Contemporary the first hypothesis stated that:

> H_{9a}: Within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.

There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p = .199). Tests of Between-Subjects Effects revealed that there was statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 5.850$, p = .004, partial η^2 = .867. Tukey post-hoc analysis reported that the mean increase between Purely Interactive group and AR Marker-based group in Contemporary was statistically significant (p = .025) and between Purely Interactive and AR Markerless (p = .004) groups. Thus, the hypothesis was partially accepted for those groups.

For Emotional intensity it was believe that:

> H_{9b}: Within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.

Homogeneity of variances was confirmed by Levene's Test of Homogeneity of Variance (p = .639) in the Two-way ANOVA. Tests of Between-Subjects Effects showed a statistically significant difference in Group score between the three

treatment conditions, $F(2, 143) = 4.780$, $p = .010$, partial $\eta^2 = .788$. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive group and AR Marker-based group in Contemporary was statistically significant ($p = .026$) as well as between Purely Interactive and AR Markerless ($p = .004$) groups. This evidence suggested that the hypothesis be partially accepted.

The next hypothesis to be tested concerning consumers' Intent to seek information applied Two-way ANOVA:

> H_{9c}: Within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.

Levene's Test of Homogeneity of Variance ($p = .656$) confirmed homogeneity of variances. Tests of Between-Subjects Effects reported a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 5.240$, $p = .006$, partial $\eta^2 = .826$ and Information seeking $F(1, 143) = 10.168$, $p = .002$, partial $\eta^2 = .886$. Tukey post-hoc analysis revealed that the mean increase between Purely Interactive group and AR Marker-based group in Contemporary was statistically significant ($p = .021$) and between Purely Interactive and AR Markerless ($p = .003$) groups. Therefore, the hypothesis was partially accepted.

Lastly, it was hypothesized that:

> H_{9d}: Within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.

The homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance ($p = .497$) was supported. Tests of Between-Subjects Effects showed a statistically significant difference in Group score between the three treatment conditions, $F(2, 143) = 6.397$, $p = .002$, partial $\eta^2 = .897$. The mean increase between Purely Interactive group and AR Marker-based group in Contemporary was statistically significant ($p = .027$) and between Purely Interactive and AR Markerless ($p = .004$) groups as reported by Tukey post-hoc analysis. Therefore, the hypothesis was partially accepted.

Even though statistically significant interaction was not present at any of the hypotheses tests, statistically significant differences between the groups existed. Chapter Five discusses in detail the implications of these analyses. Summary of the results of the hypotheses test are given in Table 7.

Table 7

Two-way ANOVA Table of Hypotheses Results

Number	*Hypothesis*	*Analysis*	*Result*
Analysis of comparison of mean differences between groups			
H_{1a}	Within the high Innovativeness Adoption consumer profile segment, the participants in the AR condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{1b}	Within the high Emotional Intensity consumer profile segment, the participants in the AR condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{1c}	Within the high Information seeking consumer profile segment, the participants in the AR condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{1d}	Within the low Perceived Risk consumer profile segment, the participants in the AR condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{2a}	Within the high Innovativeness Adoption consumer profile segment, the participants in the AR condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{2b}	Within the high Emotional Intensity consumer profile segment, the participants in the AR condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{2c}	Within the high Information seeking consumer profile segment, the participants in the AR condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{2d}	Within the low Perceived Risk consumer profile segment, the participants in the AR condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{3a}	Within the high Innovativeness Adoption consumer profile segment, the participants in the AR condition, account for higher Perceived Interface aesthetics evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{3b}	Within the high Emotional Intensity consumer profile segment, the participants in the AR condition, account for higher Perceived Interface aesthetics evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{3c}	Within the high Information seeking consumer profile segment, the participants in the AR condition, account for higher Perceived Interface aesthetics evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{3d}	Within the low Perceived Risk consumer profile segment, the participants in the AR condition account for higher Perceived Interface aesthetics evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted

H_{4a}	Within the low Innovativeness Adoption consumer profile segment, the participants in the AR condition, account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{4b}	Within the high Emotional Intensity consumer profile segment, the participants in the AR condition account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{4c}	Within the high Information seeking consumer profile segment, the participants in the AR condition account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{4d}	Within the low Perceived Risk consumer profile segment, the participants in the AR condition account for higher Usability features evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{5a}	Within the low Innovativeness Adoption consumer profile segment, the participants in the AR condition account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{5b}	Within the high Emotional Intensity consumer profile segment, the participants in the AR condition account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{5c}	Within the high Information seeking information consumer profile segment, the participants in the AR condition account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{5d}	Within the low Perceived Risk consumer profile segment, the participants in the AR condition, account for higher Organization evaluation, compared to AR Marker-based and purely Interactive conditions	Two-way ANOVA	Rejected
H_{6a}	Within the low Innovativeness Adoption consumer profile segment, the participants in the AR condition account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{6b}	Within the high Emotional Intensity consumer profile segment, the participants in the AR condition account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{6c}	Within the high Information seeking consumer profile segment, the participants in the AR condition, account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{6d}	Within the low Perceived Risk consumer profile segment, the participants in the AR condition account for higher Fun evaluation, compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{7a}	Within the high Innovativeness Adoption consumer profile segment, the participants in the AR condition, exhibit lower level of Boredom compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted

H_{7b}	Within the high Emotional Intensity consumer profile segment, the participants in the AR condition, exhibit lower level of Boredom compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{7c}	Within the high Intent to seek information consumer profile segment, the participants in the AR condition, exhibit lower level of Boredom compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{8a}	Within the high Innovativeness Adoption consumer profile segment, the participants in the AR condition, exhibit higher Daring levels compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{8b}	Within the high Emotional Intensity consumer profile segment, the participants in the AR condition, exhibit higher Daring level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Rejected
H_{8c}	Within the high Information seeking consumer profile segment, the participants in the AR condition, exhibit higher Daring level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{8d}	Within the low Perceived Risk consumer profile segment, the participants in the AR condition, exhibit higher Daring level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{9a}	Within the high Innovativeness Adoption consumer profile segment, the participants in the AR condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{9b}	Within the high Emotional Intensity consumer profile segment, the participants in the AR condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{9c}	Within the high Intent to seek information consumer profile segment, the participants in the AR condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted
H_{9d}	Within the low Perceived Risk consumer profile segment, the participants in the AR condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions.	Two-way ANOVA	Partially accepted

4.3.4 Purchase intention towards Converse brand

A questionnaire with 4 items using 1 to 7 Likert scales was employed to measure different, underlying constructs regarding potential purchases of Converse All Stars brand. The scale had a high level of internal consistency, as determined by a Cronbach's alpha of .920. To determine whether there were any differences between the means of three independent groups, a One-way ANOVA was used. Participants kept the original assignment into the three groups of Purely Interactive (n = 49), AR Marker-based (n = 50), and AR Markerless (n = 50). There were no outliers, as assessed by boxplot; data was normally distributed for each group, as assessed by Shapiro-Wilk test ($p > .05$); and there was homogeneity of variances, as assessed by Levene's test of homogeneity of variances for item 6.1 ($p = .012$). Future relationship score was statistically significantly different between different levels of the groups, $F(2,146) = 4.524$, $p < .012$, as well as probability to choose Converse for a next purchase $F(2,146) = 4.059$, $p < .019$, the probability to visit Converse website $F(2,146) = 3.716$, $p < .027$ and the probability to recommend the Converse brand $F(2,146) = 5.726$, $p < .004$. The probability of relating to, choosing, buying, recommending and visiting Converse website increased from Purely Interactive to AR Marker-based and AR Markerless groups, as seen in Table 8. Tukey post-hoc test showed statistically significant differences between Purely Interactive and AR Markerless for Future relationship ($p = .009$), for probability to buy Converse brand ($p = .025$), for probability to visit Converse website ($p = .021$) and for probability to recommend the brand ($p = .003$) but no other group differences were statistically significant.

As a second step a cluster analysis was run on all items and was performed using IBM SPSS Statistics version 22. A k-means cluster analysis produced two clusters, between which the variables were significantly different in the mean. Participants with values below the mean were grouped into the “low” consumer profile segment and consumers with values above the mean – into the ”high” consumer segment. This way, consumers were described categorically and were grouped according to the probability of relating to, choosing, buying, recommending Converse or visiting the brand website.

The k-means process of computing and selecting cluster centroids and members continued for 20 iterations until convergence was reached and no further changes were made. ANOVA compared clusters and provided information on which

variables the clusters are significantly different from one another. All items were significant ($p < .05$). As a final step Logistic Regression analysis was conducted in order to predict the probability that an observation falls into one of two categories of a dichotomous dependent variable based on the three independent variables. All observations were assigned to the category predicted as most likely.

The model explained 22.4% (Nagelkerke R^2) of the variance in likelihood to choose Converse for a next purchase and correctly classified 69.6 % of cases. Sensitivity was 53.3%, specificity was 80.7%. Of the 15 predictor variables only two were statistically significant: Arousal and Responsiveness (Table 9).

For likelihood to buy Converse brand in the future the model explained 13.9% (Nagelkerke R^2) of the variance and correctly classified 67.6 % of cases. Sensitivity was 41.4% and specificity - 84.4%. Of the 15 predictor variables only one was statistically significant: Responsiveness (Table 10).

For likelihood to visit Converse website the model explained 21.7% (Nagelkerke R^2) of the variance and correctly classified 64.9 % of cases. Sensitivity was 72.2% and specificity – 56.5 %. Of the 15 predictor variables only one was statistically significant: Organization (Table 11).

The model explained 29.8% (Nagelkerke R^2) of the variance in likelihood to recommend Converse brand and correctly classified 70.3 % of cases. Sensitivity was 76.3%, specificity was 63.2%. Of the 15 predictor variables only two were statistically significant: Responsiveness and Organization, as seen in Table 12.

Table 8

Item Statistics for Future Relation Scale

Descriptives

		N	*Mean*	*Std. Deviation*	*Minimum*	*Maximum*
6.1 What is the probablility to choose Converse (All Stars) for your next purchase?	Purely Interactive	49	2,63	1,523	1	6
	Marker AR	50	3,36	1,613	1	6
	AR Markerless	50	3,56	2,002	1	7
	Total	149	3,19	1,761	1	7
6.2 What is the probablility in the future to buy Converse (All Stars) sport shoes?	Purely Interactive	49	3,41	1,848	1	7
	Marker AR	50	4,04	1,795	1	7
	AR Markerless	50	4,22	2,112	1	7
	Total	149	3,89	1,942	1	7
6.3 What is the probability to visit Converse (All Stars) website?	Purely Interactive	49	3,06	1,713	1	6
	Marker AR	50	3,78	1,753	1	7
	AR Markerless	50	4,04	1,958	1	7
	Total	149	3,63	1,847	1	7
6.4 What is the probability to recommend the brand Converse (All Stars)?	Purely Interactive	49	3,24	1,786	1	7
	Marker AR	50	3,66	1,722	1	7
	AR Markerless	50	4,42	1,970	1	7
	Total	149	3,78	1,881	1	7

Table 9

Logistic Regression for Likelihood to Choose Converse (All Stars) for a Next Purchase

Variables in the Equation

	B	Exp(B)	S.E.	Wald	df	Sig.
Group				3,093	2	,213
Group(1)	,785	2,192	,536	2,144	1	,143
Group(2)	1,051	2,860	,623	2,849	1	,091
Innovatio adoption	-,534	,586	,480	1,241	1	,265
Positive emotional intensity	-,142	,868	,446	,101	1	,751
Negative emotional intensity	,423	1,527	,412	1,055	1	,304
Opinion leadership	,179	1,196	,312	,329	1	,566
Information seeking	-,004	,996	,296	,000	1	,990
Perceived Risk	-,115	,892	,197	,337	1	,562
Arousal	,437	1,549	,191	5,231	1	,022
Responsiveness	-,519	,595	,232	5,031	1	,025
Aesthetics	-,035	,966	,382	,008	1	,927
Usability	-,113	,893	,329	,117	1	,732
Organization	-,680	,506	,470	2,099	1	,147
Fun	,613	1,846	,578	1,125	1	,289
Boring	-,464	,629	,467	,985	1	,321
Daring	,110	1,116	,497	,049	1	,825
Contemporary	,145	1,156	,428	,115	1	,735
Constant	1,861	6,429	2,860	,423	1	,515

Table 10
Logistic Regression for Likelihood to Buy Converse (All Stars) Brand

Variables in the Equation

	B	Exp(B)	S.E.	Wald	df	Sig.
Group				,339	2	,844
Group(1)	,292	1,339	,515	,321	1	,571
Group(2)	,278	1,320	,601	,214	1	,644
Innovatio adoption	,196	1,216	,442	,197	1	,657
Positive emotional intensity	-,041	,959	,445	,009	1	,926
Negative emotional intensity	,135	1,145	,397	,116	1	,733
Opinion leadership	,284	1,329	,291	,950	1	,330
Information seeking	,005	1,005	,283	,000	1	,985
Perceived Risk	,072	1,074	,187	,146	1	,702
Arousal	,162	1,176	,175	,861	1	,354
Responsiveness	-,438	,645	,218	4,043	1	,044
Aesthetics	-,222	,801	,359	,381	1	,537
Usability	-,066	,936	,321	,043	1	,836
Organization	-,179	,836	,447	,161	1	,688
Fun	,640	1,896	,545	1,379	1	,240
Boring	-,064	,938	,437	,022	1	,883
Daring	,925	2,523	,483	3,671	1	,055
Contemporary	-,287	,751	,394	,530	1	,467
Constant	-4,443	,012	2,805	2,509	1	,113

Table 11
Logistic Regression for Likelihood to Visit Converse (All Stars) Website

Variables in the Equation

	B	Exp(B)	S.E.	Wald	df	Sig.
Group				2,390	2	,303
Group(1)	,550	1,734	,517	1,132	1	,287
Group(2)	,927	2,526	,602	2,367	1	,124
Innovatio adoption	-,419	,658	,453	,854	1	,355
Positive emotional intensity	,411	1,508	,444	,855	1	,355
Negative emotional intensity	,191	1,210	,414	,213	1	,645
Opinion leadership	,116	1,123	,293	,156	1	,692
Information seeking	-,139	,870	,296	,222	1	,637
Perceived Risk	-,314	,730	,193	2,647	1	,104
Arousal	,087	1,091	,167	,269	1	,604
Responsiveness	-,353	,703	,228	2,393	1	,122
Aesthetics	,472	1,603	,363	1,694	1	,193
Usability	,475	1,608	,328	2,097	1	,148
Organization	-1,358	,257	,486	7,814	1	,005
Fun	1,033	2,809	,565	3,343	1	,067
Boring	-,544	,580	,451	1,458	1	,227
Daring	,830	2,293	,480	2,993	1	,084
Contemporary	-,084	,920	,393	,046	1	,831
Constant	-1,281	,278	2,846	,203	1	,653

Table 12

Logistic Regression for Likelihood to Recommend Converse (All Stars) Brand

Variables in the Equation

	B	Exp(B)	S.E.	Wald	df	Sig.
Group				2,976	2	,226
Group(1)	,488	1,630	,531	,846	1	,358
Group(2)	1,071	2,918	,623	2,956	1	,086
Innovatio adoption	-,616	,540	,475	1,683	1	,195
Positive emotional intensity	,554	1,740	,473	1,373	1	,241
Negative emotional intensity	-,347	,707	,442	,616	1	,433
Opinion leadership	,551	1,735	,315	3,054	1	,081
Information seeking	,188	1,207	,318	,349	1	,555
Perceived Risk	-,215	,806	,200	1,164	1	,281
Arousal	,098	1,103	,173	,317	1	,573
Responsiveness	-,574	,563	,244	5,539	1	,019
Aesthetics	,717	2,048	,393	3,329	1	,068
Usability	,622	1,863	,345	3,253	1	,071
Organization	-1,517	,219	,506	8,981	1	,003
Fun	,296	1,345	,578	,262	1	,609
Boring	-,414	,661	,458	,814	1	,367
Daring	,811	2,250	,500	2,629	1	,105
Contemporary	-,189	,828	,408	,214	1	,643
Constant	,400	1,492	2,959	,018	1	,892

4.4 Conclusion

This chapter presented in detail the research results. The beginning of the chapter reported on qualitative method implemented in the study – a focus group trial. The findings characterize AR advertising as more fun, innovative, unique and more captivating in comparison to just the printed ads. The next part of the chapter presented a descriptive summary and analysis of the results and discussed initial considerations relating to the quality of the data obtained. In order to provide answers to study's main questions, the analysis purposed to determine if there were differences in the effects of three different interactive platforms (Purely Interactive, AR Marker-based and and AR Markerless) on the outcomes of participant testing.

In summary, data show no statistical support for confirming the hypotheses of the study. However, there is evidence of statistical differences between groups in the different treatment conditions. No results statistically support the predicted interaction between variables, although a comparison of cell means show that the AR Marker-based and AR Markerless groups differ from the Purely Interactive group in all analyses. Statistically significant differences were found between Purely Interactive and AR Markerless for Future relationship, probability to buy Converse brand, for probability to visit Converse website and for probability to recommend the brand. Overall, data show only weak support for the initial hypotheses.

Chapter 5

Discussion and conclusion

This chapter discusses the findings of the empirical study. The argumentation focuses on the results presented and analysed in Chapter Four and hypotheses developed in Chapter Two. To achieve this, key elements from each of these sections are brought together to better contextualise the discussion and interpretation of the results. Through this process, the validity of the hypotheses will be confirmed, as well as any additional insights extracted, which may be relevant to the problem under study. Following, Chapter Five addresses the scientific contributions as well as the implications of the findings on marketing research and practice. Finally, the chapter discusses the limitations of the research, proposes recommendations for further research and concludes the thesis.

As stated in the Introduction of this study, it was sought to objectively examine the effects of three types of interactive platforms on young consumers and their opinions towards the purchase of sport shoes. The study developed a methodology for evaluating the effectiveness of an AR Markerless system in comparison to AR Marker-based and Purely Interactive systems. Consumer psychological profile constructs were tested to assess which characteristics explain participants' reactions (cognitive and emotional) to AR.

The qualitative part of the study - a Focus group interview with 26 participants revealed that AR advertising was more appealing to the participants as opposed to conventional print formatted ads. In the quantitative part of the study results were

clearly contrary to initial expectations. All the pre to post study results from questionnaire assessment appeared to converge on a similar outcome with the three experimental treatments showing differences among groups. From the 44 tested hypotheses, seven were accepted, 16 were rejected and the rest were accepted partially. However, a non-significant result did not necessarily imply that an effect was absent. A non-significant effect might have been the outcome of chosen sample size or excessive variability in the data. In either of these cases, the effect might in fact have been extant but the data was unable to present indication for conclusions of its presence.

5.1 Focus group

The purpose of the focus group was to explore whether Augmented Reality simulates a satisfactory direct experience with a product in order to make an impact on the user compared to conventional approaches (e.g. print). The respondents were exposed to ad stimuli and were expected to reflect cognitively on what was presented to them. It was anticipated that young consumers, would have a sufficient knowledge about new communication technologies. The students had no previous information regarding AR technology and have never used it before, but experienced no difficulty when testing the application. This is the first evidence of the fact that some education related to AR could be beneficial to general consumers.

The findings uncovered from this qualitative study characterize AR advertising as more entertaining, innovative, unique and more captivating in comparison to just the printed ads. Therefore, AR was seen here as a stimulating and suitable tool for advertising, effective in enhancing the communication between younger consumers and brand retailers. This approach allows a deeper understanding of young consumers' motivations and emotions and provides a more explicit representation of their motives. The focus group study helped to improve leading questions and to test the methodology's accuracy and appropriateness. Several new themes to be included in the main research were identified in the course of the experiment.

5.2 Differences between groups

Hypothesis H_A predicted that there are significant differences among the three groups for the dependent variable of Arousal. This construct refers to a state of being awake, or being excited about a task. A person's arousal varies over time, from deep sleep to

highly agitated, but there are also individual differences. People with an extrovert personality tend to have a lower level of arousal and a higher need for stimulation than introvert individuals (Matthews, 1992). As this result does not directly imply better performance of one system over another, it does give evidence that the average Arousal level of participants was higher when they were attributed to AR Marker-based system than when they were attributed to the AR-system or purely Interactive one, thus confirming the hypothesis.

According to hypothesis H_B participants were expected to differ in their levels of Responsiveness. This construct is based on evaluation of whether subjects experienced enthusiasm, or if they were in a state of being super active as opposed to being passive towards the experience. However, there was no evidence suggesting that participants in any condition differed and it was assumed that levels of Responsiveness in all three groups were similar. This hypothesis was rejected contrary to the initial belief.

Further, it was believed that participants will perceive interface aesthetics of the separate systems differently. Interface aesthetics are closely related to interface usability and participants were expected to perceive the visual interface designs differently. Hypothesis H_C was confirmed while the results are consistent with the Technology Acceptance Model (TAM) where a user's attitude toward a technology is determined by the perception of usefulness and ease of use of that technology, and that this attitude influences the intention to use the technology (Smith, 2004). Correspondingly, significant differences among groups for Usability were found as previously anticipated in hypothesis $H_{D.}$ The visual appeal of an interface may play a role in the user's rating on usability. However, in terms of Organization of a system's characteristics the three groups did not differ. Hypothesis H_E was not confirmed, signifying that participants viewed the organized content and the created relationships between each piece on the interface as not distinct. In fact the systems were intentionally designed in a visually equal manner with only functionality being the differentiating characteristic. Thus, again the similarities in responses apply to performance and use of each system.

It was believed that users will evaluate the three systems as more or less entertaining, depending on their experience. As expected, the AR Markerless condition received a higher score followed by AR Marker-based and the purely Interactive system. Thus, hypothesis H_F was accepted implying that having an

entertaining and a pleasant encounter with a system reflects evaluation of overall user experience.

A somewhat contradictory result was obtained when participants were asked to assess the systems in terms of whether it was boring or not to them. There were significant differences among groups for Boring, as hypothesized in $H_{G.}$ It was initially expected that AR Markerless condition will result in lower score compared to the rest of the systems, however final result reported the system as the one with the highest mean value. Looking back at the items forming the construct it appears that the interface of the system was perceived as confusing and disappointing, characteristics which relate more to usability features. Nevertheless, this result stresses the importance of improved overall aesthetical and usability requirements for designing of systems in order to carry out a sound acceptance by users.

It should also not be left out that the brand present in a given ad may influence overall perception of a system. Positive or negative attitudes towards a brand can be translated into corresponding pleasant or unpleasant feelings towards the ad, and consecutively towards a system. A given brand may be liked or disliked due to interpreted momentary judgmental feelings experienced during interaction with advertising platform or an ad. Therefore, it was important that attitudes towards the Converse brand were investigated in this study. As initially hypothesized that groups would differ in terms of evaluating the advertised brand as “daring” and “contemporary”, the obtained results confirmed both of the hypothesis H_H and $H_{I.}$ The groups were graded with the AR Markerless system having the highest mean value followed by the AR Marker-based and Interactive systems, in that order for both hypotheses. “Daring” encompassed items like bold, exciting, pioneer, youthful and cool, while “contemporary” included fashionable, imaginative, unique and independent. As much as those items referred to the brand itself, in the experience both the brand and the system were united in one. This is consistent with the extensively researched so called “affect transfer” (MacKenzie, Lutz, & Belch, 1986).

5.3 Systems and the pre-defined consumer constructs

Building upon the above findings it was crucial to determine whether the group treatment condition and the pre-defined consumer constructs of Innovativeness adoption, Emotional intensity, Information seeking and Perceived risk and the measured dependent variables (Arousal, Responsiveness, Aesthetics, Usability,

Organization, Fun, Boring, Daring and Contemporary) would interact with one another. It was believed that the effect of the measured independent variables on the dependent ones would depend on the treatment condition.

5.3.1 Arousal

Hypothesis H_{1a} expected that within the high Innovativeness adoption consumer profile segment, the participants in the AR condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions. In other words, consumers who generally tend to be more interested in embracing innovative technologies were seen as prone to demonstrate higher arousal levels. However, the data did not support this hypothesis and by reviewing the results it is clear that there is no statistically significant distinction between the levels of Arousal in the high segment of consumer Innovativeness adoption among the three groups. This result in itself is counterintuitive and completely opposed to what was theorised. Therefore, the null hypothesis cannot be rejected in this case and thereby infer that interaction with the AR system was no more “awaking” or “stimulating” than the rest of the systems.

Next, it was believed that within the high Emotional intensity consumer profile segment, the participants in the AR condition, exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions. Arousal is a key variable in any emotional experience, as when in state of arousal, humans experience heightened physiological activity and extremes of emotion. Emotions were tested here as dimensions of valence, varying from negative to positive with cognitive factors being the major determinants of emotional states. However, the results indicated that there was no interaction or difference in the effect of Emotional intensity in the different groups on Arousal and hypothesis H_{1b} was not confirmed. Many consumers associate their cognitive experiences with emotional experiences, thus eliminating the perceived notion of cognitive influences on their fashion choices (Lee et al., 2008).Younger consumers are typically highly involved with fashion, guided by affective experiences to make decisions. This differs from the general consumer, for whom more effort and thought goes into the decision making process than for young consumers.

Further, according to H_{1c}, it was hold that within the high Information seeking consumer profile segment, the participants in the AR condition, exhibit higher Arousal

level compared to AR Marker-based and purely Interactive conditions. In the context of this study, the high Information seeking consumer segment is assumed to consist of opinion leaders, whose ideas and behavior serve as a model to other people. This segment is also identified by the ones who exchange social information, in a community, to whom others turn for advice, opinions, and views. Futhermore, people who constantly search, retrieve and apply information about products may influence both other people's thinking and their behavior. However, there was no evidence suggesting that participants in any condition differed. The reason for this result may be due to the fact that young consumers may hesitate to adopt new trends because they do not have sufficient prior experience using innovation to judge whether or not it would suit their needs.

While the above constructs may help explain some of the interrelated constructs for customer purchase intention, one of the common reasons for consumers to show reluctance to make purchases are risk concerns. In order to uncover insights on the subject, it was hypothesized that within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition exhibit higher Arousal level compared to AR Marker-based and purely Interactive conditions (H_{1d}). In fact, levels of Arousal for the low segment in this case did not significantly differ across conditions. These results are surprising in light of exhaustive literature on perceived risk and indicate that individuals had similar patterns of perceptions regarding hazard in purchasing online or in general.

5.3.2 Responsiveness

For this study, the construct of Responsiveness is seen in terms of personal emotions and reflections of participants in regards to an interaction with a system. It was assumed that within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, exhibit higher Responsiveness level compared to AR Marker-based and purely Interactive conditions. The information obtained directly reflects user's individual view regarding a system, however this evaluation depends on one's account of endorsing new technologies. Opposite to initial belief, no matter whether participants belonged to a high or low Innovativeness adoption segment, data showed no difference when it came to Responsiveness. Participants were not influenced from any of the systems

to a state where they would feel enthusiastic or excited to interact with a new technology. Therefore hypothesis H_{2a} was not confirmed.

Similarly, it was expected that consumers belonging to a high Emotional intensity consumer profile segment, would exhibit higher Responsiveness level in the AR Markerless condition compared to AR Marker-based and purely Interactive ones. Emotional intensity encompasses positive or negative affective state, but it is differentiated from mood here due to the fact that emotions usually last for a shorter period of time and are evoked in response to a particular event. Just like with arousal, responsiveness towards a system should reflect emotional state of a user. Despite it was believed that innovative technology would provoke stronger feelings in participants there was no statistical ground for any effect between the constructs, resulting in the rejection of hypothesis H_{2b}.

People engage in pre-purchase stage after identifying a product need and are seeking information that will enable them to make better decisions and increase the probability of satisfaction with a purchase outcome. Consumers are the users of a service and information search is fundamental for decision making, and thus for purchase intention formation. It seemed relevant that people who are interested in commonly obtaining more information regarding products would also acknowledge a system that is unique and innovative, thus exhibiting higher level of responsiveness (H_{2c}). However the data did not support this hypothesis, and there was no difference between the groups, regardless of a system experience. Curiously, this result implies that users did not respond differently, thus rejecting the hypothesis. However, there is a difference in the way consumers care about information and they might not take into consideration certain information in cases where little perceived risk is involved. Considering the fact that users were exposed to a prototype system in an artificial setting might explain why results did not form distinct subgroups.

Information acquisition is a common method carried out by consumers to reduce perceived risk. Consumer information search occurs when the consumer is motivated to search for information concerning his/her needs, however there is always a tradeoff between wants and associated risks. Higher risks would result in too much precaution and less decisiveness in making purchase decisions, however consumers who do not consider a risk high (e.g. low segment) would also exhibit higher level of responsiveness in a shopping platform (H_{2d}). Similarly to risk association in information seeking domain in this experiment, perceived risk for

utilizing a prototype system should not be high. Surprisingly, this did not reflect on levels of responsiveness, as data confirmed that there were no differences between the different treatment conditions thus rejecting the alternative hypothesis.

5.3.3 Perceived interface aesthetics

Hypothesis H_{3a} assumed that consumers belonging to high Innovativeness adoption segment would evaluate Perceived interface aesthetics of AR Markerless system higher than in the rest of the systems. Aesthetics are directly linked to adoption of a system, moreover it is one of the key determinants in consumers' final decision whether to use a system or not. As expected, the mean increase between Purely Interactive group and AR Marker-based group was statistically significant as well as between Purely Interactive and AR Markerless groups. This result signifies that the two more technologically advanced systems are distinct in terms of their interface aesthetics for users who adopt new technology easily. This hypothesis was partially accepted due to the fact that although results did not reach statistical significance there was ground to believe that differences between the groups do exist.

The power of aesthetics in interface design mostly arises from its capacity to influence and enhance visual perception, which strongly influences the way that humans understand and evaluate a given system. On the other hand, emotions are key to understanding consumer behavior. Although interface design cannot be conceptualized solely on the visual grounds (i.e. aesthetics), it is self-evident that design is perceived through visual senses, particularly during the initial stages of system-consumer encounter. The impact of aesthetics on perception translates as emotional responses to a system design and is crucial in increasing the pleasure of its use, which on its side could lead to increased purchase intention. The initial belief that the high consumer segment of Emotional intensity in the AR Markerless condition account for higher Perceived Interface aesthetics evaluation (H_{3b}) turned out to be partially true for significant differences found between Purely Interactive and AR Markerless groups. Consumers with personalities who generally experience more powerful emotions evaluated aesthetical side of the AR system higher than the conventional interactive one. This hypothesis had no sufficient ground to be rejected despite of the statistical rejection and therefore was partially accepted. This result is similar to the one obtained for the expectation that within the high Information seeking consumer profile segment, the participants in the AR condition would

account for higher Perceived Interface aesthetics evaluation, compared to the other systems (H_{3c}). Here, Purely Interactive and AR Marker-based groups as well as the Purely Interactive and AR Markerless groups differed significantly, demonstrating that aesthetics do matter for consumers involved intensely in information search, especially when it comes to technology.

Furthermore, it was assumed that within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition account for higher Perceived Interface aesthetics evaluation (H_{3d}). In other words, this means that customers' positive attitudes towards an interface would once again increase certainty and possibly lower associated risks. As anticipated, consumers who perceived less risk in the task justified higher level in aesthetics regarding AR Markerless system.

5.3.4 Usability

The key to innovation adoption is usability. It is crucial to obtain understanding on how to translate usability evaluation results to interface design improvements, especially for new technology. It was hypothesized that within the low Innovativeness adoption consumer profile segment, the participants in the AR condition, account for higher Usability features evaluation, compared to AR Marker-based and Purely Interactive conditions (H_{4a}). The results showed a statistically significant difference between the Innovativeness segment and Usability features, as well as mean increase between all three groups. This implies that the effectiveness, efficiency, and satisfaction requirements were met, however the evaluation by groups was different. The result stresses out the importance of usability by shifting the focus from just interface creation to its actual evaluation.

Another interrelated factor for studying Usability in human-computer interaction is emotion. Together with the importance of interface aesthetics, this study assumed that within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition account for higher Usability features evaluation, compared to AR Marker-based and Purely Interactive conditions (H_{4b}). This construct is once again relevant to visual perception while emotions are simultaneously elicited. The statistically significant difference between the group score: (Purely Interactive and AR Markerless, and AR Marker-based and AR

Markerless) suggests that the hypothesis is true for those groups. Due to evidence the hypothesis was partially accepted.

In general more informed consumers are seen as also more experienced when it comes to Usability evaluation in interactive contexts. Thus consumers in the high Information seeking segment were expected to account for higher usability evaluation in the AR condition (H_{4c}). As presumed, statistically significant differences existed the Group score, between the three treatment conditions, specifically between Purely Interactive and AR Markerless, as well as between AR Marker-based and AR Markerless. There was no sufficient evidence to reject the alternative hypothesis, as differences between the groups were present. Perhaps consumers who actively pursue information in interactive settings are also knowledgeable and accustomed to various platforms.

Although information seeking, emotions and innovativeness seem to closely reflect on Usability it was curious to uncover what is the role of perceived risk when it comes to usability. It was admissible that within the low Perceived risk consumer profile segment, the participants in the AR Markerless condition would account for higher Usability features evaluation (H_{4d}). Differences were found between groups and although small, the hypothesis was partially accepted. Participants in the low segment of Perceived risk of AR condition still showed higher levels of Usability evaluation compared to the rest of the groups.

5.3.5 Organization

Grouping objects with similar functions together can make a system feel more consistent. Organizing purposefully groups of items, along with appropriate layout design, can lead to easier navigation and increased speed. It was hypothesized that even in the low Innovativeness adoption consumer segment, the participants in the AR condition would account for higher Organization evaluation (H_{5a}). From the results it was clear that this relationship was not significant, as none of the groups differed sufficiently to reject the null hypothesis. Participants who belonged to the segment of low Innovation adoption did not evaluate Organization as a distinctive factor in the AR condition.

A corresponding factor for exploring the variable of Organization in interactive domains is again emotion. It is proposed that the better the organization of an interface is perceived, the favorable the emotional responses will be. Therefore, this

study assumed that within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition account for higher Organization features evaluation, compared to AR Marker-based and Purely Interactive conditions (H_{5b}). Emotions are inseparable part of initial visual inspection, however there was no interaction effect or significant difference in the effect of Emotional intensity in the different groups on Organization. Evaluation on Organization was not distinct, even for participants with generally high emotional intensity.

To uncover whether consumers within the high Information seeking profile segment account for higher Organization evaluation in the AR Markerless condition, hypothesis H_{5c} was posited. There was no evidence for support of this hypothesis meaning that the ones who actively search for information expressed no different reflections in the three conditions. Organization of the three systems was evaluated similarly in this case thus the hypothesis was rejected.

In every case consumers try risk reduction strategies to lower the perceived risk levels to below the level of acceptable risk. The main goal for consumers is not to regret a purchase after the transaction is completed. Again, visual characteristics, such as organization of interfaces, might be of importance when consumers are still in the pre-purchase stage. Therefore, the next hypothesis (H_{5d}) pursued to uncover whether within the low Perceived risk consumer profile segment, the participants in the AR condition account for higher Organization evaluation. Contrary to previous expectation no effect was reported from the analysis. Organization of the AR interface did not account for perceived risk more than in any other system. Therefore the hypothesis was not accepted.

5.3.6 Fun

Whether an interface is interesting, pleasant and most of all fun can be crucial for its overall assessment. Different personality characteristics however might influence the overall evaluation and from different perspectives. For example, consumers who did not belong to the high Innovativeness adoption cluster were expected to account for higher evaluation of Fun characteristics in the AR Markerless condition (H_{6a}). Here participants differed in mean increase between Purely Interactive and AR Marker-based as well as between Purely Interactive and AR Markerless groups. Although differences were relatively small, it was assumed that people who were not early adopters felt more entertained with the AR system that in the other two.

Pleasant emotions are associated with entertainment. As this is the goal for any positive system evaluation, it was important to objectively explore whether within the high Emotional intensity consumer segment, the participants in the AR condition would account for higher Fun evaluation (H_{6b}). Small differences were reported from the conducted analysis suggesting that the Purely Interactive system was considered less entertaining than the other two conditions with the AR system. Contrary to what was initially believed, the results did not give enough base to retain the alternative hypothesis. What this implies is that personalities, who are capable of experiencing intense emotions in general, found the three systems very similar.

Whether consumers in the high Information seeking segment, accounted for higher Fun evaluation in the AR Markerless condition was tested in hypothesis H_{6c}. It was believed that people who are consistent in their patterns for information searching would feel more entertained with the AR Markerless platform. Statistically significant difference in the three treatment conditions, as well as in Information seeking confirmed this assumption. The mean increase was found between Purely Interactive and AR Marker-based as well as between Purely Interactive and AR Markerless groups. Thus, hypothesis H_{6c} was partially confirmed - participants who engaged with the purely Interactive platform were less entertained than the ones in the AR conditions.

It is reasonable to believe that consumers who feel less threatened by risk consequences in purchasing products would also enjoy more fun experiences. As the AR systems were developed with entertainment functionality in mind in terms of 3D visualization and markerless approach, it was considered also diverting. However, if within the low Perceived risk consumer segment, the participants in the AR Markerless condition accounted for higher Fun evaluation, compared to AR Marker-based and Purely Interactive conditions was tested in hypothesis $H_{6d.}$ Again, the analysis revealed that the mean increase between Purely Interactive and AR Marker-based as well as between Purely Interactive and AR Markerless groups was statistically significant. This indicated that the purely Interactive condition accounted for a score of less entertainment and therefore higher perceived risk.

5.3.7 Boring

To be objective, a study must look at all possible angles for an authentic evaluation of a system. Therefore the construct of Boring was included in the study as part of

interface evaluation. First, it was hypothesized that within the high Innovativeness Adoption consumer profile segment, the participants in the AR Markerless condition would exhibit lower level of Boredom compared to AR Marker-based and purely Interactive conditions (H_{7a}). Early adopters are likely to express more vigor when they encounter with an innovative system. This was confirmed from the analysis result, which stated that difference exist between the groups as well as between Group and Innovativeness. Thus, the hypothesis was partially confirmed.

For the emotionally intense person, details which to a moderately emotional person might seem unremarkable, can take on a crucial importance or might be extremely disinteresting, even boring. On the other hand, boredom is an emotional state which stimulates search of new activities when the previous are no longer favorable to an individual. Therefore, it was interesting to combine the two constructs for evaluation of the three interfaces. It was hypothesized that within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, would exhibit lower level of Boredom compared to the other systems (H_{7b}). Statistically significant difference was present in Group score between the three treatment conditions. The probability of a user feeling boredom in the AR condition was smaller compared to the other systems and the hypothesis was partially confirmed.

The urge for information seeking is somewhat contradictory to the state of experiencing boredom. Consumers who eagerly pursue information on products and services are perceived as more active, as opposed to a condition of boredom, where finding new tasks is the goal. Also, information search is critical in formation of purchase intention since it often precedes brand preference formation while search practices depend on individual characteristics. In light of these arguments it was believed that within the high Information seeking consumer segment, the participants in the AR Markerless condition would exhibit lower level of Boredom compared to other conditions (H_{7c}). Group score between the three treatment conditions was significantly different with the mean increase between Purely Interactive and AR Marker-based as well as between Purely Interactive and AR Markerless groups. Although differences were small, consumers who intently look for materials, recommendations or reviews about a product or a service appeared to experience less boredom within the AR platforms. Thus, the hypothesis was partially accepted.

5.3.8 Daring

In terms of evaluating the brand in the experience - Converse, a brand personality set characteristics were included in the tests. As identified in literature, consumers tend to establish symbolic relationships with brands and attach various personality qualities to them. One such characteristic, identified in the course of the experiment was Daring. It was believed that within the high Innovativeness adoption consumer profile segment, the participants in the AR condition, exhibit higher Daring levels compared to AR Marker-based and purely Interactive conditions (H_{8a}). Statistically significant difference was reported for an increase between Purely Interactive and AR Markerless groups. This result implies that early adopters perceived the advertised brand as Daring to a higher degree when interacting with the AR Markerless system, partially confirming the hypothesis.

Further, the next construct of relevance to brand personality characteristics were emotions. The act of assigning human qualities to brands signifies that emotional attachment of some kind must be present. The construct of Daring here encompasses qualities like bold or courageous, fearless or adventurous and once again refers to the advertised brand. To uncover whether within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition, exhibit higher Daring level compared to AR Marker-based and Purely Interactive conditions, hypothesis (H_{8b}) was tested. Due to lack of sufficient evidence for differences among the groups the hypothesis was rejected. The result indicates that attitudes of respondents with high emotional intensity in all three groups towards the brand were similar.

Following up on the previous result it was essential to find out whether within the high Information seeking consumer profile segment, the participants in the AR Markerless condition, exhibit higher Daring level compared to AR Marker-based and purely Interactive conditions (H_{8c}). Again, the participants in this segment are perceived as having somewhat more active nature, a quality that drives them to pursue finding of information. Therefore, they might be inclined to describe a brand as Daring. As expected there was a statistically significant difference in the three treatment conditions for Information seeking with the mean increase between Purely Interactive and AR Markerless groups reported in favor of the latter. Thus, the high segment of information seekers were considered as assigning the characteristic of

Daring to a greater extent after interacting with the AR platform in comparison to the other systems.

It was also hypothesized that participants in the low Perceived risk segment, would exhibit higher Daring levels compared to AR Marker-based and Purely Interactive conditions (H_{8d}). This group was seen as less wary to purchase-associated risks. The mean increase between Purely Interactive and AR Markerless group was statistically significant, showing that differences although small do exist between the conditions. The hypothesis was accepted in part, however the reason for not obtaining a higher result might reside in preconceptions towards the advertised brand.

5.3.9 Contemporary

The last construct to be tested in the experiment – Contemporary, also belongs to the brand personality set of characteristics, encompassing characteristics such as pioneer, unique or independent. It was hypothesized that within the high Innovativeness adoption consumer profile segment, the participants in the AR Markerless condition, exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions (H_{9a}). The understanding behind this hypothesis was that high segmented Innovation adopters may have a greater grasp of new or contemporary. As reported the mean increase between Purely Interactive and AR Marker-based and between Purely Interactive and AR Markerless groups was statistically significant. Although there was no interaction effect in this analysis, still the alternative hypothesis was retained partially.

As the concept of Contemporary comprises qualities identical to the ones applicable to people, emotions were found to be relative in examining the next hypothesis in the study. Hypothesis (H_{9b}) supposed that within the high Emotional intensity consumer profile segment, the participants in the AR Markerless condition would exhibit higher Contemporary levels compared to AR Marker-based and purely Interactive conditions. From the analysis the Purely Interactive and AR Marker-based as well as Purely Interactive and AR Markerless groups were statistically different. This result signified that emotional personalities perceive Contemporary as a quality applicable to the brand however only in the AR Marker-based and AR Markerless conditions and therefore the hypothesis was retained as partially applicable to the obtained results.

A decision to seek information is subsequent to an information need. Referring back to consumers who are strong information seekers, it was believed that within the high Information seeking consumer profile segment, the participants in the AR Markerless condition would exhibit higher Contemporary levels compared to AR Marker-based and Purely Interactive conditions (H_{9c}). The differences reported were once again between the Purely Interactive and AR Marker-based and between Purely Interactive and AR Markerless groups. This result implies that Information seekers are advantaged in that they intentionally go after and obtain the latest information, which is also "contemporary". This hypothesis was retained in part due to some evidence of differences between the groups.

The need for additional information could influence consumer search due to the presence of uncertainty and greater perceived risk. The last hypothesis in this study refers to whether within the low Perceived Risk consumer profile segment, the participants in the AR Markerless condition would exhibit higher Contemporary level compared to AR Marker-based and purely Interactive conditions (H_{9d}). Once again, the mean increase between Purely Interactive and AR Marker-based and between Purely Interactive and AR Markerless groups was statistically significant, suggesting that the perceived Contemporary understanding for the brand reported, obtained higher levels in the conditions other than the control one. Low Perceived risk segment consumers are more prone to accept a "pioneering" brand image, suggesting that the hypothesis be partially accepted.

5.4 Purchase intention towards Converse brand

In order to obtain an even deeper insight into consumer base, the study collected answers to specific questions that gave more details of brand opinions and potentially predicted buying behavior of consumers. The Converse brand was chosen for this study due to its appeal to young consumers and due to the fact that it stands for "rebellion", "independence" and "and originality"[44]. Founded in 1908, the Converse company was purchased by Nike Inc. in 2003 - almost hundred years after. Also, Converse has proven to be very successful in building a relationship between the brand and the target consumer. Their most popular product, the All Star shoe, is the same shoe for both genders. Participants were clustered in order to be described categorically and were grouped according to the probability of relating to, choosing,

[44] Converse Inc. http://www.converse-sa.co.za/about/ Retrieved on October 27, 2014.

buying, recommending Converse or visiting the brand website. For the likelihood to choose Converse (All Stars) for their next purchase 69.6% of overall cases were classified. This result signifies that almost two thirds of the participants expressed probability of choosing the brand. Next, for the likelihood to buy Converse brand in the future, the analyzed model classified 67.6% of cases. Again, this result was above average. Converse's brand image has transformed over the years from a sport shoe, associated with functionality to one that reflects individuality of its consumers. Converse's primary competitors reflect this change: Adidas[45] competes in the sport shoe market, Puma[46] in the sport lifestyle market, and Vans[47] in the lifestyle/fashion market. For likelihood to visit Converse website, the model classified 64.9% of cases. The reason for this result might be the fact that Converse's innovation is seen through its consumers' individual expression through the shoes, which was made possible through the "design your sneakers"[48] section on their website. For likelihood to recommend Converse brand 70.3% of cases classified. This suggests, that the way that Converse brand is recognized is no longer just about serving a utilitarian purpose, but is also about expressing the views and opinions of their consumers. Those findings also explain positivelly whether attitude towards the advertised brand affects evaluation of the effectiveness of the system.

5.5 Scientific contribution

The present work contributes to the body of knowledge in extending the comprehension on consumer behaviour through an empirical examination for assessing consumer reflections towards three types of computer-based interactive systems. Specifically, the study compares the effectiveness of two AR solutions (AR Marker-based and AR Markerless) and a Purely Interactive system in the consumer experience of young adults. The research outlines a groundwork for a thorough set of criteria to evaluate users' stance towards purchase intentions.

Very few studies have engaged to investigate the topic of AR user experiences through either qualitative approach (Olsson, et al. 2013, Bulearca & Tamarjan, 2010) or single ready-made AR Marker-based ads (Sung & Cho, 2012). In contrast, the current research is the first attempt to register the effects of three

[45] Adidas Global http://www.global.adidas.com/ Retrieved on October 27, 2014.
[46] Puma http://us.puma.com/ Retrieved on October 27, 2014.
[47] Vans http://www.vans.com/ Retrieved on October 27, 2014.
[48] Converse http://www.converse.com/ Retrieved on October 27, 2014.

separate, specifically developed interactive systems for studying consumer cognitive factors and purchase intentions. The current research represents an attempt to fill the gap in this domain and reports on findings, obtained from empirical investigation. Therefore, the major contribution of this thesis is in the outcome of the findings, relevant to both academic and managerial practices.

Results indicate that differences among the effects of the three tested systems do exist, particularly between the interactive and augmented reality solutions. Both Markerless and Marker-based systems belong to augmented reality realm in terms of technology and combined together prove more effective in comparison to a purely Interactive system. A good overall perception of a system is crucial for its effectiveness. It is critical that AR experiential campaigns should focus on the entire experience developed especially for the consumer (Yuan & Wu, 2008). Thus, it is maintained that AR systems may serve as an acceptable alternative of consumer "direct experience" with a product in order to make an impact on the user. The above-mentioned statements are, in addition to a number of quantitative methods, confirmed by the results of the analyses conducted.

The focus has also been aimed at exploring the cognitive constructs, such as feelings, cognitions, and behavioral responses that determine the evaluation of an overall brand experience with a system (Brakus, Schmitt, & Zarantonello, 2009). The established system of measurements for assessment in terms of innovativeness adoption, emotions, information seeking, arousal, aesthetics, usability and brand personality evaluation confirmed to be appropriate and congruent to objectives.

This research incorporates disciplines, such as psychology, marketing and human-computer interaction, blend together to give a new perspective, corresponding to the demands of a continuously changing technological and business environment of today. Finally, the present study is designed to present a sequential example for research and application where practice might require.

5.6 Limitations

This research has certain limitations that should be acknowledged. Although the sample of this study consisted of university students in an age group targeted by Converse and other sport apparel brands, the highly involved fashion shopper is not the only type of consumer these brands aim at. Future research can explore how the brand experiences of moderate and low involvement consumers in diverse age

groups differ from those of highly involved consumers. Also, as this study used human subjects, who had to be present at a given time and place, recruiting participants has been an impediment. Therefore, the sample size used for the experiment was the minimum recommended for undertaking the appropriate statistical analyses. This limitation reflects directly on generalizability of findings.

The set of customer perceptions and projected images of a brand produce inevitable associations with the brand itself (Sheth & Mittal, 2004). In the case of this study, past positive or negative encounters the participant might have had with the brand used, influencing the perceptions of the brand and subsequently the overall evaluation of the experience, were not taken into account. As consumers perceptions translate into brand loyalty, market leaders as Puma or Adidas, are the ones having the highest and strongest loyalties. However, using a niche brand like Converse has advantages such as reaching targeted demographic by focusing on the scarcity of product features in comparison to bigger companies, appealing to the consumer through the unique aspects offered. The Converse brand is viewed as a lifestyle as much as a shoe company which represents the brand's strong niche in the lifestyle market with a genuine product based upon. It was conceded that modern consumers do not just buy a product, but they buy experiences (Kotler, 2009, p. 426). Future research should investigate participants' pre-set opinions of the brand in order to divide consumer reflections into groups based on their experiences.

The study used only one product and only one brand for the prototype system. Perhaps, a future study should be conducted with a different type of product or with a system where users could have a bigger choice of brands.

Some of the limitations with AR itself are still technological. It is not a fully understood concept and is sometimes associated with virtual reality or Quick Response codes. Current commercial uses are limited due to equipment cost, availability of software, and social acceptance. Present research into AR in advertising is still scarce; it lacks recommendations for undertaking a study and research design. Finding relevant literature and solid theoretical relevance has also proven difficult for a study in this domain.

5.7 Managerial implications

Augmented reality technology, as part of human-computer interaction is a currently evolving research field. Therefore, it will be strongly recommended to start where this thesis ends.

This study was able to learn empirically what constitutes a successful shopping AR experience through profound trial and error approach. The first and most important requirement is without a doubt the quality of the images presented to the audience. The information obtained from direct product experiences, such as in product trials, is perceived as more authentic and credible compared to indirect experiences. While it is possible to interact with products directly in a physical location, the inability to do so while shopping online may contribute to the general drawbacks of this shopping experience. AR is the only technology that currently has the capability of presenting a product in a very realistic manner and in real time, on the web, at home or in-store. Therefore, achieving flawless representation for a real-life product coupled together with technologically robust system is critical for engaging consumers and subsequently encouraging a “virtual purchase”. The more life-like the graphical content is – the easier it will be to immerse a user.

The second element to consider is that the provided experience must be well-directed, meaningful, unique as well as engaging for the consumer. AR can add a memorable dimension to the retail shopping experience and lead to ongoing consumer engagement with a brand.

The third aspect concerns the measuring experiential advertising effectiveness. Theoretically, marketing “effectiveness” is a fundamental determinant of overall performance of an organization and it is traditionally viewed as a construct established on realization of a company’s ultimate (marketing) goals (Kahn & Myers, 2005). Measuring marketing effectiveness poses numerous challenges due to the number of possible metrics for evaluating it. To be effective a system must combine technological as well as behavioral measures. In terms of accepting AR technology, two determinants seem to be especially important when evaluating users’ acceptance, namely system usability and organization. As for behavioral measures, this study focused on nine different variables, but future studies should not be limited to this number.

Managers are advised to find out how to differentiate between their customers. It must be noted that the variables measured here (Innovation adoption, Emotional

intensity, Information seeking and Perceived risk) can differ between High and Low segment groups. In this study the differences have been explained in detail and their examination for focusing on different cluster groups is advised, especially for better allocation of resources for marketing strategies. Results of logistic regression revealed that it is useful to predict the possibility of a consumer belonging to High and Low consumer segment based on exposure source.

One remaining aspect that must be accounted for on the side of managers is the link between purchase intent and actual sales. With this information, future research can build upon the present findings.

5.8 Conclusion

The study was set out to provide understanding on whether AR Markerless shopping platform can operate as a tool for enriching consumer experiences more effectively in comparison to the use of simpler platforms, such as a purely Interactive and a AR Marker-based system from the angle of multiple interrelated constructs. These constructs form the base for uncovering what are the driving determinants of a satisfactory consumer experience and are important components in the formation of the subsequent purchase intention. The study has also sought to acquire knowledge on consumers' cognitive responses, assessed through an empirical investigation of aspects such as innovativeness adoption, emotions, opinion leadership, information seeking, arousal, pleasure, system usability, perceived interface aesthetics and brand personality. The study also aimed to answer the main research question: *Does change in three different types of advertising exposure influence advertising effectiveness?*

In order to collect sufficient information to answer the research question the study applied specific measures for all of the variables of interest. The demographic analyses were used to identify population characteristics in order to determine potential customer profile. The behavioral and psychographic measures of interest to the study were the degree of familiarity with AR (pre-test and focus group), online shopping habits for sport shoes, brand preference, innovativeness adoption, information seeking, attitudes toward the brand, emotional intensity, opinion leadership, brand personality, perceived risk, arousal, responsiveness, usability, perceived interface aesthetics, brand attributes evaluation and attitudes towards Converse brand. The study is unique in that it developed and used three different

prototype systems as well as measured and compared their effectiveness on consumers' intentions for purchase. To answer the objectives of the research, the study compared groups and obtained data from experimental treatments through a true experimental design with a Pretest-Posttest with a Control Group implementation.

The main contribution of the study belongs to the outcome of the findings, which may be used as a reference in both academic and managerial practices. Qualitative research was applied in the beginning of the investigation process in order to obtain a more adequate understanding of the topic under study. Focus group interviews and self-reports of knowledge and attitudes were adopted as sources of insight for identifying consumer attitudes and behaviours. The findings allocated AR advertising as more fun, innovative, unique and more captivating in comparison to printed ads.

Quantitative results showed differences among the effects of the three tested systems, namely between the interactive and augmented reality. Since the Purely Interactive system is seen as more traditional in comparison to the other two, this result is consistent with the initial belief that conventional systems are less engaging. Experience with augmented reality made difference. Consumers who tend to adopt innovations accounted for higher levels of aesthetics evaluation, demonstrated less boredom, and accounted for more "daring" and "contemporary" in terms of brand personality. Emotionally intense consumers also showed higher levels of aesthetics, usability and "contemporary" assessment, as well as lower levels of boredom. Tests also showed that participants who intensively pursue information demonstrated high evaluation of aesthetics, usability, felt more entertained as opposed to bored, and perceived the brand as more "daring" and "contemporary" once again. In all of the above levels of perceived risk was low. Those arguments positioned augmented reality as an acceptable alternative of consumer "direct experience" with a product.

In terms of purchase intention towards the brand after reviewing the findings of research methods it is apparent that Converse is successful in maintaining a strong brand image and loyalty among avid Converse users. Participants expressed intention to choose, recommend, visit the website and even buy the brand. However it is also clear that among non-loyal consumers there is less of a concise association with a particular group of people and a system.

Although this experiment failed to support all hypothesis, results indicate that differences among the effects of the three tested systems do exist, particularly between the interactive and augmented reality systems. Addressing these experimental issues in future research will hopefully shed more light on the effect of cognitive factors on consumers. As human psychology is rather complex, other aspects can be investigated based upon the findings from this study. Those outcomes can be useful in advancing the understanding about consumer behavior, as well as helpful in developing more relevant experiential marketing strategies with augmented reality.

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APPENDIX

Consent for Participation in Research

Title: Research about consumer profile and shopping preferences

Introduction: The purpose of this form is to provide you information that may affect your decision as to whether or not to participate in this research study. Your participation is voluntary. Read the information below and ask any questions you might have before deciding whether or not to take part. If you decide to be involved in this study, this form will be used to record your consent.

Purpose of the Study: You have been asked to participate in a research study about Consumer profile. The purpose of this study is to compare and evaluate the effectiveness of user shopping experiences.

What will you to be asked to do? If you agree to participate in this study, you will be asked to complete three steps: (1) fill in a self-administered questionnaire online, (2) interact with a system for the purchase of sport shoes and (3) fill-in a second questionnaire, regarding your experience.
This study will take approximately 20 minutes and will include up to 20 study participants. Your participation in step 2 will be video recorded.

What are the risks involved in this study? There are no foreseeable risks to participating in this study.

What are the possible benefits of this study? While we cannot compensate you for your time, your participation will be valuable to our project and will help us broaden our understanding of the topic under investigation. The contribution of this project to science and society can only be achieved with your help.

How will your privacy and confidentiality be protected? You will remain anonymous and your answers are confidential. The data resulting from your participation may be made available to other researchers involved in the study. In these cases, the data will contain no identifying information that could associate it with you, or with your participation in any study.

Whom to contact with questions about the study? Prior, during or after your participation you can contact the researcher Jasmina Stoyanova at xyz@fe.up.pt for any questions or concerns.

Participant signature Date

_____ _____

As a representative of this study, I have explained the purpose, procedures, benefits, and the risks involved in this research study.

Researcher signature Date

_____ _____

Questionário – Perfil do Consumidor

01. Nº de correspondência entre questionários____ 02. Sexo: M...../ F..... 03. Idade: _____ anos

1. Quais as marcas de ténis (sneakers) que conheces?

1.1 _____; 1.2 _____; 1.3 _____

1.4 _____; 1.5 _____; 1.6 _____

2. Quando é que foi a última vez que compraste par de ténis/? (podes escolher mais que uma alternativa se for o caso)
2.1 Há menos de 3 meses ___ 2.2 Entre 3 meses e 6 meses ___ 2.3 Entre 6 meses e 1 ano ___ 2.4 Há mais de 1 ano ___

3. Quais foram as marcas que já adquiriste? 3.1_____; 3.2_____; 3.3_____

4. Já visitaste sites de ténis (sneakers)? Sim__ Não___

4.1 De que marcas eram? 4.1.1_____; 4.1.2_____; 4.1.3_____
4.2 Já fizeste alguma compra de algum produto/serviço na Internet? Sim__ Não___

4.3 Que tipo de prod./serv.é que compraste na internet? 4.3.1_____; 4.3.2_____; 4.3.3_____
4.5 Quando foi a última vez que compras-te alguma coisa online? _____mês; _____ano

5. Responde de forma sincera como te defines a ti próprio (usando a escala discordo-concordo de 1 a 5) em relação aos seguintes aspetos:

5.1 Em geral eu sou no circulo dos meus amigos o último a comprar uma novidade quando aparece no mercado

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

5.2 Quando ouço que um novo produto está disponível nas lojas, não fico suficientemente empolgado para o ir comprar

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

5.3 Comparado com os meus amigos eu quase não possuo as últimas novidades

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

5.4 Em geral, sou quase o último a saber sobre o lançamento de uma novidade

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

5.5 Eu compro um novo produto mesmo quando ainda não se ouviu falar nele

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

5.6 Eu conheço os nomes dos novos modelos antes das outras pessoas

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

6. Classifica as seguintes marcas nos respectivos atributos/características: usar a escala e circula o nº respectivo

1-Não se aplica nada; 2- Aplica-se muito pouco; 3-Aplica-se mais ou menos; 4- Aplica-se; 5-Aplica-se completamente

(preenche apenas a marca que conheceres - se não conheceres deixa em branco)

	Addidas	Nike	Puma	Reebock	Vans	Converse (all stars)	Le Coq Sportif
6.1 Qualidade do material	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5
6.2 Conforto	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5
6.3 Moda	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5
6.4 Diversidade de escolha	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5
6.6 Tecnologia/inovação	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5
6.7 Estética	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5
6.8 Durabilidade	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5
6.9 Versatilidade(para todas as ocasiões)	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5	1|2| 3| 4| 5

Questionário – Perfil do Consumidor

7-EIS

7.1 Se alguém me elogia, eu sinto:

1=que tem pouco efeito em mim;... 2=ligeiramente agradado/a;...3=Agradado/a;...4=Muito agradado/a;...5=Extremamente agradada/o

7.2 Quando penso sobre coisas horríveis que me podem acontecer, eu sinto:

1=que tem pouco efeito em mim;.. 2= Ligeiramente preocupado/a;..3= Preocupado/a;..4=Muito preocupado/a;..5=Extremamente preocupada/o

7.3 Quando estou mesmo feliz, eu sinto:

1=que tem pouco efeito em mim;... 2=Ligeiramente alegre;...3= Alegre;...4=Muito alegre;...5=Extremamente alegre /eufórica/o

7.4. Veja uma criança a sofrer, eu sinto:

1=que tem pouco efeito em mim;... 2= Ligeiramente triste;...3= Triste;...4=Muito triste;...5=Extremamente triste/perturbado/a

7.5 Alguém para o/a qual eu sinto uma grande atracão convida-me para tomar café, eu sinto:

1=Extremamente excitado/a;... 2= Muito emocionado/a;...3= Emocionado/a;...4= Ligeiramente emocionado/a;...5= que tem pouco efeito em mim

7.6 Se algo me frustra/contraria, eu sinto:

1=que tem pouco efeito em mim;... 2= Ligeiramente frustrado;...3= Frustrado;...4=Muito frustrado;...5=Extremamente chateado

7.7. Atingi o melhor resultado de sempre no meu desporto favorito, eu sinto:

1=que tem pouco efeito em mim;... 2=Ligeiramente satisfeito;...3=Satisfeito;...4=Muito satisfeito;...5=Extremamente satisfeito/eufórica/o

7.8 Eu digo ou faço algo que não devia ter feito ou dito, eu sinto:

1=que tem pouco efeito em mim;... 2= Ligeiramente culpado;...3= Culpado;...4=Muito culpado;...5=Extremamente culpado

7.9 Eu estou a brincar com o meu filho/a (irmã/irmão) ou uma criança que gosto muito, eu sinto:

1=que tem pouco efeito em mim;... 2= Ligeiramente divertido;...3= Divertido;...4=Muito divertido;...5=Extremamente divertido

7.10. Alguém critica-me, eu sinto:

1=que tem pouco efeito em mim;... 2= Ligeiramente chateado;...3= Chateado;...4=Muito chateado;...5=Extremamente chateado

7.11 Recebi um elogio de um professor, eu sinto:

1=que tem pouco efeito em mim;... 2=Ligeiramente satisfeito;...3=Satisfeito;...4=Muito satisfeito;...5=Extremamente satisfeito/eufórica/o

7.12 Pessoas que me irritam, eu sinto:

1=que tem pouco efeito em mim;... 2= Ligeiramente incomodado;...3=Incomodado;...4=Muito incomodado;...5=Extremamente incomodado

7.13 Quando ouço um discurso de um líder que respeito, eu sinto:

1=que tem pouco efeito em mim;...2=Ligeiramente impressionado;...3= Impressionado;...4=Muito inspirado;...5=Extremamente inspirado/a

7.14 Quando tenho uma experiencia constrangedora, eu sinto:

1=que tem pouco efeito em mim;. 2= Ligeiramente envergonhado;.3= Envergonhado;.4=Muito envergonhado;.5=Extremamente envergonhado

7.15 Alguém que conheço é rude/indelicado comigo, eu sinto:

1= Feriu bastante os meus sentimentos;... 2= Muito ofendido;...3= Ofendido;...4= Ligeiramente ofendido;...5= que tem pouco efeito em mim

7.16 Eu estou numa festa divertida, eu sinto:

1=que tem pouco efeito em mim;... 2=Ligeiramente alegre;...3=Animado/a;...4=Muito animado/a;...5=Extremamente alegre/animado/a

7.17 Qualquer coisa de maravilhoso me acontece, eu sinto:

1= Extremamente rejubilante;... 2= Muito contente;...3= Contente;...4= Ligeiramente contente;...5= que tem pouco efeito em mim

7.18 Vi um filme dramático/trágico, eu sinto:

1= Extremamente triste;... 2= Muito triste;...3= Triste;...4= Ligeiramente triste;...5= que tem pouco efeito em mim

7.19 Consegui concretizar algo importante para mim, eu sinto:

1=que tem pouco efeito em mim;... 2=Ligeiramente satisfeito;...3=Satisfeito;...4=Muito satisfeito;...5=Extremamente satisfeito/eufórica/o

7.20 Quando alguma coisa me enfurece, eu sinto:

1=que tem pouco efeito em mim;.. 2= Ligeiramente irado;...3= Raiva;...4=Muito enraivecido;...5=Extremamente enraivecido

7.21 A pessoa com quem eu estou envolvido prepara-me um jantar à luz de vela, eu sinto:

1=que tem pouco efeito em mim;... 2=Ligeiramente romântico;...3= Romântico;...4=Muito romântico;...5=Extremamente romântico

Questionário – Perfil do Consumidor

7.22 Eu feri os sentimentos de alguém, eu sinto:

1=que tem pouco efeito em mim;.. 2= Ligeiramente arrependido;...3= Arrependido;...4=Muito arrependido;...5=Extremamente arrependido

7.23 Estou atrasado para o trabalho/escola, eu sinto:

1= Extremamente furioso;... 2= Muito furioso;...3= Furioso;...4= Ligeiramente furioso;...5= que tem pouco efeito em mim

7. 24 Estou envolvido numa situação na qual eu tenho que ser bem sucedido, por exemplo num exame ou numa entrevista de emprego, eu sinto:

1=que tem pouco efeito em mim;.. 2= Ligeiramente ansioso;...3= Ansioso;...4=Muito ansioso;...5=Extremamente ansioso

7.25 O meu chefe/professor dá-me uma palmadinha nas costas e elogia o meu desempenho, eu sinto:

1= Extremamente gratificante/exuberante;...2= Muito gratificante;..3= Gratificante;..4= Ligeiramente gratificante;..5= que tem pouco efeito em mim

7.26 Eu estou envolvido numa relação romântica, eu sinto:

1= consumida/o pela paixão, não consigo pensar em mais nada;... 2= Muito apaixonada/o;...3= Apaixonada/o;
...4= Ligeiramente apaixonada/o;... 5= que tem pouco efeito em mim

7.27 Assisti ao funeral de alguém próximo, eu sinto:

1=que tem pouco efeito em mim;.. 2= Ligeiramente triste;...3= Triste o;...4=Muito triste;...5=Extremamente triste

7.28 Eu estou a discutir com alguém, eu sinto:

1=que tem pouco efeito em mim;.. 2= Ligeiramente alterado;...3= Agitado ;...4=Muito alterado;...5=Extremamente alterado/nervoso/a

7.29 A minha conta está deficitária (divida), eu sinto:

1= Pânico;... 2= Muito preocupado;...3= Preocupado;...4= Ligeiramente preocupado;...5= que tem pouco efeito em mim

7.30 Alguém oferece-me um presente de surpresa, eu sinto:

1=que tem pouco efeito em mim;... 2=Ligeiramente grato/a;...3= Grato/a;...4=Muito grato/a;...5=Extremamente grato/a

8-Influencia – expert

8.1 - Os meus amigos e vizinhos pedem-me frequentemente conselhos sobre certos produtos que pretendem comprar

1	2	3	4	5	6	7
Discordo completamente			nem concordo nem discordo			Concordo completamente

8.2 - Costumo influenciar algumas das compras dos meus amigos

1	2	3	4	5	6	7
Discordo completamente			nem concordo nem discordo			Concordo completamente

8.3 - Cada vez mais os meus amigos procuram-me para dar informações sobre certos produtos que pretendem comprar

1	2	3	4	5	6	7
Discordo completamente			nem concordo nem discordo			Concordo completamente

8.4 - Eu sinto que geralmente sou uma boa referência para os meus amigos e vizinhos em dar bons conselhos sobre possíveis aquisições

1	2	3	4	5	6	7
Discordo completamente			nem concordo nem discordo			Concordo completamente

8.5 - Eu lembro-me de pelos menos duas pessoas a quem falei sobre moda nos últimos seis meses

1	2	3	4	5	6	7
Discordo completamente			nem concordo nem discordo			Concordo completamente

8.6 – Eu frequentemente peço conselhos aos meus amigos quando compro certos produtos

1	2	3	4	5	6	7
Discordo completamente			nem concordo nem discordo			Concordo completamente

8.7 – Eu gasto imenso tempo a falar com os meus amigos algumas compras que faço ou pretendo fazer

1	2	3	4	5	6	7
Discordo completamente			nem concordo nem discordo			Concordo completamente

8.8 – Os meus amigos ou vizinhos normalmente dão bons conselhos sobre algumas compras que faço ou pretendo fazer

1	2	3	4	5	6	7
Discordo completamente			nem concordo nem discordo			Concordo completamente

Questionário – Perfil do Consumidor

9. Atitude em relação á tua marca preferida de ténis/sneakers apenas a preferida (Por favor indicar explicitamente qual é a marca de ténis/sneakers preferida?_____

	Não se aplica nada		mais ou menos		Aplica-se completamente
9.1 Ousadia/atrevimento	1	2	3	4	5
9.2 Tendência da moda	1	2	3	4	5
9.3 Excitante/emocionante	1	2	3	4	5
9.4 Na vanguarda/pioneira	1	2	3	4	5
9.5 Vivaz/animada	1	2	3	4	5
9.6 Jovem	1	2	3	4	5
9.7 "Cool"	1	2	3	4	5
9.8 Imaginativa	1	2	3	4	5
9.9 Única	1	2	3	4	5
9.10 Independente	1	2	3	4	5
9.11 Contemporânea	1	2	3	4	5

10-Assinala na escala de 1 a 7 o teu grau de concordância com as seguintes afirmações relativamente às compras na Internet:

1=Discordo completamente ..... 2 ..... 3 ..... 4= nem concordo nem discordo ..... 5 ..... 6 ..... 7=Concordo completamente

10.1 Pessoalmente acho que as perdas financeiras podem ser importantes	1	2	3	4	5	6	7
10.2 Tendo em conta o montante a pagar numa compra online, essa compra online comporta risco	1	2	3	4	5	6	7
10.3 Dadas as potenciais despesas financeiras associadas com a compra online, o risco financeiro global associado com uma compra online é elevada	1	2	3	4	5	6	7
10.4 Eu penso que a compra de um produto/serviço online pode levar a perdas financeiras na medida em que existe uma certa incerteza	1	2	3	4	5	6	7
10.5 Não estou convicto que um produto/serviço comprado online revele na prática as funções/características tal com é descrito	1	2	3	4	5	6	7
10.6 Tenho sérias dúvidas que um produto/serviço comprado online resulte satisfatóriamente	1	2	3	4	5	6	7
10.7 Eu não tenho a certeza que um produto/serviço comprado online funciona tal e qual é descrito no site	1	2	3	4	5	6	7
10.8 Caso haja problemas pode ser preocupante a ausência de resposta sobre as garantias prometidas ……	1	2	3	4	5	6	7
10.9 Eu fico preocupado/a sobre os prejuízos que podem decorrer de um escolha menos adequada de um produto/serviço que me interessa	1	2	3	4	5	6	7

Questionário – Perfil do Consumidor

01. Nº de correspondência entre questionários____ 02.Sexo: M...../ F..... 03. Idade: _____ anos

1. Por favor, avalia as **tuas emoções pessoais** na sequência do que acabaste de experimentar:

Eu sinto-me:

1.1 Estimulado ……7……6……5……4……3……2……1……. Relax

1.2 Excitação ……7……6……5……4……3……2……1……. Calmo

1.3 Frenético ……7……6……5……4……3……2……1……. Lento

1.4 Agitado ……7……6……5……4……3……2……1……. Mole

1.5 Bem desperto ……7……6……5……4……3……2……1……. Sonolento

1.6 Estimulado ……7……6……5……4……3……2……1……. Relax

1.7 Super-activo ……7……6……5……4……3……2……1……. Passivo

1.8 Entusiasmado ……7……6……5……4……3……2……1……. Desconsolado

2. Avalia as características da interface que observaste relativamente à usabilidade e ao aspecto:

2.1. Facilidade de utilização_____ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.2. Navegação intuitiva_____ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.3. Rapidez de resposta_____ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.4. Organização_____ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.5. Facilidade de controlo_____ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.6. Estética do grafismo/layout____*(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.7. Design agradável_____ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.8. Design "clean"_____ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.9. Utilização de efeitos especiais_ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.10. Design simétrico_____ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.11. Design criativo _____ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.12. Design original_____ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.13. Design sofisticado_____ *(1) mínima……..(2) limitada…..… (3)moderada…….. (4) boa……..(5) excelente*

2.14. Em geral qual o nível de satisfação em relação **<u>à usabilidade</u>** do interface *usando a escala de 1 a 7*?

1.....2.....3.....4.....5.....6.....7		
Muito insatisfeito	neutro	Completamente satisfeito

2.15. Em geral qual o nível de satisfação em relação **<u>ao aspeto</u>** do interface usando a *escala de 1 a 7*?

1.....2.....3.....4.....5.....6.....7		
Muito insatisfeito	neutro	Completamente satisfeito

Questionário – Perfil do Consumidor

3. Qual o sentimento/opinião relativamente ao **Interface online** que acabaste de experimentar:

3.1 Divertido

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

3.2 Confuso

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

3.3 Aborrecido

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

3.4 Gratificante

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

3.5 Decepcionante

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

3.6 Agradável

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

3.7 Irritante

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

3.8 Interessante

1	2	3	4	5
Discordo completamente		nem concordo nem discordo		Concordo completamente

4-Qual a marca de ténis (sneakers) que estava no site/interface?

_____

Questionário – Perfil do Consumidor

5-Atitude em relação á marca de ténis/sneakers - **Converse (all stars) ?**

	Não se aplica nada		mais ou menos		Aplica-se completamente
5.1 Ousadia/atrevimento	1	2	3	4	5
5.2 Tendência da moda	1	2	3	4	5
5.3 Excitante/emocionante	1	2	3	4	5
5.4 Na vanguarda/pioneira	1	2	3	4	5
5.5 Vivaz/animada	1	2	3	4	5
5.6 Jovem	1	2	3	4	5
5.7 "Cool"	1	2	3	4	5
5.8 Imaginativa	1	2	3	4	5
5.9 Única	1	2	3	4	5
5.10 Independente	1	2	3	4	5
5.11 Contemporânea	1	2	3	4	5

6- Posição sobre a marca **Converse (all stars)** ?

6.1 Qual a probabilidade na tua <u>próxima compra</u> de ténis/sneakers optares pela **Converse (all stars)?**

1	2	3	4	5	6	7
Nula			neutro			Elevadíssima

6.2 Qual a probabilidade <u>no futuro</u> comprares uns ténis/sneakers da **Converse (all stars)?**

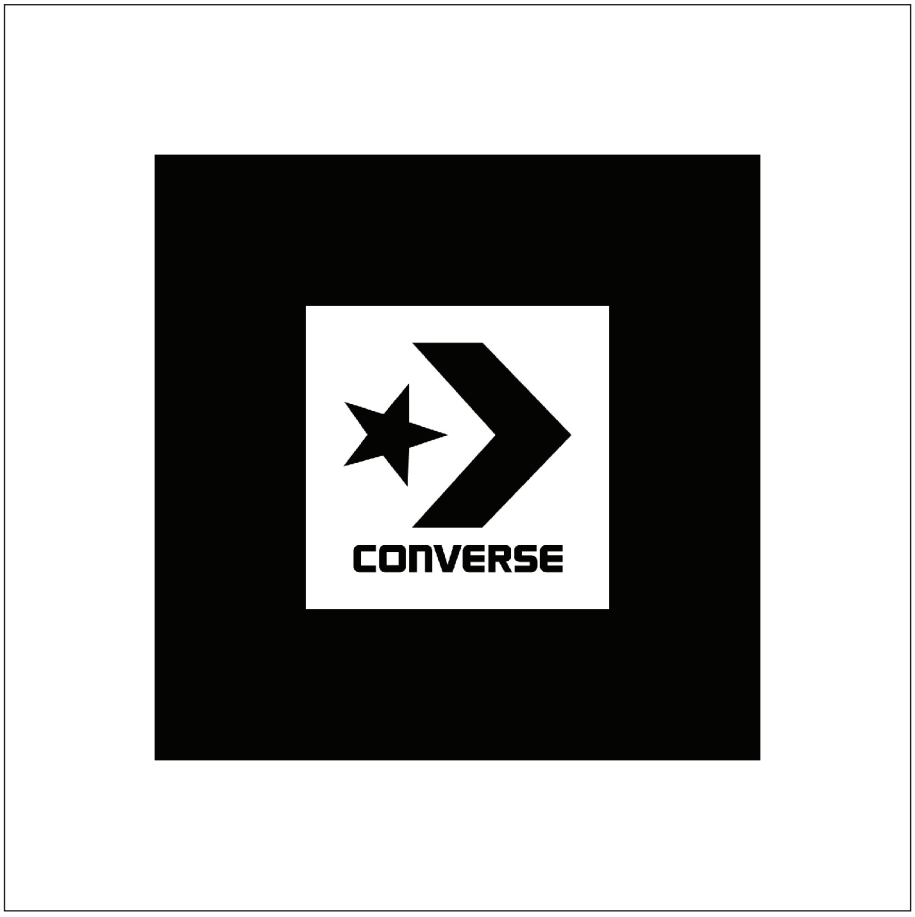
1	2	3	4	5	6	7
Nula			neutro			Elevadíssima

6.3 Qual a probabilidade de visitares o site da marca **Converse (all stars)?**

1	2	3	4	5	6	7
Nula			neutro			Elevadíssima

6.4 Qual a probabilidade recomendares a marca **Converse (all stars)?**

1	2	3	4	5	6	7
Nula			neutro			Elevadíssima


CONVERSE

AR Markerless platform

AR Marker-based platform

Purely Interactive platform