“Reality is in the air”
Concept of perceived augmentation and exploration of its impact on consumer experience

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Submitted to the

Faculty of Communication Sciences

Università della Svizzera italiana

for the degree of

Ph.D. in Communication Sciences

April 2016

Commission

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External jury members:

Officially submitted to the Ph.D. committee of the Faculty of Communication Sciences, Università della Svizzera italiana, in April 2016.

This work is dedicated to my dear Mum.

To delo je posveceno moji dragi mami.

Abstract

Augmented reality (AR) technology is becoming increasingly used in marketing as a tool for enhancing consumer experience. Developed and defined in the fields of computer science and human-computer interaction, AR technology simulates an overlay of virtual annotations in the physical environment and interacts with it in real-time (Azuma et al., 2001). Some popular examples of AR include virtual mirrors (Ray Ban, ModiFace) and smartphone applications that simulate products such as furniture (IKEA). Despite its increasing deployment in marketing, related academic research about the significance of AR for consumer experience and its impact on consumer behavior has been scarce.

This thesis approaches this gap in the literature by studying media characteristics of AR and examining their impact on consumer affective, cognitive and behavioral responses, following the approach of Theory of Interactive Media Effects by Sundar et al. (2015). Throughout a series of four articles, it aims to define salient media characteristics of AR technology and evaluate how they alter consumer experience.

The *1st article* examines to which extent AR shares media characteristics of other interactive technologies and how these characteristics – namely interactivity, modality, hypertextuality, connectivity, location-specificity, mobility, virtuality – influence consumer responses. Based on a literature review, a research agenda is proposed that identifies the knowledge gaps related to the impact of AR on various types of consumer responses. For example, it suggests that future research should investigate: how lower levels of hypertextuality in an AR app influence consumer satisfaction and exploratory behavior; how can AR represent a social experience, given that little connectivity is present in the current AR apps; what combinations of modality in terms of text, visuals and audio are most effective for AR; to which extent consumers perceive AR apps to be interactive and how that impacts their experience. Finally, the research agenda also underlines the importance of investigating the AR media characteristic *augmentation* (Preece et al., 2015), absent in previous interactive technologies.

The *2nd article* focuses on two salient media characteristics of AR apps – interactivity and augmentation. It shows that the presence of AR does not translate into an app being perceived as more interactive in comparison to a non-AR app in terms of control and responsiveness. On the other hand, the study offers first evidence that perceived augmentation is significantly higher for AR apps than for non-AR apps and that it represents a suitable psychological correlate (Sundar et al., 2015) for measuring the perception of AR characteristics that set it apart from other technologies. Two experimental studies demonstrate that perceived augmentation impacts the level of immersion into flow, which then mediates the impact of perceived augmentation on consumer attitude towards the app and behavioral intentions to use it again and talk about it.

Based on the previous study, the *3rd article* further develops the measurement items of perceived augmentation and investigates its impact on consumer experience. An in-the-wild study (Rogers, 2012) was conducted in a retail store, where we observed consumers' interaction with an AR make-up try-on application. The findings show that such an application creates a playful experience and that shoppers would use such tool to narrow their consideration set or, in some cases, to even choose products to purchase. Furthermore, the survey study confirms that perceived augmentation significantly relates with playfulness, perceived convenience and behavioral intentions.

Finally, a more complete scale for perceived augmentation is developed and validated in the *4th article*. Items are refined through several qualitative studies, based on which we propose that perceived augmentation is comprised of two dimensions – virtual enhancement and virtual-physical congruency. An online study with 213 participants confirms this dimensionality and, furthermore, shows that virtual-physical congruency elicits significant impact on enjoyment and perceived informedness, which further impacts future use and purchase intention, while virtual enhancement does not yield a similar impact.

The contribution of this thesis lies in defining *perceived augmentation* as the psychological correlate of AR's unique media characteristic, *augmentation*, and in

proposing and validating its measurement items. Furthermore, a series of three larger studies, all situated in different contexts (in a lab, in a retail store, online), explain how perceived augmentation yields a significant impact on consumer affective responses and behavioral intentions, and in some cases also on cognitive responses such as perceived convenience and informedness. It also highlights the importance of AR app integration in a specific context, which can prevent it from being perceived as gimmicky. The results of this work have implications for both practitioners and academics and offer numerous directions for future research.

Keywords: Augmented Reality (AR), Media characteristic, Augmentation, Attitude, Flow, Purchase intentions, Consumer experience, Virtual try-on, Retail, Scale development.

Acknowledgements

First of all, I would like to thank my supervisors Prof. Andreina Mandelli and Prof. Ivan Snehota for offering me the opportunity to embark on the PhD journey in the first place and to both support and challenge me during it, as well as allowing me to develop my own research profile. I especially appreciated Prof. Mandelli's significant expertise in digital marketing, her feedback on my dissertation project and her support of my academic pursuits. Thank you Andreina!

I would like to express deep gratitude to Prof. Yvonne Rogers. It has been an incredible honour to collaborate with such an inspiring academic. Thank you for warmly welcoming me to the University College London Interaction Centre, for your priceless supervision time, for being so motivating and for the stimulating debates. Above all, I appreciated the new research paths that you have shown me, which have been so exciting to explore and inspired me with ideas for future research!

This PhD would not have been possible without the extremely generous help of Swiss National Science Foundation, allowing me to spend my final year at UCL. I would also like to thank Slovenian agency Ad Futura, which greatly aided me when I started my academic career. I could not have made it without this help – thank you!

I would like to thank IMCA institute and Università della Svizzera italiana for all the opportunities I was offered during my PhD. I also greatly appreciated the encouragement of professors at USI– Peter Seele, Peter Schulz, Reto Hofstetter, Jeanne Mengis, Fabio Crestani and Michael Gibbert. Thank you for having your doors open!

Dusko Kos and Sandi Cesko from Studio Moderna offered me my first professional opportunities and generous help in the beginning of my academic career abroad, which I will never forget. I would especially like to thank Dusko who taught me so much about marketing and, mostly, to believe in myself.

Special thanks go to Ana Moutinho, Russell Freeman and Jonathan Chippindale from Holition who helped me to conduct studies with their amazing technology and were accepting of my ideas. Working with you has been beyond exciting and I am looking forward to our future collaborations!

Very personal thanks go to Irina, Lisa, Federica and Marta P. who, each in their own way, inspired me, encouraged me when I needed them and shared my happiness when I succeeded. Sincere thanks also to my other USI colleagues and friends – Marta Z., Fabio James, Fabio, Roland, Arthur, Morana and many others. We shared many precious moments together during our PhD journeys!

The last year at UCLIC has been a real experience and, as usual, it's the people that make it such. With my thesis buddy Aneesha we ran the final kilometers of the PhD marathon and what a team we were! Thank you UCLICers – Frederik, Melanie, Aisling, Kathy, Marta, Judith and others - for the writing clubs, chats and inspiring work! I would also like to thank Paul Marshall for his valuable advice and collaboration, be it related to research papers, conference submission or academic career.

I feel very fortunate to have amazing friends in my life – Nina, Ines, Natalia, Julia and Judit. Thank you so much for staying close even when we are far apart!

My deep appreciation goes to my parents who taught me that knowledge is the most precious asset and bought me tons of books when I was a little girl. Those books inspired me for a lifetime and I will never forget that. I would also like to thank the rest of my family and to my cousin Sara and aunt Branka for offering successful examples of academic careers. I would also like to thank Pam and Gus for their kindness.

But the biggest "thank you" goes to Morgan. You believed in me more than anyone else, inspired me, taught me so much about research, read and proofread my papers, rubbed my shoulders when they hurt from writing, never allowed me to give up and made this challenging journey a happy one. I know now I would not have made it without you and I feel incredibly lucky to share my life with you.

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1. INTRODUCTION

1.1 Background and motivation for the dissertation project

1.1.1 Interactive technologies & consumer responses

Interactive technologies have considerably changed consumer activities. Mobile applications, geo-location services, virtual worlds, wearables, social media and online communities allow consumers to communicate, access or create content and perform activities via digital devices (Shankar & Balasubramanian, 2009; Yadav & Pavlou, 2014; Varadarajan et al., 2010). However, interactive technologies fundamentally differ among themselves in the way they function and these differences impact how consumers experience them and how they react to them. In other words, the specific type of interactions they allow has an important impact on the way consumers respond to them (Stewart & Pavlou, 2002; Sundar, 2009). Participating in an online community (such as My Starbucks Idea or Harley Owners Groups) is for example highly engaging in terms of social interaction (Calder et al., 2009) because a high level of connectivity is enabled and exchange of communication can take place on various levels among the involved parties (such as group conversations, exchange of comments or private dialogues). In comparison to that, a delivery of marketing communication via smartphones represents a different type of experience where a brand might request access to consumer's geo-location information, which can have a negative impact on the consumer's attitude because of a sentiment of privacy invasion, but can also create a higher level of convenience for a consumer (Rohm et al., 2012). The sentiments of affective commitment can be very high for a member of an online community (Bagozzi & Dholakia, 2006), while for a user of geo-local services the convenience would represent the dominant trait of the experience (Rohm et al., 2012).

There are numerous other examples where consumer experience differs precisely because of the affordances of the technologies (Varadarajan et al., 2010). While other factors such as social, psychological, economic, financial or contextual evidently also play an important part, the role of technology in defining consumer experience is undeniable and continues to evolve (Deighton & Kornfeld, 2009). It thus comes as no surprise that when a new technology appears with the potential to deliver value to both consumers and marketers, it is scrutinized with the purpose of understanding what its role in creating consumer experience will be (if any). Given the rapid pace of technological development, the marketing field is currently facing this challenge with many novel gadgets and digital innovations (Yadav & Pavlou, 2014). Among them, one represents a particularly disruptive and unprecedented case, which is why it continues to capture a significant amount of attention: augmented reality (AR).

1.1.2 Augmented reality

Augmented reality (AR) has emerged in recent years and is progressively applied in commercial contexts. While a limited number of AR applications have been successfully adopted in marketing so far, the current cases only narrowly reflect the potential that AR holds for designing consumer experience. Nevertheless, these emerging cases indicate the developing directions, which is why it is so relevant that they are to be examined.

The first commercial AR app was launched in 2008 (Carmigniani et al., 2011) and since then, the marketing field has been investigating and experimenting with AR in order to understand its prospective role for marketing communication. The result of this being that AR has been applied in a relatively large number contexts and developed with different content; some of which has resulted in gimmicks, while a few gave way to successful new approaches in marketing communication. These experimentations and applications continue to rise: industry agencies estimates that AR will generate $150 billion revenue by 2020 (Digi-Capital, 2015), while Gov2020 predicts that in 2018, enterprise and general entertainment sectors will each reach over $1 billion users in mobile AR (Impact Lab, 2013). While such projections need to be viewed with caution, as they might be intended as a driver for building up a “hype” around a certain phenomenon, the increasing attention that AR is receiving in marketing is indisputable both for academia and for practitioners. For example, AR apps for consumers are continuously show-cased at global high-tech events, AR as an academic and educational topic is making its way to research agendas, curriculums and coursebooks and the number of brands that are using AR in their marketing communication strategy is increasing as well as the number of agencies specializing in designing AR experiences for consumers. And, most importantly, in terms of the technology adoption, the relevance of AR technology for end-users is being confirmed by the increasing use of AR apps: for example, they are spread steadily amongst the UK pre-school child population - 8.5% use AR apps on a smartphone and 18.5% use it on a tablet (Marsh et al., 2015).

Furthermore, AR can be integrated with numerous devices and has thus a wide array of applications. It can be implemented as part of smartphones, wearables, tablets and large interactive screens (Carmigniani et al., 2011). The type of device further impacts the type of delivered experience and allows for distinctive uses in various contexts (Javornik, 2014). Despite this potential variety, patterns have started to emerge about which applications seem to offer a viable experience – and those that fail to do so. AR apps developed for smartphones represent for example the most widespread category, which is related also to its potential for broader reach and lower costs in comparison to some of the more demanding versions, such as the implementation of AR with large interactive screens, wearables or holograms (Javornik, 2014). Some of the most popular cases of AR apps are virtual try-ons for apparel and make up (Huang & Hsu Liu, 2014; Huang & Liao, 2014), AR gaming apps and AR apps that simulate products directly in the physical surroundings, such as for instance an IKEA AR app that places furniture in one's home (Javornik, 2014). Furthermore, AR has also been adopted as a promotional/PR tool as it holds the potential to create fascination with the visual effect that it produces and can thus translate into a buzz. An example of such a campaign is one by National Geographic where wild animals were simulated on an interactive screen in a shopping mall as if alive and interacting with the visitors passing by. The level of realism generated a highly positive response. AR potential as a marketing tool is thus relatively vast, but in order to understand how that potential will concretely develop into practices, a more in-depth examination of AR technology features is required.

In some ways, AR resembles other interactive technologies in the sense that the type of actions that are taken to access the AR content on smart devices are typical for other interactive technologies – such as browsing and tapping. However, AR substantially differs in the sense that the core interaction takes place in a different manner than consumers were used to before: it goes beyond the screen as the digital and the physical become intertwined in a way that has not been the case with previous technologies. This feature represents a key media characteristic of AR and, as will be discussed later on, an impactful determinant of consumer experience with AR.

It is relevant to acknowledge that AR is gaining momentum in many other sectors as well. In tourism, AR apps are used to provide contextualized information and act as a type of virtual/digital tourist guide (Yovcheva et al., 2014). In the cultural sector, AR acts as an enhancement for art objects or performances (Chang et al., 2014; Marchiori & Cantoni, 2015) and in education, its vividness can deliver a reinforcement of the learning process (Zimmerman et al., 2015). In the construction industry and architecture the simulations support working processes (Chi et al., 2013) and in the military and aviation the overlaid information is visualized in a way that it is situated in a specific, relevant location (Livingston et al., 2011). The AR apps in marketing are therefore just one piece of the AR system that is progressively being integrated in different areas of human activities – and these other contexts can serve as a relevant source of examples for further understanding of the user interactions with AR.

1.1.3 Augmented reality and consumers

For marketers to be able to deploy AR in a successful manner and to set it up in a way that it provides value for the consumer, an understanding is necessary of the type of experience that AR creates for the consumers. With consumer experience, we refer to an "*experience that is holistic in nature and involves the customer's cognitive, affective, emotional, social and physical responses to the retailer*" (Verhoef et al., 2009). This definition has been widely adopted in the consumer behavior field: numerous other researchers have also defined consumer experience as a concept referring to different types of consumer responses (Schmitt, 1999; Tsai, 2005; Brakus et al., 2009). While discussion in the literature goes also beyond this conceptualization in some research streams (Caru & Cova, 2003) and focuses on other dynamics of the phenomenon, the definition by Verhoef et al. (2009) has been adopted for the purpose of this research. Studies of this type of responses to a technology provide insight into how consumers feel about it, what type of thoughts it evokes and what behavior they respond with.

Given the wide array of consumer behavior that this definition covers, it is not difficult to appreciate that consumer experience represents a complex phenomenon that is shaped by numerous factors – personal demographics and psychographics, types of tasks, goals, pricing strategy and incentives, marketing communication and branding, social environments, situational factors, atmosphere and technology - to name but a few. While all these factors play a crucial role, the impact of technology and its features proves to be especially pivotal to understand as it represents an infrastructure, a sort of playground for consumer experience. The consumer behavior field thus requires a better understanding of what type of consumer experience AR technology creates. The next question that arises is how is one to approach this challenge?

1.2 Interdisciplinarity of the project

Whilst developing the framework of the project, it became clear early on that an interdisciplinary approach would represent a significant advantage for various reasons. Firstly, the literature in the marketing field does not yet offer sufficient conceptual and measurement tools for studying AR, mainly because of the novelty and uncertain influence that this technology will exert on marketing activities. Technical fields have, however, so far examined numerous aspects related to AR – progressively more also of user behavior - and the most advanced knowledge about AR functioning therefore comes from computer science and human-computer interaction fields where AR has been developed and defined (Azuma et al. 2001; Billinghurst et al. 2001), examined in different contexts (Pucihar & Coulton, 2015; Preece et al., 2015) and assessed in relation to the user (Swan & Gabbard, 2005; Olsson et al., 2013).

Secondly, following the interdisciplinary approach did not merely mean adopting the established definitions - it mainly allowed a deeper understanding of interactions between consumers and AR. It is not only the commercial aspects that provide the value of a technology for a consumer. The consumer experience is multi-faceted and to understand both the nature and the value of the interaction, an inclusion of two fields was necessary: communication theory and human-computer interaction. Firstly, communication theory permitted the development of a model related to aspects of media characteristics and their impact on potential consumer experience. Human-computer interaction on the other hand offered tools for a) understanding and defining the unique media characteristics of AR and b) studying more in-depth consumer experience with AR technology, which offered a basis for one of the main steps in the scale development process, as it revealed an understanding of how users perceive the media characteristics of AR.

Discussion on the applicability of theory from the communication field to this project was initiated during a doctoral colloquium of the International Communication Association conference in June 2013 and further developed during my research visit at the MediaEffects Lab at PennState University in August 2013.

Furthermore, a significant part of this project was developed and realized during a research stay at University College London Interaction Centre, a center of excellence in human-computer interaction, where the interdisciplinary character of AR related to human-computer interaction was advanced through empirical studies.

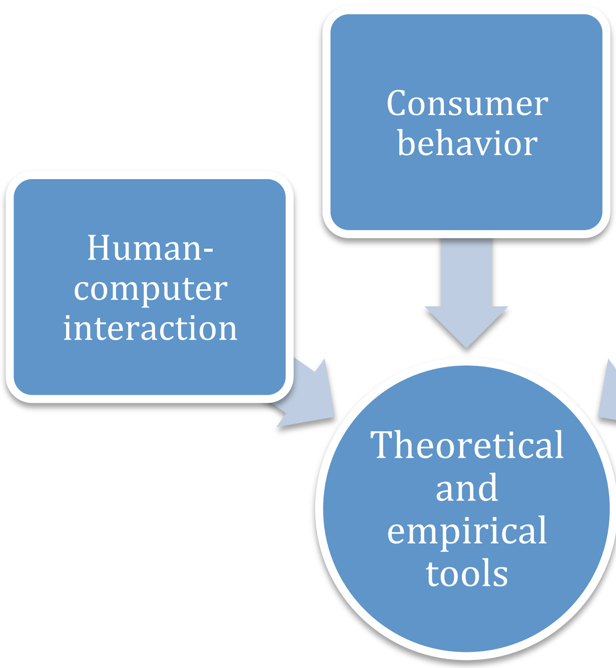


Figure 1: Underlying interdisciplinary character of the project

1.3 Types of AR apps used

There are numerous forms of AR apps and it would be challenging to examine all the different types of devices and applications. However, some variety of the apps and devices on which the apps were used, was ensured. This work studied the following commercial AR apps: a) AR app on a tablet that allows "space augmentation" (i.e. simulation of a product in a surrounding space) and b) AR apps on computers, tablets and smartphones allowing "self augmentation" (simulating the appearance of objects on a user's face, observed in a virtual mirror). In the majority of the cases the apps used in the studies were examples of virtual mirror, simulating make-up or glasses on a face, developed by companies for commercial use and available for download.

1.4 Approach

1.4.1 Media characteristics

Interactive technologies possess media characteristics. This term stands for the technological features that define the character of a technology (Stewart & Pavlou, 2002; Sundar et al., 2015) and – to some extent - the type of interactions these technologies will allow a user to get involved in (Norman, 1999). While traditional media effects theory assumed a deterministic approach, suggesting that consumers or users mainly respond in the way that has been pre-designed for them – referred to also as "hypodermic needle model" (Bineham, 1988; Scheufele & Tewksbury, 2007) – this view has long been discarded as inaccurate. Rather, it has been replaced with an approach where the main focus is placed upon the investigation of the modes of interaction between a technology and a user or, in commercial contexts, consumer. The current approach in media effects theory thus does not assume that media characteristics determine the consumer activities or in any way program consumer responses. Rather, the "how" of interactions between a technology and a user is of the main interest (Stewart & Pavlou, 2002). This shift is aligned with the paradigm change in marketing that instead of persuasion, communication and dialogue represent the basis of marketing with interactive media (Duncan & Moriarty, 1998).

The media characteristics of interactive technologies provide possibilities for types of interactions that were unsupported or impossible prior to the rise of digital technologies: computer-mediated environments (Hoffman & Novak, 1996) for example have enabled a more dynamic and effective approach to information search with its high level of hypertextuality and search engines (Koenemann & Belkin, 1996; Richard et al., 2010);

virtual worlds show realistic 2-D and 3-D product simulations that permit the consumer to evaluate a product without seeing it in person or touching it thanks to virtuality (Daugherty et al., 2008; Kim & Forsythe, 2008; Blascovich & Bailenson, 2011) and mobility of smart devices provides opportunities for ubiquitous digital interactions (Deighton & Kornfeld; 2009) – to name but a few. While technology to a large extent improves the shopping process and renders consumption activities in some way better for the consumer, some research also pointed out the changes caused by technologies that can have a negative impact on consumer activities (Lysonski & Durvasula, 2008) or on marketing performance (Lee et al., 2008).

In this thesis I adopt the approach as proposed in the MAIN (Modality, Agency, Interactivity, Navigability) model (Sundar, 2008) and more recently further developed in Theory of Interactive Media Effects or TIME (Sundar et al., 2015). TIME proposes that media possess technological characteristics that act as affordances (Norman, 1999), meaning that they allow users to perform certain activities. Furthermore, these affordances are then perceived by consumers through a psychological correlate of the characteristic. A characteristic can be perceived in different ways – navigability of an interface for example can make the user perceive the media as controllable and customizable, in the sense that it is easy for him to control and personalize it in the way that it reflects his actions and choices (Sundar et al., 2015).

Let us take a look at interactivity as another example. Interactivity represents one of the most often-studied media characteristics and is a highly relevant cue for user behavior online (Fiore & Kim, 2005; Hoffman & Novak, 2009; Yoo et al. 2009; Sundar et al. 2015). There exist numerous definitions of interactivity (Liu & Shrum, 2002; Kiousis, 2002; Song & Zinkhan, 2008; Sundar, 2015), all emphasizing in some way the two-way communication and the convergence of actions one upon the other, enabled by a medium. However, two different, and opposing, approaches have been adopted among scholars when studying interactivity: feature-based and perception-based. In the feature-based approach, the medium is defined as interactive based on the features it possesses (Sundar, 2004), while the perception-based approach defines a medium as interactive only when a user perceives it as such (Song & Zinkhan, 2008).

TIME (Sundar et al. 2015) overcomes this schism by proposing a model that includes both conceptualizations, but also defines a clear distinction between them. According to TIME, media characteristics are objective characteristics of a technology and exist independently of a user or type of interaction. On the other hand, the perception of these characteristics is very much dependent on users and is defined as a psychological correlate of a certain characteristic –these perceptions can greatly vary across users, depending on a number of external factors such as for example cognitive innovativeness, familiarity with technology, type of task and content (Song & Zinkhan, 2008; Huang & Liao, 2014).

A medium is for example interactive if it allows – among others – exchange of messages across different parties, dynamic access across different information sources or use of mechanisms to co-create content. When a user engages with a medium, she then perceives it in a certain way. For instance a user could perceive that they have a high level of control over type of content, or perceive the medium to be very quick in responding to her request. The same medium, however, could be perceived as unresponsive and not interactive if the user doesn't know how to use certain features or feels overwhelmed by choice (Song & Zinkhan, 2008).

While media characteristics thus represent the infrastructure for interactions, the psychological correlates represent the transformation of such characteristics into the drivers of consumer responses, based on which consumers orient themselves to form attitudes, facilitate recall, and intend to use a medium again (Sundar et al., 2015). For instance, when a consumer has a lower motivation to engage in decision-making (Petty & Cacioppo, 1986), attitudes act as a trigger for subsequent behavior (Ajzen, 1991).

The impact of media characteristics on consumer behavior has been abundantly investigated in frameworks of different theories, such as the technology acceptance model, theory of planned behavior, theory of reasoned action, innovation diffusion theory and others (Hoffman & Novak, 1996; Stewart & Pavlou, 2002; Yadav & Pavlou, 2014).

While AR certainly shares some features with other technologies - the same as computer-mediated environment did with traditional media (Hoffman & Novak, 1996; Stewart & Pavlou, 2002) - it also distinguishes itself from them. A question this raises is how exactly does it do this and how does this impact consumers?

1.5 Research question

Given the motivation and the background for this project, the research question that acted as a driving force of this project is the following:

Which are the media characteristics of augmented reality and how do they impact consumer experience?

To answer it, research aims and research sub-questions were defined, based on which theoretical and empirical studies were conducted.

1.6 Research aims

The two main objectives of the thesis are to understand:

1) the distinctive media characteristic of AR and the corresponding consumer perception or the "psychological correlate of media characteristic" (Sundar et al., 2015);
2) the type of experience that is related to this media characteristic in terms of consumer affective, cognitive and behavioral responses.

Pursuing these objectives, this thesis brings attention to a media characteristic that has not been investigated in previous studies, but emerged as salient only with AR. That characteristic is called augmentation (Preece et al., 2015; Billinghurst & Kato, 2002) and it represents a key to understanding the uniqueness of AR technology and therefore also the related consumer experience.

To date, consumer perception of it has so far not been investigated and in order to offer conceptual and measurement tools for doing so, this thesis aims to

a) propose ways of measuring the perception of augmentation, AR's exclusive

media affordance.

Aligned with the second objective, this thesis sets out to

b) explain how the perception of this characteristic impacts consumer responses.

These challenges were approached via a series of studies through which these aims were achieved. After conducting a literature review and proposing a research agenda for studying consumer experience with AR, a number of empirical studies were conducted that iteratively re-evaluated the concept of perceived augmentation and its relevance for consumer experience. This main research question was developed further into sub-questions in the four articles as follows:

- 1st Article

a) Which are the media characteristics of interactive technologies and to which extent do these characteristics apply to AR?

b) How do these media characteristics impact consumer responses?

c) Which media characteristics of AR that are unique to AR and not present in other interactive technologies?

- 2nd Article

d) Does AR lead to higher perceived interactivity than non-AR technology, such as websites and virtual settings?

e) Is augmentation a salient media characteristic of AR?

f) How do consumers perceive augmentation? Is there a difference in how consumers perceive the augmentation of the self and augmentation of the space?

g) Do consumers experience flow when using AR apps?

h) Does flow mediate the impact of perceived augmentation on consumer cognitive, affective and behavioral responses?

- 3rd Article

i) How do consumers react to AR virtual mirrors in a store? What type of experience does it create for them? How can their behavior in the store help us to understand their perception of augmentation?

j) Does perceived augmentation lead to a playful experience in a store with a virtual mirror? Does it represent a convenient tool for shopping? Does perceived augmentation correlate with behavioral intentions?

- 4th Article

k) How can perceived augmentation be conceptualized and operationalized?

l) What are the consumer cognitive, affective, sensory and behavioral responses to an AR app and what type of consumer experience does this lead to?

1.7 Methods

In this work, we adopted both qualitative and quantitative methods. While quantitative studies represent the core approach, numerous qualitative studies were conducted as they represented the appropriate methodological tool given some of the research objectives. As already defined in the previous section of this introduction, this work followed two main objectives:

- Developing and validating a perceived augmentation scale (Figure 2)
- Examining consumer experience related to perceived augmentation (Figure 3)

These two objectives required different methodological approaches.

1) For the scale development, the following steps were taken:

- 1st development of perceived augmentation measurement items based on:
    - Literature review
    - Study of 51 commercial AR apps
- Test of perceived augmentation measurement items:
    - 2 experimental studies
- 2nd development of perceived augmentation measurement items based on:
    - Qualitative analysis of participants' comments
- Test of refined perceived augmentation measurement items:
    - Survey with real-world shoppers
- 3rd development of perceived augmentation measurement items based on:
    - Observational study of real-world shoppers
    - 2 expert groups

- Focus group

- Validation of two-dimensional scale of perceived augmentation:
  - Online survey study

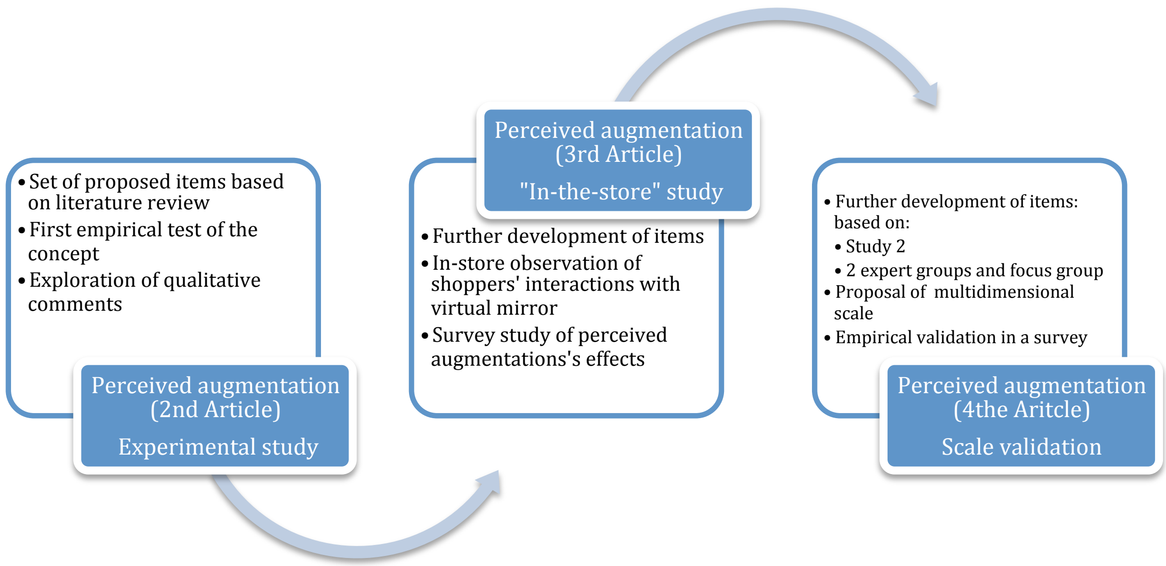


Figure 2: Sequence of studies investigating the perceived augmentation concept

The process for the scale development required numerous steps and an iterative process, where items were continuously re-examined and developed further. The reason for this high number of studies is connected to three main conditions. Firstly, the concept of "perceived augmentation" has not been previously specified or developed and a thorough understanding of it thus required several different studies. Secondly, AR technology is still in the early stage of being adopted by users. Thus, having access to different participants in terms of demographics provided a substantial advantage for understanding how diverse groups of users perceive this enhancement of reality to take place as it increased external validity of the concept. Finally, given that AR technology is still in its development, this process allowed different AR types to be tested, ensuring greater generalization of the perceived augmentation concept. The concept development represents the crucial basis for scale development (Hinkin, 1995). The 2nd and the 3rd Article ensured such a basis by examining three different AR apps used by two different sets of participants in two different countries (Switzerland and the Netherlands), complemented by further exploratory studies – expert groups and focus group – conducted in the United Kingdom.

In the 2nd Article, factor analysis and tests for internal reliability were conducted to test the first set of measurement items. In the 3rd Article, the measurement items of perceived augmentation were refined and factor analysis and tests for internal reliability were again applied. The scale development process reached its final stage in the last study of this thesis, where two-dimensionality of the scale was proposed and validated in an online survey with over 200 participants from the United Kingdom. For this purpose, both exploratory and confirmatory factor analysis were conducted, following the required steps for scale refinement and validation (Clark et al., 1995; Hinkin et al., 1997). Furthermore, structural equation modeling was used for the test of nomological validity.

2) Some of the studies conducted for the purpose of perceived augmentation concept and scale development also pursued the objective of examining consumer experience with perceived augmentation. These were:

- 2 experimental studies (2nd Article)

- Survey study with real-world shoppers (3rd Article)

- Online survey (4th Article)

More specifically, these tested relations between perceived augmentation and consumer responses, as presented in Figure 3.

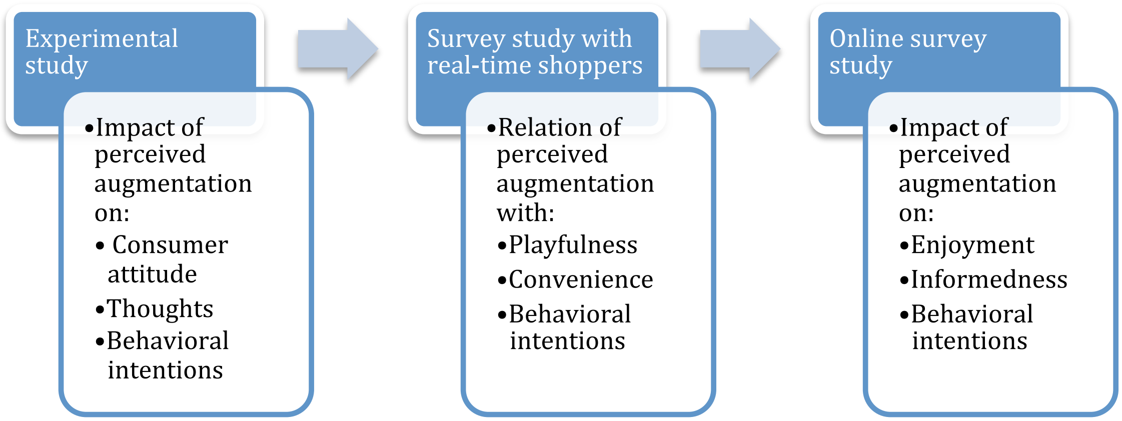


Figure 3: Sequence of studies examining relations of perceived augmentation with consumer affective, cognitive and behavioral responses

The first empirical study replicated a research model by van Noort et al. (2012) and followed methodology from that study for examining the effects. ANOVA analysis and mediation analysis with bootstrapping procedure were conducted.

In the survey study from the store, factor analysis was used for examining the measurement constructs and linear regression analysis for testing relations between the observed variables.

In the third empirical study, structural equation modelling was applied to test the proposed hypotheses between perceived augmentation and consumer cognitive, affective and behavioral responses, which further allowed discussion and understanding of consumer experience with AR.

1.8 Structure

This thesis is structured as a cumulative one: chapters are written in the form of academic articles that are separate research reports, published or submitted to respectable academic venues. However, as is the norm, the dissertation project has been guided by a coherent research objective, which is explained and discussed in more detail in the introduction and in conclusion of the dissertation.

1.8.1 Augmented reality: Research agenda for studying the impact of its media characteristics on consumer behavior (1st Article)

The main research question was approached by examining AR both on its own and also within the context of other interactive technologies' media characteristics and their impact on consumer responses. By studying related literature on media characteristics, the most salient characteristics of interactive technologies are defined. Furthermore, their impact on consumer responses is examined and special attention is placed on the different types of consumer experience according to the "affordances" (Sundar et al., 2015) that allow for engagement with medium, content, technology, people or space in unique manners.

Moreover, we then examine if and to which extent these media characteristics are emblematic for AR technology by relating these characteristics to AR functioning. This was done by studying current commercial AR applications (Javornik, 2014) and focusing in-depth on two most popular/prominent types in commerce: smart device AR apps and AR on fixed interactive screens. Through examining if and how these characteristics are present in AR, a discussion is opened about AR representing a new interactive technology.

Upon that, the attention is placed on the second part of the research question: what is the impact of the media characteristics on consumer responses? In order to answer this question, a related literature review is required. I examine 44 academic papers, published in reputable journals in consumer behavior, marketing and human-computer interaction. In literature review, the specificity of consumer responses is taken into account in order to avoid generalization and maintain detailed overview.

Based on the literature review, there are (at least) 8 media characteristics that are highly relevant for studying consumer responses to AR. 7 of them have been examined in other contexts and studied in consumer behavior: interactivity, virtuality, hypertextuality, connectivity, modality, mobility and location-specificity. However, a focus is placed not only on how AR resembles other interactive technologies, but also and mainly on how it differs from them. One characteristic has been so far unexplored and that is the characteristic of *augmentation* (Preece et al., 2015; Billinghurst & Kato, 2002), related to the novel way of AR visualizing and situating content and information. Augmentation has been neither conceptualized in-depth nor operationalized as a measurement construct.

Finally, research agenda for impact of AR on consumer behavior is proposed. It covers different directions based on the eight characteristics of the technology and offers ground for investigating how consumers respond to AR as well as propositions and hypotheses about consumer responses to it.

1.8.2 "It's an illusion, but it looks real!" Consumer affective, cognitive and behavioral responses to augmented reality applications (2nd Article)

The real value of understanding AR media characteristics for marketing lies in their implications for specific consumer responses. This paper approaches this challenge by focusing on two media characteristics of AR - interactivity and augmentation. Interactivity represents a crucial component on several levels and has been importantly advanced over last two decades in both communication and marketing fields. Especially examination in the frame of TIME theory (Sundar et al., 2015) developed an important step forward by offering a viable solution in terms of conceptualizing interactivity as an objective media characteristics to which consumers respond with their psychological correlates. Sundar et al. (2015) differentiate between medium and person interactivity and classify further differences of interactions that a technology can offer.

To answer the research questions *d) – h)* as presented above, we replicate a study by Van Noort et al. (2012) and apply the model, originally investigating interactivity online/website, to AR environment. Van Noort et al. (2012) tested the impact of perceived interactivity on consumer affective, cognitive and behavioral responses and examined if perceived interactivity's impact on these responses are mediated by flow. Their two experimental studies showed that when consumers perceived a website to be highly interactive, they get more immersed into flow which further mediates their attitude both towards brand and the website, their related thoughts and the behavioral intentions related to purchase and repeated usage of the website.

This chapter thus discusses the concept of interactivity and its implications for AR, investigating if presence of AR features leads to higher perception of interactivity - the way it has been defined by Sundar et al. (2015) - when consumer interacts with an app.

Besides investigating this well-established media characteristic and its psychological correlate (perceived control, perceived responsiveness), the second paper further focuses on augmentation, proposing it as a core media characteristic of AR based on previous research. Here again, we apply the framework proposed by Sundar et al. (2015) and Sundar (2008), where a media characteristic is an objective feature of a technology and consumer perceives and registers it through psychological correlate of the characteristic. First set of measurement items of perceived augmentation is proposed, based on literature review and observation of AR apps (Javornik, 2014). These items are tested for it validity, as well as for their relations with flow and consumer affective, cognitive and behavioral responses.

1.8.3 Revealing the Shopper Experience of Using a 'Magic Mirror' Augmented Reality Make-Up Application (3rd Article)

In the third article, consumer experience with AR is observed in a real-life setting with the purpose of investigating further the concept of perceived augmentation and to examine consumer responses to them. Previous study showed that perceived augmentation correlates with flow which further mediates an impact on app-related responses: attitude towards the app, app-related thoughts and intentions to use the AR app again and talk to other people about it. However, the experiment did not confirm a correlation between perceived augmentation and brand-related responses or purchase intentions.

We thus wanted to test that further in a different setting to a) investigate further the concept of perceived augmentation and to b) further examine the effects of perceived augmentation on playfulness and convenience as experienced by a consumer when using a technology. Furthermore, we also analyze the effects of playfulness and convenience on behavioral intentions.

This study is composed of two empirical parts: observation study in the store where shoppers' interactions with the virtual mirror are observed and survey study, based on which the quantitative analysis is performed.

1.8.4 "Beyond the wow effect of augmented reality" – Development of perceived augmentation concept and measuring its effects on consumer responses (4th Article)

In the final article, a model of consumer experience with AR is proposed and tested. This model includes the main dimensions of consumer experience: affective, cognitive and behavioral. As stated above, the main interest is linked to the question to which extent the perception of perceived augmentation affects or relates consumer responses. Based on the assumption the augmentation can be perceived on different levels, the concept of perceived augmentation is proposed to be two-dimensional. The items of subdimensions have been developed based on a) observational study in a store (Paper 3) and b) two expert groups and a focus group that are presented in this paper.

The study validates the measurement items by conducting a survey study with 213 participants. After several interaction episodes with the app, participants were asked to fill out a survey. Based on the survey data, perceived augmentation scale is validated and its impact on consumer experience is investigated by measuring consumer cognitive, affective, sensory and behavioral responses.

2. AUGMENTED REALITY: RESEARCH AGENDA FOR STUDYING THE IMPACT OF ITS MEDIA CHARACTERISTICS ON CONSUMER BEHAVIOUR

Article published:

Javornik, A. (2016), Augmented reality: Research agenda for studying the impact of its media characteristics on consumer behavior. *Journal of Retailing and Consumer Services*, 30, 252-261

Abstract:
Augmented reality has emerged as a new interactive technology and its unprecedented way of complementing the physical environment with virtual annotations offers innovative modes for accessing commercially-relevant content. However, little is known about how consumers respond to its features. This paper approaches augmented reality (AR) by studying media characteristics of interactive technologies and shows to which extent they are indicative of current AR commercial apps. Based on a literature review about consumer responses to these characteristics, potential media effects of AR on consumer behaviour are discussed. Finally, the article proposes a research agenda for further study of this new phenomenon in consumer behaviour.

Keywords: Augmented reality, Interactive technologies, Media effects, Consumer behaviour, Human-computer interaction, Literature review

"To myself I am only a child playing on the beach, while vast oceans of truth lie undiscovered before me." (Sir Isaac Newton)

2.1 Introduction

Augmented reality (AR) has emerged as a relevant interactive technology in the marketing environment, increasingly used in retail contexts and often developed in formats of smart device applications. Its ability to overlay the physical environment with virtual elements such as information or images, which can interact with the physical environment in real time, provides new possibilities for content delivery to consumers. It consequently holds the potential to alter a large number of consumer activities, among which information search and product trials. As its use increases, there is an ever-growing need to better understand its impact on consumer behaviour and on the experience that it delivers.

This paper proposes a research agenda for investigating consumer behaviour related to the use of AR in marketing channels, building on previous knowledge about interactive technologies and their impact on consumer behaviour. Interactive technologies have considerably transformed the way consumers engage in shopping and brand activities (Hoffman & Novak, 1996; Yadav & Pavlou, 2014). Some of the most influential changes since the evolution of web 2.0 and web 3.0 are participation in online communities (Kozinets et al., 2010), B2C and C2C interactions through social media (Kaplan & Haenlein, 2010), increased use of mobile phones and smartphone applications (Shankar & Balasubramanian, 2009; Ström et al., 2014), digital signage (Dennis et al., 2010) and engagement with immersive virtual reality (Nah et al., 2011). While challenges related to consumer responses to more established interactive technologies led the way to a rich body of research (Agarwal & Karahanna, 2000; Childers et al., 2001; Liu & Shrum, 2002; Novak et al., 2003; Pagani et al., 2011; Sheth & Solomon, 2014), the possible impact of emerging

AR technology on consumers has only been discussed in very few cases (Huang & Hsu Liu, 2014) and, furthermore, no systematic research agenda has been proposed.

The AR industry is estimated to reach $56.8 billion by 2020 (MarketsandMarkets, 2015), while Fortune expects it to generate $120 billion in revenue by 2020 (Gaudiosi, 2015). Given its rise, it is progressively more important to investigate how AR affects consumer responses. With such knowledge, marketers can acquire a better understanding of how AR can be used as a tool in various shopping channels for specific purposes.

This article starts by discussing how AR functions and its current commercial applications by drawing parallels with earlier interactive technologies and their media characteristics: interactivity, hypertextuality, modality, connectivity, location-specificity, mobility and virtuality. By studying the impact of these characteristics on consumer behaviour, we are able to propose a research agenda for future studies of AR in marketing. The agenda outlines specific directions for how research could study the specificity of these characteristics in AR – or the lack thereof –, their impact on consumer responses and the type of consumer experience they deliver in different marketing channels, such as in retail and online.

2.2 Theoretical background

AR is an interactive technology that modifies physical surroundings with superimposed virtual elements. This virtual layer, placed between the physical environments and the user, can add textual information, images, videos or other virtual items to the person's viewing of physical environment. The devices that enable such superimposition can be smartphones or tablets, wearables (head-mounted displays), fixed interactive screens or projectors (Carmigniani et al., 2011).

AR technology has been largely investigated in the areas of computer technology and human-computer interaction, where also the most relevant definitions have been developed (presented in the Table 1).

Authors	Definitions
Azuma et al., 2001	*An AR system supplements the real world with virtual (computer-generated) objects that appear to coexist in the same space as the real world. While many researchers broaden the definition of AR beyond this vision, we define an AR system to have the following properties: combines real and virtual objects in a real environment; runs interactively, and in real time and registers (aligns) real and virtual objects with each other.*
Zhou et al., 2008	*Augmented Reality (AR) is a technology which allows computer generated virtual imagery to exactly overlay physical objects in real time. Unlike virtual reality (VR), where the user is completely immersed in a virtual environment, AR allows the user to interact with the virtual images using real objects in a seamless way.*
Reitmayr & Drummond, 2006	*Augmented reality (AR) is a promising user interface technique for mobile, wearable computing and location-based systems.*
Van Krevelen & Poelman, 2010	*Augmented reality (AR) is this technology to create a "next generation, reality-based interface" and is moving from laboratories around the world into various industries and consumer markets. AR supplements the real world with virtual (computer-generated) objects that appear to coexist in the same space as the real world.*
Carmigniani et al., 2011	*Augmented Reality (AR) is a real-time direct or indirect view of a physical real- world environment that has been enhanced / augmented by adding virtual computer- generated information to it. AR is both interactive and registered in 3D as well as combines real and virtual objects.*

Table 1: Definitions of augmented reality from computer science literature

The formulation of AR by Azuma et al. (2001), recognised as the most accepted one, emphasizes not only the co-existence of virtual and real in the same space, but also interactive alignment and mutual registration of computer generated sources with physical reality. It underlines the embeddedness of AR in real time (thus deviating from virtual reality) and its interactive character. Reitmayr and Drummond (2006) added that an important element of an AR device is also its ability to be portable or wearable, thus mobile in some way. However, that applies only to some groups of AR technologies (Carmigniani et al., 2011) – fixed interactive displays for instance do not allow mobility. Overall, the focus of all the revised definitions is the augmentation of the real with the virtual layer (Van Krevelen & Poelman, 2010; Preece et al., 2015), computer-generated information (Carmigniani et al., 2011) in combination with interactivity (Van Krevelen & Poelman, 2010; Carmigniani et al., 2011; Azuma et al. 2001; Zhou et al., 2008; Reitmayr & Drummond, 2006).

The most relevant media characteristics of augmented reality as stated in these definitions are the following: interactivity, virtuality (presence of elements of virtual reality), geolocation feature / location specificity, mobility (in terms of portability and wearability) and synchronisation of virtual and physical/real (augmentation).

The first forms of AR were developed in the 1950s in cinematography by Morton Heilig, who named the special cinema features "Sensorama" (Carmigniani et al., 2011). In the 1960s, Ivan Sutherland developed the first prototype of AR at Harvard that enabled viewing of 3-D graphics using a holographic projection. In the 70s and 80s, research institutes, NASA, the aviation industry and other industry centres continued to develop wearable devices, digital displays and 3-D graphics with AR. Scientists Caudell and Mizell coined the term in the 1990s in the area of aviation, developing an AR assistance system for workers who were wiring harnesses (Azuma et al., 2001; Carmigniani et al., 2011). Since the 1990s, wearable computers and mobile AR were developed and put to use for the first time and AR has gained increased attention in computer science, linked with the areas of virtual reality, 3-D technology and mobile technology (Azuma et al., 2001; Van Krevelen & Poelman, 2010; Preece et al., 2015). The technology has also been applied in medicine, industry, gaming, military, art, navigation, education, tourism and architecture.

Initial forms of AR were not robust enough, cost-effective or sufficiently intuitive enough to be launched broadly and to have the potential of being adopted by average consumers by offering intuitiveness and ease-of-use, which are some of the crucial factors for engagement with technology (Davis et al., 1989; Pavlou, 2003). However, the conditions have changed in comparison to the 1990s when AR was still in its infancy. Technological advancement, decrease of related costs, increased mobility and portability of AR and its embeddedness in the existing digital landscape together with geolocation applications, global positioning system (GPS) and near-field communication (NFC) have increased both the utility and consequently the relevance of AR. The current digital environment allows deployment of AR technology for marketing purposes at various touchpoints of consumer journey, especially in retail, mobile and online, as Mandelli and La Rocca (2014) have noted in one of the early studies on AR and consumer services. The following section presents the most common AR applications in marketing at the moment, with regards to the channels where they are used and the type of augmented content they provide.

2.1. *Current uses of augmented reality in retail and mobile marketing*

In recent years, brands have been using and testing various AR apps in different contexts to examine the most suitable settings for their use. So far, AR used on smart devices and large interactive screens, either privately or publicly in retail are among the most common ones (Javornik, 2014). AR apps on smart devices allow a consumer for example to see a virtual product situated in the environment (such as a virtual furniture in a physical room) or to access additional digital content by scanning a product's logo or a related image (such as a scanned magazine's ad that transforms into a video on a tablet's screen). Large interactive screens on the other hand can present a greater part of the physical surrounding on the screen, to which the virtual elements are added (as for instance an AR campaign in a shopping mall with a purpose of raising consciousness about endangered species, that showed on a large screen the threatened animals that seemed to be walking around the mall).

Besides the context of use, the AR apps also differ with regard to the entities they augment (Carmigniani et al., 2011). In that sense, AR capability of enhancing the physical reality - also referred to as augmentation (Preece et al., 2015) – can overlay virtual elements on: person, products or surrounding space.

The augmentation of a person can refer either to an enhanced view of someone else or of a self. An enhanced view of another person can be for instance provided through augmented reality glasses (e.g. Google Glass or Hololens), however such applications have so far been rare in marketing due to the limited access to the head-mounted displays or goggles. On the other hand, apps for enhanced view of a self or "self-augmentation" have been more widely disseminated in the form of virtual mirrors or virtual try-ons. While digital try-ons existed in earlier versions (websites allowed uploading a piece of apparel on one's photo or a personalised avatar), the AR virtual mirrors deliver a more realistic and interactive experience. The screen conveys a reflection of your body or of its part (for instance face, head or hand) with virtual add-ons, such as glasses, make-up and clothes. Virtual try-ons represent one of the more popular AR cases and have been adopted by several apparel and cosmetics brands.

Furthermore, AR apps allow also augmentation of a product, usually by scanning an item with a smart device that can then visualise an enhanced view. Some examples of such apps are for instance those that provide additional nutritional information about food products on a shelf, show reviews as if directly linked to the products, change the colours of an item on a screen or add gaming elements.

Finally, some apps allow an augmentation of a surrounding space with virtual elements. That is used for seeing how a product would look like in a certain space (for instance a piece of furniture in the room) or for getting additional content about surrounding space (for instance the screen shows on the camera view of the street where a nearby coffee place is and which stores have a sale).

But in what way does AR act as an interactive technology? Answering that question will allow better understanding what consumer experience can AR offer.

2.2. *Augmented reality as the next interactive technology?*

Interactive technology is an umbrella term for diverse forms of computer-mediated and digital environments. Varadarajan et al. (2010) defined it as tools and devices that enable entities to engage in mediated communication and are based on digital technology, such as: e-mail, hyper-text technologies, web browsers, instant messaging, access technologies (i.e. wi-fi and GPS), mobile phones, social networking, search engines and others. Furthermore, interactive technologies share *media characteristics,* which are communication variables that are connected to the aspects of communication that represent an exchange and transmission of messages with various entities (Stewart & Pavlou, 2009; Littlejohn & Foss, 2008). In communication and marketing theory the term describes functional traits of technologies that permit objective, error-free measurement (Hoffman & Novak, 1996; Sundar, 2009; Lister et al., 2008) and as such offer solid conceptual and methodological tools that allow understanding consumer responses to specific parts of experience with technology (Sundar, 2009; Pagani & Mirabello, 2011). For instance, a media characteristic telepresence represents a crucial driver for the user immersion in virtual reality (Steuer, 1992), while interactivity leads to higher involvement of a user in a computer-mediated environment (Hoffman & Novak, 1996). This approach differs from the stream that focuses on media characteristics based on subjective criteria such as social presence (Kaplan & Haenlein, 2010), media synchronicity (Dennis et al., 2008) and uses and gratifications approach (Calder et al., 2009).

The most representative media characteristics of interactive technologies are assembled in Figure 1. Only characteristics or features that can be manipulated are included, among others also to avoid proxies for interactive technologies.

Media characteristics of interactive technologies	Definition (author)
Interactivity	Machine and personal interactivity, feature-based or perceived, composed of control, responsiveness and two-way communication (Song & Zinkhan, 2008)
Hypertextuality	Potentially high number of linked sources (Hoffman & Novak, 1996)
Modality	Diversity of content representation (Sundar et al., 2012)
Connectivity	Technological capability of expanding and sustaining a model of network, where many users can be connected among themselves (Lister et al., 2008; Varadarajan et al., 2010)
Location-specificity	Specificity with which a technology and its user can be targeted based on the precise geolocation (Shankar & Balasubramanian, 2009; Varadarajan et al. 2010)
Mobility	Portability and wearability that allow a mobile use (Shankar and Balasubramanian, 2009; Varadarajan et al., 2010)
Virtuality	Combination of virtual elements that causes immersion in an environment constructed with computer graphics and digital video (Lister et al., 2008; Blascovich & Bailenson, 2011)

Figure 1: Framework of interactive technologies' media characteristics

Interactivity (Steuer, 1992; Lister et al., 2008) has been extensively investigated and remains one of the core concepts for assessing digital and virtual media. Although no final consensus about its meaning has been reached, it is most often referred to as "…*the degree to which two or more communication parties can act on each other, on the communication medium, and on the messages and the degree to which such influences are synchronized*" (Liu & Shrum, 2002). Similarly, Sundar (2009) define it as "*the choices provided to users and the ability to go back and forth with the interface*". While interactivity is an objective feature, its link to related consumer responses is established for instance through consumer perception of how much control they view to have over a medium, to which extent it allows them to lead two-way communication and how responsive the see the medium to be (Song & Zinkhan, 2008; Sundar, 2009; van Noort et al., 2012). By definition, AR tools are also interactive as they allow communication both with other people and with the medium (Billinghurst & Kato, 2002). However, current commercial AR apps offer more features in terms of machine interactivity (i.e. allowing to access different content and interact with interface) and less so in terms of allowing augmented communication between different human parties.

Hypertextuality is a synonym and a proxy for the number of linked sources (Hoffman & Novak, 1996) and refers to the non-sequential connections among different data or navigability (Sundar, 2009) and is associated with the actions of users moving through a mediated environment and the interface that offers a large number of linked sources and different paths of how they are related together. In comparison to a standard website, current interfaces of AR view modes often don't have as many linked sources as the technology does not offer switching across so many icons as with websites, however a certain level of hypertextuality is present.

Modality refers to the types of content provided by the medium (Hoffman & Novak, 1996; Sundar, 2009) and can appear in audio and visual formats, such as music, voice narrative, video, images, text and others, all represent information in a different way which impacts the communication process. Content in AR apps is predominantly visual but the formats can range between 2-D or 3-D images, videos or animated content or purely textual information.

The *networked* character or *connectivity* (Hoffman & Novak, 1996) refers to the type of communication model that is considered a revolutionary trait of social media: the transformation of the one-to-one or one-to-many communication model into many-to-many models of interactions where all sides can participate in the exchange of messages and are simultaneously potential senders and receivers. While AR is often embedded in the applications that contain features for such connectivity, the AR view as such does not yet allow (at least not the current commercial applications) connectivity with as many other parties as for instance social media. However, integration with social platforms and higher connectivity is expected to be more present in the future versions.

Mobile devices represent a special category of interactive technologies because of their *mobility/portability*, *wirelessness* and *location-specificity* (Shankar &

Balasubramanian, 2009; Varadarajan et al., 2010). Location-specificity refers to the GPS system that allows tracking of the user location through personal devices and delivering location-specific information. With AR, location is relevant in a different way. The content delivery is not linked to the GPS position but to the elements that the camera tracks in its immediate surrounding based on which the augmented content is delivered. Some AR content is delivered without spatial tracking and just appears on the screen, seemingly fitting in the physical environment.

Portability or *mobility* (the characteristic of mobile devices being effortless to carry around) indicates a device's affordance for spatial dynamism (Rohm et al., 2012), which also included wearability (like with Apple's iWatch, FitBit or GoogleGlass). The extent to which AR is mobile, depends on the type of device it is used on. Fixed interactive screens, situated in a retail store, do not allow mobility, while smart devices can be carried around and allowing AR to be mobile, which then also affects the type of content that can be displayed based on the location.

Virtuality refers to media's capability of showing virtual elements or virtual worlds, as experienced by the user through immersion or telepresence in the environment created by computer graphics or visual elements (Lister et al., 2008; Steuer, 1992). Gaming apps, virtual worlds or virtual simulation create distinctive consumer experiences through virtual reality (Jennett et al., 2008). Virtual annotations represent an important part of AR (Billinghurst & Kato, 2002), but with an important distinction: virtual reality is separated from physical reality while AR is embedded into it. As explained in virtuality continuum (Milgram & Kishino, 1994), the reality that a user sees in virtuality, is computer generated as it does not include elements from physical surrounding on the screen (e.g. Second life). In AR, only one part of what the user sees is computer generated while the rest corresponds to physical reality and there is thus not a disconnect between the physical and the virtual. According to these criteria, AR is closer to the physical reality than the virtual reality, but has elements of virtuality.

	AR apps on smart devices	AR apps on fixed interactive screens
Interactivity	Medium to high	Medium to high
Hypertextuality	Few-to-many linked sources	Few linked sources
Modality	Video, Text, Image	Video, Text, Image
Connectivity	One-to-few; Few-to-few	One-to-few, One-to-many
Location-specificity	Medium to high	Low
Mobility	Medium	Low
Virtuality	Medium	Medium

Table 2: Media characteristics applied to two types of augmented reality tools

By studying the relation of AR to the media characteristics of interactive technologies, AR can be better understood in terms of its features. Table 2 presents to which extent are these media characteristics present in the AR apps on smart devices and on fixed interactive screens, which are two of the most common AR applications in marketing. As already discussed above, AR apps posses all media characteristics of interactive technologies to some degree, however some – interactivity, virtuality, modality, location-specificity - are much more present and indicative of commercial AR apps than for example hypertextuality, connectivity, mobility.

AR commercial apps at this stage do not offer high connectivity with other parties as for instance social media and are often not linked to a large number of other sources when in AR mode. While smart devices by definition allow high mobility, the AR viewing mode only permits movements to a limited extent before the AR content disappears from the visual field or from the screen. On the other hand, AR apps offer rich plethora of content modality, are often highly interactive and virtual elements are in most cases indispensable to it. The relevant question for understanding the impact of AR on consumer behaviour is how media characteristics impact shopping experience and what responses do they elicit from them. We review the recent findings about consumer responses to these characteristics based on which research agenda for AR and consumer responses is developed.

2.3 Methodology

A selected literature review about the effects of interactive technologies' media characteristics on consumer behaviour was conducted for the period between 2008 and 2014 (Table 3). 2008 was used as a cut off because similar reviews were done or the period prior to 2008 (Dennis et al., 2008; Varadarajan et al., 2010; Voorveld et al., 2009; Hoffman & Novak, 2009; Ström et al., 2014). References to them are made throughout the study in order to build on the previously established knowledge. The review serves as a basis for derivation of research directions relating to consumer responses to AR in marketing.

The search was performed on Google Scholar and ABI/Inform by using the keywords: consumer behaviour and the above assembled media characteristics (interactivity, hypertextuality, virtuality etc). If keywords yielded too few results, other related keywords were used such as browsing in the case of hypertextuality. Only articles with quantitative studies were taken into account, as the main focus was to survey measured consumer responses to media characteristics. Such an approach towards a literature review (classification based on technologies' effects on users) has been conducted in previous reviews (Varadarajan et al., 2010; Voorveld et al., 2009). The aim was to assemble at least 5 highly cited articles per characteristic. Final number of the articles selected for the review was 44. For each study, we classified consumer responses according to the media characteristics. 3 articles were used for two categories, the other 41 relate to only one category.

Media characteristic	Relevant literature	Consumer responses brought forward by the characteristic
Interactivity	Song & Zinkhan, 2008	Mediates website effects on satisfaction, loyalty, perceived quality, WOM and purchase behavior
	Chang & Wang, 2008	Flow, Positive website attitude; Future use intentions
	Cyr et al., 2009	E-loyalty; Enjoyment; Efficiency, Trust
	Gao et al., 2009	Positive attitude towards mobile ad
	Huang, 2012	Affective involvement; Flow
	van Noort et al., 2012	Flow, Affective (brand & website attitude) and cognitive responses (related thoughts), Behavioral intentions
	Chu & Yuan, 2013	Positive website attitude; E-Trust
	Sundar et al., 2014	Positive website attitude; Intention for future use
Hypertextuality	Su, 2008	Complex search on sites or across sites leads to lower search for product information
	Parra & Ruiz, 2009	Navigation leads to smaller consideration sets, especially under higher information load
	Richard et al., 2010	Exploratory behavior and consequently to positive website attitude and involvement.
	Flavian-Blanco et al., 2011	Effort and positive emotions during the online search positively impact positive attitude after the search
	Park et al., 2012	Hedonic browsing correlates with impulse buying, but the utilitarian browsing correlates to it negatively
Modality	Park et al., 2008	Product rotation leads to cognitive response (perceived information), affective response (mood, attitude), behavioral intentions.
	Kim & Lennon, 2008	Verbal & visual information affect brand attitude and knowledge, but verbal representations exhibit superior effects on purchase intentions.
	Jin, 2009	Positive brand and product attitude; Purchase intentions (for consumers with high involvement)
	Goel & Prokopec, 2009	Less rich media (website) leads to higher trust, product diagnosticity and informativenes than 3D world
	Lin et al., 2012	Visual information impact e-Wom perceived message quality, credibility, interest, purchase intentions
	Hsieh et al., 2012	Visually and acoustically richer media lead to more positive attitude and higher eWom
	Li & Meshkova, 2013	Richer media increase informativeness and purchase intention for both search and experience product.
	Huang & Hsu Liu, 2014	Rich media with storytelling have stronger impact on consumer responses than those without narration
Connectivity	Calder et al., 2009	Positive attitude towards the ad and intention to click.
	Chan & Li, 2010	Individual enjoyment acts as a strong predictor of community reciprocity and commitment.
	Pagani et al., 2011	Social engagement leads to more active medium usage
	Huang, 2012	Social identity impacts flow and commitment.
	Laroche et al., 2012	Community connectivity leads to brand use, trust and loyalty

	Pescher et al., 2014	Tie strength leads to higher influence, but users with weak ties are more likely recommending an ad.
Location-specificity	Xu et al., 2009	Location-based advertising leads to positive attitude, intention to use and purchase, but also to irritation
	Gao et al., 2009;	Customization of brand communication significantly impacts the perceived interactivity and flow, attitude and purchase intentions.
	Xu et al., 2011	Benefits of personalization can override privacy concern in some contexts
	Zhou, 2013	Contextual offerings lead to flow and higher trust, which impacts further usage intention.
	Luo et al., 2014	Advertising at specific location significantly increases customer willingness to purchase.
Mobility	Sultan et al., 2009	Increased mobile activity leads to higher willingness to provide information and access content.
	Dickinger & Kleijnen, 2009	Mobile advertising leads to privacy concern and lack of perceived control
	Kowatsch & Maass, 2010	If mobile recommender agent is useful, consumers intend to use it in the future
	Rohm et al., 2012	Mobile marketing can lead to positive attitude when perceived usefulness, personal innovativeness and attachment are high
	Bart et al., 2014	Impact of mobile displayed advertising on product attitude and purchase intentions depends on the type of product and on prior product knowledge.
Virtuality	Daugherty et al., 2008	Higher product knowledge, brand attitude and purchase intentions (in comparison to magazine).
	Lee & Chung, 2008	Stronger quality assurance and enjoyment in virtual shopping hall in comparison to ordinary mall.
	Kim & Forsythe, 2008	3D view is perceived easier to use than 2D and virtual try-on, but virtual try-on is more entertaining.
	Goel & Prokopec, 2009	Lower informativeness, trust and product diagnosticity than on websites.
	Jin & Bolebruch, 2009	Increased product involvement and product attitude with spokes-avatar advertising.
	Gabisch, 2011	Stronger impact of virtuality on purchase when higher perceived diagnosticity and self-congruence.
	Nah et al., 2011	3D induces greater sense of enjoyment and telepresence than 2D environment.
	Merle et al., 2012	Personalized virtual try-on leads to higher hedonic and utilitarian value than non-personalized try-on.
	Huang & Liu, 2014	Virtual media have a significantly higher impact on ROI, aesthetics, playfulness and excellence when narrated.
	Huang & Liao, 2014	Presence, playfulness, reported aesthetics, usefulness and behavioral intentions.

Table 3: Literature review about effects of interactive technologies and their media characteristics on consumer behaviour for the period 2008 – 2014

2.4 Literature review on consumer responses to media characteristics of interactive technologies

One of the most consistently confirmed effects of *interactivity* is flow (Chang & Wang, 2008; van Noort et al., 2012; Hoffman & Novak, 2009), which refers to immersion of consumers into the highly absorbing state when using interactive features allowing communication either with machine or other people, supported by challenge and sense of control (Csikszentmihalyi, 1997). Flow can improve learning, establish perceived behavioural control, increase exploratory and participatory behaviour and create positive subjective experiences and distortion in time perception, but it can also cause a distraction from the original task and physical and mental fatigue (Hoffman and Novak, 2009). With time, the relevance of certain constructs change – user skill and perceived utility become more relevant with continuous web experience, while challenge, attention and exploratory behaviour decrease (Novak et al., 2000), which suggests that with longer use of the web technologies, attention is placed more on skill-based, goal-directed activities than on the experiential ones (Novak et al., 2003). Flow caused by interactivity can act as a mediator for consumer responses such as brand and website attitude (Chang & Wang, 2008; Song & Zinkhan, 2008; Gao et al., 2009; van Noort et al., 2012), cognitive responses (van Noort et al., 2012), behavioural intentions to use the website again in the future (Sundar et al., 2012; van Noort et al., 2012) and purchase intentions (van Noort et al., 2012; Chang and Wang, 2008; Huang, 2012). Interactivity was found to also lead to loyalty (Song & Zinkhan, 2008; Cyr et al., 2009) and trust (Cyr et al., 2009; Chu & Yuan, 2013). Other factors such as the quality of the message and the type of a task (complaining vs. search) significantly impact consumer perception of interactivity (Song & Zinkhan, 2008). However, while there have been solid results confirming that interactivity leads to affective responses (van Noort et al., 2012; Huang, 2012; Gao et al., 2009; Chang & Wang, 2008), there is less evidence for it to result in more cognitive involvement for which some studies report positive effect (van Noort et al., 2012; Cyr et al., 2009) and others lack thereof (Huang, 2012). There are also contradictory findings with regards to purchase intentions if they are significantly affected by perceived interactivity or not (van Noort et al., 2012; Chu & Yuan, 2013). Finally, different types of interactivity (e.g. medium, modality and source interactivity), relate to diverse consumer responses (e.g. perceived control, responsiveness and two-way communication) (Sundar et al., 2014).

Hypertextuality has been largely investigated in the frame of navigability, i.e. users' navigation and search across different sources of content, which can result in exploration of the myriad of different links and sources on their devices (Hoffman & Novak, 2009). Richard et al. (2010) found that the drivers differ across gender – men are more likely to explore based on their skills, while women are more motivated by the challenge, however in both cases such exploration leads to a more positive attitude towards the site and involvement with it. Affective states and perceptions experienced during the explorations positively impact the post-search activities and emotional states (Flavian-Blanco et al., 2011) and entertaining content is a stronger predictor for site involvement and exploration than effectiveness of information content (Richard et al., 2010). Consumers are more willing to search for different types of information when search is made easy both within sites or across sites (Su, 2008) and higher information load and search allows them to narrow consideration sets of products they want to consider (Parra & Ruiz, 2008). Finally, Park et al. (2012) show that the purpose for browsing leads to different purchase behaviour – hedonic browsing can result in impulse buying, while the utilitarian browsing decreases the possibility.

The different types of information representation or *modality* – visual, verbal, audio, video – elicit different responses from consumers. Psychology research established paradigm about dominance of visual cues' effects on memory and attitude in comparison to the verbal ones (Childers & Houston, 1984). Marketing research shows that richer online information creates more positive responses (Lin et al., 2012; Hsieh et al., 2012) and even increased willingness to pay (Li & Meshkova, 2013). Visual cues as opposed to the verbal ones lead to higher credibility of eWom and its perceived quality, as well as to higher interest in a product and purchase intentions (Lin et al., 2012). Also, richer visual and sound effects in video ad impact consumers' positive attitudes and willingness to share such a video (Hsieh et al., 2012). Furthermore, the product category plays an important difference. For search and hedonic product visual information delivers a satisfying comprehension of a product, while some utilitarian products require additional verbal information (Lin et al., 2012). Richness in modality contributes to the formation of more positive attitudes towards a brand and related products and consequently more intense purchase intentions (Jin, 2009). Such an effect is significant for consumers with lower prior involvement, while the ones with higher prior involvement are not significantly more affected by the richer 3D environment (Jin, 2009). While consumer responses can become more intense with higher media richness, a presence of narration, cause-effect and storytelling in virtual and augmented reality experience reveals even stronger impact on consumer ROI, playfulness and perception of service quality in comparison to rich media without narrative elements (Huang & Hsu Liu, 2014).

However, a study by Kim and Lennon (2008) presented contrary findings, i.e. that effects of online verbal representation as opposed to the visual one were found to have a stronger impact on brand knowledge, attitude and purchase intentions. Also, Goel and Prokopec (2008) showed that despite the fact that virtual worlds offer a richer media, websites are significantly better in establishing trust, informativeness and product diagnosticity, as they offer more information.

Connectivity between brands and consumers in social networks is high and all consumers, not just brands, are potential influencers, depending on their reach, influence and credibility (Hanna et al., 2011; Pescher et al., 2011). The embeddedness of users in social networks and social identity has a strong impact on consumers' flow and involvement with a certain website (Huang, 2012). Social-interactive engagement, for instance, leads to a positive attitude towards the ad and thus a greater probability of the user clicking on it

(Calder et al., 2009), to reciprocity behaviour to other members (Chan & Li, 2010;) and to more active contribution to the content on social media in comparison to a non-social engagement (Pagani & Mirabello, 2011). Also, the most influential recommendations are made through strong ties (Pescher et al., 2011).

The *location-specificity* allows for geolocation and personalisation, enabling marketers to deliver a more precise and tailor-made messages to consumers, which leads to more positive attitude, higher intention to purchase and higher trust (Zhou, 2013; Xu et al., 2009; Gao et al., 2009, Luo et al., 2014). However, privacy represents a high concern (Xu et al., 2011; Zhou, 2013) that can act as detrimental to the advantage of the location-specific marketing messages (Xu et al., 2009). Accuracy in terms of location-specificity requires precise knowledge of spatial proximity in order to time the marketing messages efficiently (Luo et al., 2014).

While *mobility* represents a significant advantage and can deliver solutions at the exact time and place where needed, acceptance and effectiveness of mobile marketing communications face an obstacle related to privacy concerns (Sultan et al., 2009; Dickinger & Kleijnen, 2009; Ström et al., 2014). But once consumers start using a mobile device for commercial purposes, they report intentions to use it again in the future (Sultan et al., 2009; Kowatsch & Maass, 2010) and develop positive attitudes towards it (Rohm et al., 2012), especially when the activity was perceived useful (Kowatsch & Maass, 2010; Rohm et al., 2012). Personal characteristics such as innovativeness and tech-savviness play a strong role with adopting smart phones for shopping purposes in retail (Ström et al., 2014; Rohm et al., 2012). There also exist substantial differences in responses to promotion of utilitarian and hedonic products, as mobile advertising works better for utilitarian products (Bart et al., 2014), while Pescher et al. (2013) showed that entertainment value has reportedly a stronger impact in the decision-making process. There exists a common agreement that the value of device mobility is perceived highest when integrated in the existing consumer journey (Ström et al., 2014).

Virtuality typically causes sensation of immersion or telepresence, where one feels detached from a physical reality and absorbed by the activities on the screen and the virtual elements on it (Jennett et al., 2008; Animesh et al., 2011; Nah et al., 2011, Faiola et al., 2013). Surprisingly, the level of enjoyment can be higher in virtual shopping malls than in real, physical ones (Lee & Chung, 2008). A 3D environment, which is richer in comparison to the 2D one, has been proven to lead to stronger enjoyment (Nah et al., 2011) and, furthermore, virtual try-on technology provides a stronger entertainment value of the shopping experience than 2D or 3D rotations and exhibits a stronger hedonic role (Kim & Forsythe, 2008). A virtual experience positively impacts consumer intentions towards the purchase (Jin, 2009, Gabisch, 2011) and willingness to pay for both search and experience products, however excitement is higher for experience products, especially for female consumers (Li & Meshkova, 2013).

Types of virtuality can be different – either the entire world on the screen is represented as virtual (like Second life or virtual games) or there are only separated virtual elements, like for instance avatars or virtual try-ons. While the virtual worlds create a strong immersive experience (Animesh et al., 2011), spokesavatar contributes to a positive shopping experience by increasing the product involvement and product attitude to a significantly higher level than unimodal audio messages (Jin & Bolebruch, 2009).

Virtual try-ons allow consumers to see a simulation of how a certain product would look like on a person, for instance on a generic avatar or a personalised model (Kim & Forsythe, 2008; Cho & Schwarz, 2012; Merle et al., 2012). They are generally related with a high entertainment/hedonic value (Kim & Forsythe, 2008), but contrary to that Merle et al. (2012) show that virtual try-on display higher utilitarian value with respect to 2D and 3D product simulation. Other 3-D technologies were proven to perform both a functional and hedonic role in the purchase process (Kim & Forsythe, 2008). Product rotation is also a type of a visual simulation that creates a sense of telepresence and impacts both cognitive and affective responses towards a product and leads to behavioural intentions (Nah et al., 2011;

Park et al., 2008). Daugherty et al. (2008) have shown that both virtual and direct experience with a product leads to the same brand attitude and purchase intention, but the virtual experience provides better brand knowledge (cognitive response) than the direct experience.

While a typical website cannot always provide a sense of direct experience with a product, the virtual product simulations have the potential to overcome the shortcoming of the lack of a physical presence on websites. On the other hand, trust towards the virtual store is lower in comparison to the websites, as the novelty of virtual world being utilised as a shopping channel creates a negative impact (Kim & Forsythe, 2008; Goel & Prokopec, 2009). Finally, personal characteristics such as cognitive involvement (Kim & Forsythe, 2008; Huang & Liao, 2014) and self-congruence (Gabisch, 2011) also display impacts on the relationships between virtual features and consumer responses.

2.5 Research agenda for studying consumer responses to augmented reality

The review provided a framework within which the impact of AR different characteristics on consumer behaviour can be discussed. In the continuation, we therefore examine these relations in-depth and propose directions for how to advance this knowledge in future research.

Research on *interactivity* has shown this feature is strongly linked to flow and that it represents a driver for numerous affective responses as well as some behavioural and cognitive ones. Future studies should thus explore if that is the case also for interactivity in AR and if flow constitutes a core part of the experience with that technology. To which extent do the correlates of interactivity – such as perceived control, responsiveness and two-way communication (Sundar et al., 2015) – also represent part of the experience with AR and does interactivity in AR exist in other forms given that its *modus operandi* goes beyond the screen and interacts with the space? As the two-way communication is not yet a salient feature of current commercial AR modes and the interaction is focused on augmenting the surrounding space, it is not clear how that affects consumer experience with AR. To which extent does the interactivity represent a driver for affective responses (e.g. product and brand attitude), for cognitive responses (e.g. brand knowledge and recall) and behaviour or behavioural intentions (e.g. word-of-mouth, revisit and purchase)? If previous studies on interactivity showed that the consumer experience is in many cases predominantly impacted by affective drivers, to which extent is that true also for AR and what is the role of cognitive factors? Is consumer experience with AR principally hedonic and serving as an entertainment tool or is it used for utilitarian purposes? Does that change over time when consumer gets more used to the technology and thus focuses less on exploration and more on goal-oriented behaviour (Hoffman & Novak, 2009)?

High number of linked sources – *hypertextuality* – allows for involvement in web exploration and browsing. Given that current AR apps offer less links to other sources and focus more on the immediate physical points that can be digitally augmented, it is important to understand if that represents a disadvantage for consumers. Should future AR apps be embedded to a higher level with other social media platforms and would that display a significant impact on consumer experience with AR? Would the linked sources have a similar impact on decision-making as they have shown to have in the web studies - for instance by narrowing down the consideration set of products and, supported by other linked content, encourage consumers to explore more of the related material?

How do different *modalities* in AR – video, audio, text, image – yield different consumer responses? Dominant belief in psychology has established supremacy of visual information in terms of its impact on attitudes and knowledge in comparison to the textual cues. Given that AR mode visually displays some part of the surrounding on the screen, future studies need to investigate what modality combines best with the camera view of physical environment for the most well received response: text that adds information directly to the specific elements, imagery that modifies or enhances some part of the surrounding or videos that directly augment the physical elements? Are there specific combinations that work better for certain types of tasks / contexts / products / experiences?

Connectivity is less enabled in current AR apps in comparison to social media. Given that the forms of online and offline social engagement display a strong value and drive consumer involvement, positive attitude and content contribution, relevant research question is how does the potential lack of connectivity influence consumer experience? Will the future AR apps develop more into that direction?

Numerous AR apps are *location-specific*, given that much of the AR content is delivered when the camera tracks a certain object, target, location. That can make some AR apps highly relevant for retail, as the AR content would appear on a person's smart devices when tracking pre-defined points in the stores. Privacy concerns with AR on smart devices will likely represent less of an issue, as the AR content is delivered based on pull and not push communication and therefore perceived as less intrusive. Will the AR apps that are linked to a location, be viewed as a tool of highly personalised customer service delivery and thus lead to more positive attitude, purchase intentions and higher trust, as is the case with other location-specific interactive technologies? Will such impacts diminish with AR apps that are not location-specific, such as for instance virtual try-on? Furthermore, the apps that are not linked to a specific location and can deliver the AR content anywhere, are likely to provide the advantages of *mobility,* therefore allowing a tailor-made solution at the exact time and place defined by consumer. Virtual try-ons or product simulations shown on smart devices are accessible at one's fingertips and if consumers perceive them useful, they are likely to use them again and develop positive attitude towards the app as was the case with other technologies, however future research needs to test these assumptions. Some retailers may offer their AR apps only in the store on fixed interactive screens that do not allow mobility. Would that represent a disadvantage? The success of such applications may rely heavily on how they are integrated in consumer journey and the extent to which they support other marketing activities.

Immersion and telepresence are one of the most often recorded consumer responses to *virtuality*. Given that AR possesses some of its elements, but differs from it by being much closer to the physical environment, one of the most crucial future research *foci* would be to determine the difference in consumer responses to the two environments and compare the advantage and disadvantages of the two. Research on virtual reality in consumer studies also discovered that enjoyment and experiential value have a strong impact on consumer behaviour in virtual environments (Kim & Forsythe, 2008; Chan & Li, 2010; Huang & Hsu Liu, 2014) while that is not always the case for utilitarian or purposive value and that the related affective commitment is a stronger predictor of behavioural intentions than cognitive commitment (Huang, 2012), which is also the case for interactions on website (van Noort et al., 2012). Future research on AR should explain if affective commitment and experiential value are of a higher relevance and a stronger motivator for consumers to get engaged with it than the rational, cognitive commitment and the pursuit of more utilitarian values. Will the difference between consumer cognitive and affective responses become even more noticeable in using AR technologies, given the AR potential for creating an entertaining consumer experience? To which extent do the underlying reasons for these differences depend on the tasks consumers pursue in their engagement with the technology, the type of goods they are interested in (search vs. experience goods) or personal characteristics (such as cognitive innovativeness)? Furthermore, virtual models and simulations led to high product involvements, which can lead to assumption that AR virtual try-ons will bring the same. How will that depend on the type of product and contexts of trial (retail vs. home)? Also, given that trust was lower for virtual environments in comparison to ordinary websites, will trust represent an issue also for product involvement and purchasing behaviour with AR apps? Will that depend on the amount and quality of supporting information that will be available to consumers in addition?

Furthermore, there are other crucial issues that arose from the review and are related more to the specificities of AR. Given that AR technology represents a recent form of interaction, what role does a user's technological savviness and cognitive innovativeness/ openness to novelty play in adoption of AR-based tools and with what rate are AR marketing apps actually being used and adopted for shopping activities? Because of its technological advancement, AR often elicits a fascination, a so-called "wow" effect. How do consumer interactions with AR change when they get used to it and the initial magic disappears? Will goal-oriented behaviour progressively become more important than the exploratory one, especially when appropriate skills are adopted, as was the case for web behaviour (Hoffman & Novak, 2009)?

One of the most important emphases should be placed on investigating the uniqueness of AR technology, i.e. its ability to overlay the physical environment or some part of it with virtual images or information, which makes AR apps interacting with physical space and significantly distinguishes AR from virtual reality. Human-computer interaction field names this characteristic as *augmentation* (Billinghurst & Kato, 2002; Preece et al., 2015). Further research is needed to conceptualise and operationalise this characteristic and to understand what type of consumer experience it creates. How exactly users are drawn into this new form of reality and what effects it has on them has not yet been exploited in consumer behaviour literature.

Given that there exists a noticeable heterogeneity across AR tools and that new forms are expected to emerge, the next step is to investigate if differences exist in consumer responses across AR tools, keeping other confounding variables constant. For instance, what would be the alteration (if any) in consumer responses to an AR app on a fixed public interactive screen in comparison to the same app on his or her individual device? Would there be a change in response between an AR app on a wearable/portable device in comparison to the same app on a smartphone? How does the device and the size of the screen (smartphone vs. tablet vs. large screen) impact the experience?

Finally, with regards to the methods, most of the studies base their findings on experimental design with students or other invited participants, which results in non-voluntary exposure to the manipulation check (Voorveld et al., 2010). While such research designs allow high control of user activities and high internal validity, this does not accurately capture the effect of contextual factors, of other possible moderators and the difference between "non-voluntary" technology exposure and intentional usage. Human interaction with technology is highly dependent on contexts and on external factors that are not replicated in the lab studies, which is why studies "in-the-wild" (Rogers, 2012) are of relevance as they offer in-depth insights into use of technology and increase external validity. Also, they reveal a larger part of consumer journey as they investigate interactions in context and thus reach beyond isolated episodes.

2.6 Conclusion

The present study approaches the largely unexplored subject of AR in marketing and discusses the consumer responses that this technology can potentially elicit. It does so by studying salient media characteristics of interactive technologies, applying them to two prominent AR formats in marketing: smart device apps and large interactive screens. By conducting a literature review on consumer responses to media characteristics, and combining this with current knowledge about AR, numerous directions for future research emerge.

Firstly, while most AR apps have an interactive character, the AR interactivity is predominantly machine- and space-related and less associated with two-way communication, which is typical for web and mobile interactivity. Interactivity in AR may thus possibly lead to consumer responses that differ from responses to web interactivity. Furthermore, connectivity is less present in AR apps, which can cause an absence of responses that are associated with social-interactive engagement. Location-specificity and mobility on the other hand are symptomatic of AR, which typically ensures customised or convenient customer service. Future studies will demonstrate whether this translates to higher willingness of future use and positive attitude, as it has been the case for mobile technology.

This study suggests that AR differs from other interactive technologies in its so-called *augmentation*, arguably its defining characteristic, which refers to its ability to overlay physical environments with virtual elements. The proximity of virtual elements with physical space, seamlessness of real and simulated and augmentation of the user's surrounding elements are concepts that have not yet been investigated in detail in marketing theory. Further conceptualisation and operationalisation of this characteristic is required, as well as empirical testing of its relations with consumer responses.

AR-related studies should also aim to reach beyond separated consumer responses and investigate the consumer experience as a whole. Previous research, for instance, shows that some of the interactive technologies can be highly immersive, as is the case for virtual reality. Future studies need to investigate to which extent the immersion defines AR consumer experience, given that AR possesses some traits of virtual technologies, but also differs from it in the sense that it does not create a disruption between the physical and virtual world. Furthermore, the research agenda proposes that consumer experience with AR might be more hedonic than utilitarian, especially during the initial episodes with the technology, and that the affective component plays a stronger role in leading to the behavioural responses than the cognitive. Such assumptions are based on the findings from previous research and need to be tested empirically in future studies.

More in-depth investigation of this new form of human-computer interaction is clearly required (Yadav & Pavlou, 2014). It brings with it significant challenges for consumer studies and makes the case for further investigation of the questions evoked above. Answers to these would expand upon our existing knowledge about consumer responses to interactive technologies and would allow marketers to design AR campaigns more efficiently and avoiding gimmicky applications.

As AR technology in marketing is currently evolving at high speed, future developments will likely go in different directions, also to some that have not been mentioned in this work. However, hopefully this paper offers insight into some of the current advances of AR and the type of consumer responses this technology will incite.

3. "IT'S AN ILLUSION, BUT IT LOOKS REAL!" CONSUMER AFFECTIVE, COGNITIVE AND BEHAVIORAL RESPONSES TO AUGMENTED REALITY APPLICATION

Article accepted for publication:

Javornik, A. (2016), "It's an illusion, but it looks real!" Consumer affective, cognitive and behavioral responses to augmented reality applications. *Journal of Marketing Management*, Special Issue: Academy of Marketing Annual Conference 2015 Magic in Marketing.

Presented at conferences:

Javornik A. (2015) "“Wow, I can augment myself?" Measuring effects of perceived augmentation and interactivity on affective, cognitive and behavioral consumer responses. *Conference proceedings of Academy of Marketing 2015*. Limerick, Ireland. July 2015

Javornik A. (2015) "Wow, it looks like it's real! But can you fix it a bit?" Measuring effects of augmented reality on affective, cognitive and behavioral aspects. *Proceedings of EMAC - European Marketing Academy Conference*. Leuven, Belgium. May 2015

Abstract

The paper investigates two augmented reality (AR) applications and corresponding consumer responses to their media characteristics. Firstly, it discusses the role of interactivity with AR technology. Secondly, it introduces augmentation as a salient media characteristic of AR applications and tests measurement items of perceived augmentation. Two experimental studies replicate the research design of van Noort et al. (2012), applying it in the context of AR. The results show that perceived augmentation represents a fitting concept for understanding consumer responses to AR features and, furthermore, that flow mediates effects of perceived augmentation on consumers' affective responses and behavioral intentions. AR features on the other hand do not increase perception of interactivity. Finally, implications of the study and further research directions are discussed.

Keywords: Augmented reality, Augmentation, Interactivity, Flow, Affective responses, Behavioral intentions

"The important thing is not to stop questioning."
(Albert Einstein)

3.1 Introduction

Augmented reality (AR) can create an enchanting experience for consumers as it visually transforms physical reality by superimposing virtual elements directly into the real-time environment through a screen or projector. The presence of this technology has been increasing in the field of marketing in recent years and has introduced a new way of visualizing products, information and experiences in the real-life context (Huang & Hsu Liu, 2014; Huang & Liao, 2015). The first commercial use of AR is generally accepted to be an application for the automobile brand Mini in 2008 which allowed a 3-D simulation of the car model to appear on a screen when a paper with markers was placed in front of a camera (Carmigniani et al., 2011). The car model then turned on the screen in accordance with the user's movements of the paper, which allowed a controlled viewing of a simulated model. Since then, numerous types of AR apps have arisen in marketing (Javornik, 2014): virtual annotations created by wearables (e.g. Google Glass), virtual try-ons, content augmentation, holograms and project mapping are some of the existing developments (Carmigniani et al., 2011; Van Krevelen & Poelman, 2010).

While AR represents a novel marketing communication tool, and thus a new challenge in the marketing field (Yadav & Pavlou, 2014), this technology has a solid tradition as a research topic in the areas of computer vision and human-computer interaction (HCI) and this paper partially relies on the literature from these fields (Azuma et al., 2001; Billinghurt & Kato, 2002; Carmigniani et al., 2011; Preece et al., 2015). HCI in particular offers useful approaches for investigating such technology, given that it lies at the intersection of computer science and human behavior (Preece et al., 2015).

While AR is hailed as playing an important role in the future, it has been largely neglected in the study of consumer behavior research (Yadav & Pavlou, 2014) and there currently exists only limited research about how consumers react to this technology (Huang & Liao, 2015). This paper addresses this gap by studying two of AR's most prominent media characteristics and examines to which extent they act as the drivers for consumer affective, behavioral and cognitive responses.

Media characteristics or media features represent important conceptual and measurement tools for investigating the potential impact of technology on consumers and the interactions between the two (Hoffman & Novak, 1996; Stewart & Pavlou, 2009; Jin, 2009; Jin & Bolebruch, 2009; Gao et al., 2009; Li & Meshkova, 2013; Sundar et al., 2015). Interactivity, modality and virtuality have, for example, allowed the discovery of how a media format in a commercial context impacts consumer immersion in the experience and how that immersion further leads to brand knowledge, brand attitude and purchase intentions (Liu & Shrum, 2002; Daugherty, Li, & Biocca, 2008; Voorveld et al., 2009; van Noort et al., 2012).

Following this stream of research, two media characteristics – and consumer perception of them - are taken into account in this study: interactivity and augmentation. Interactivity is one of the most established concepts related to digital technologies (Hoffman & Novak, 1996; Coyle & Thorson, 2001; Liu & Shrum, 2002; Kiousis, 2002; McMillian & Hwang, 2002; Fiore et al., 2005; Song & Zinkhan, 2008; Deighton & Kornfeld, 2009; Sundar et al., 2015). This paper adopts a revised conceptualization by Sundar et al. (2015) in their Theory of Interactive Media Effects (TIME) and examines in what way interactivity remains relevant for this novel mode of viewing reality. Augmentation on the other hand has already been discussed in the field of HCI as one of the core characteristics of AR (Billinghurst & Kato, 2002; Preece et al., 2015), however it has not yet been introduced in marketing and remains an under-investigated concept. This paper calls for more focused research on AR tools in marketing and suggests augmentation as a characteristic that can allow marketing research to better understand the specific nature of AR and, consequently, its effects on consumers.

The main questions that guided this research are the following: Firstly, are augmentation and interactivity salient media characteristics of AR? Do they create an immersive experience for consumers? And what is their impact on consumer affective, cognitive and behavioral responses? We adopted experimental methodology and evaluated these questions by testing whether interactivity and augmentation trigger strong perception of media features when using AR. The experimental research design was replicated from van Noort et al. (2012) and investigated whether perception of augmentation leads to flow and if, furthermore, flow represents a mediator to consumer affective and cognitive responses and behavioral intentions.

This paper is structured as follows. First, AR technology is discussed more in-depth, followed by a literature review of the previous work on media characteristics of interactive technology and consumer responses. The two experimental studies carried out to test the proposed hypotheses are described. Findings from these studies are discussed, showing that AR acts as an immersive technology, especially through perceived augmentation, which significantly impacts consumer affective responses and also some behavioral intentions. As current AR applications are still in their relative infancy, this paper proposes directions for future work that could help the field to advance further in understanding the possibilities of this novel technology.

3.2 Magic of AR technology

In the film "The Illusionist" (2006), the main protagonist is a magician running spectacular shows in 19^{th} century Vienna. His most admired and feared trick is of him calling absent people who respond to his quest and appear on the stage as ghosts, looking like themselves, real. They cannot be touched, as one's fingers would run through them, but they engage with the magician and the audience. In that period, such appearances were seen as magical phenomena, impossible to explain. While we nowadays still do not have the ability to magically create visions of absent people, we are able to simulate people and objects with holograms. Holograms represent a particular type of AR technology that bring the virtual simulations outside of the screen and, through projections, create a real-looking person or object, able to interact in real time and space (Fei et al., 2012). One of the more known recent examples was a protest in Spain in April 2015 where participants responded to the ban of demonstration by protesting through their holograms – virtual simulations of people, marching past the parliament in Madrid. While holograms are still in their infancy and, due to the related technical challenges, are one of the least expanded types of AR, their existence depicts the principle of this particular type of technology – its ability to simulate virtual objects in a way that they interact with the physical environment (Azuma et al., 2001; Carmigniani et al., 2011).

AR can be combined with some existing media, such as interactive screens and smart devices, and complement them in various ways. However, AR applications represent a heterogeneous group (Carmigniani et al., 2011; Javornik, 2014). They significantly differ among themselves in terms of features (e.g. virtual try-ons, simulation of an information layer), type of technology (e.g. rendering, holograms, project-mapping), devices on which they are used (e.g. fixed interactive screen, smart device, wearable) and, consequently, the context of use (fixed interactive displays with AR features are public or semi-public, while AR smartphone applications allow also a private use). Despite their heterogeneity, a common link underlies them: they convey a simulation of spatially-contextualized visual annotations and/or textual information that provides an illusion of an enhanced world (Billinghurst & Kato, 2002; Preece et al., 2015). Azuma et al. (2001) emphasize the following characteristics of AR: the combination of real and virtual objects, interactive functioning in real-time and alignment of real and virtual objects.

In other words, AR creates an enriched environment where the computer-generated visual elements co-exist with the physical environment and respond to some of the changes in it (Carmigniani & Furht, 2011), which is an important development, serving to differentiate such technology from virtual worlds (Blascovich & Bailenson, 2011; Gabisch, 2011). Virtual reality bases many of its interactive features on avatars (Kim & Forsythe, 2008a; Jin & Bolebruch, 2009), 3-D simulation of products (Kim & Forsythe, 2008b; Park et al., 2008; Huang, 2012) and creation of virtual space (Lee & Chung, 2008; Papagiannidis et al., 2013). AR thus differs most manifestly from virtual reality (VR) in the sense that it also provides enrichment of the physical environment, but in variance with VR, the simulation and virtual addition are synchronized with the physical environment and can also react to its changes. In other words, virtual and augmented realities differ in their level of proximity with physical reality. While VR exists as a separate entity, AR is the closest one to the physical environment - it is more integrated with it and interactive with it in real-time (Milgram & Kishino, 1994; Preece et al., 2015). Virtual imitations of the products that are directly situated in the surrounding space or virtual try-on of apparel on the self are thus a step further away from the 3-D simulations that appear on an avatar (Kim & Forsythe, 2008a) or a user's photo (Cho & Schwarz, 2012) but do not interact with the physical context. While research on VR has yielded rich findings about consumer behavior in virtual worlds (Blascovich & Bailenson, 2011; Saren et al., 2013; Papagiannidis et al., 2013), less is known about changes in consumer behavior that are triggered by use of AR technology.

Even though AR has been developing since the 1990s (and, in fact, the very first prototype by Ivan Sutherland appeared in early 1968), it only recently became accessible to the average consumer through commercial apps. Some of the successful cases of AR in marketing are: simulations of furniture on a screen, as if they were placed in the room where the consumer is; virtual try-ons that appear to place clothes or accessories on the consumer; and informational or entertaining content that can be unlocked by scanning physical surfaces with a smart device.

To understand how consumers (will) interact with technology, numerous factors need to be taken into account. While some of the common marketing approaches, such as the technology-acceptance model (Venkatesh & Davis 2000; Moon & Kim, 2001; Pavlou, 2003), examination of perceived value (Forsythe et al., 2006) and typologies of consumers' modes of interaction (Kaplan & Haenlain, 2010), have proven highly relevant for studying new technologies, the field of HCI has also developed useful approaches for examining the factors that impact the interactions between people and technology. Concepts such as appeal to (visual) sense (Dix et al. 2009; Preece et al., 2015; Billinghurst & Kato, 2002) and *affordances* that refer to the possibilities that technology offers to users for interaction (Norman, 1999; Sundar et al., 2015), represent useful tools for this study and were adopted for examining the phenomena.

We follow the definition by Azuma et al. (2001) of AR as the technology that "*combines real and virtual objects in a real environment; runs interactively, and in real time and registers (aligns) real and virtual objects with each other*" (pp. 34). Based on this definition, interactivity and augmentation (i.e. combining virtual objects with the physical environment) represent two of AR's main features. In the following sections we examine previous work related to these two media characteristics and consumer responses to them.

3.3 Media characteristics

In previous research, media characteristics have served as a catalyst for investigating media effects on consumer responses and also as a tool for understanding the individualities of interactive technologies (Steuer, 1992; Hoffman & Novak, 1996; Burke & Chidanbaram, 1999; Eveland, 2003; Sundar, 2004; Voorveld et al., 2009). While the traditional media effects approach, which assumes one-way or universal media effect on a user, has been criticized, more recent media effects streams follow the understanding that the media characteristics are perceived and employed in diverse ways across different segments

(Bryant & Oliver, 2009; Stewart & Pavlou, 2009; Voorveld et al., 2009; Dennis et al., 2009; Dennis et al., 2013), for instance according to the user's motivations, skills, interest, goals, knowledge and body, among others (Dennis et al., 2009; Yakhlef, 2015). Also, studies in the HCI field emphasize that user responses to media features vary depending on the social contexts of use (Brignull & Rogers, 2003; Marshall et al., 2011). Media characteristics still represent an important research tool for studying interactions between media technology and users (Sundar et al., 2015; Stewart & Pavlou, 2009) because they are able to isolate certain consumer behaviors as direct responses to the technological feature (Coyle & Thorson, 2001; Cyr et al., 2009; Li & Meshkova, 2013).

Among the existing media characteristics of computer-mediated environments, *interactivity* has proven to be one of the most crucial (Hoffman & Novak, 1996; Liu & Shrum, 2002; Eveland, 2003; Fortin & Dholakia, 2005). Research has shown that interactivity creates a strong impact on consumer responses, mainly through mediation of consumer experience related concepts, such as immersion, enjoyment and trust (Hoffman & Novak, 2009; Gao et al., 2009). Higher perceived interactivity yields higher e-loyalty when mediated by enjoyment and efficiency (Cyr et al., 2009) and also strong brand, website attitude and even behavioral intentions when mediated by flow (van Noort et al., 2012). Song and Zinkhan (2008) showed that highly personalized messages establish stronger perception of interactivity, which further directly impacts satisfaction, loyalty, attitude and quality.

Studies of interactivity have produced diverse conceptualizations of the concept (Raffaeli, 1988; Steuer, 1992; Kiousis, 2002; Sundar, 2004; Song & Zinkhan, 2008; Sundar et al., 2015). Researchers in marketing strategy have considered it as a constant of computer-mediated communication, and an overarching explanatory variable for the activities taking place therein (Deighton & Kornfeld, 2009; Day, 1998). Such an approach focuses more on the communalities of interactivity across contexts and less on its different types and the various modes of appropriation by users. Moreover, in consumer behavior research, the conceptualization and operationalization of interactivity were developed in two different directions: either based on media features or on user perception (Mollen & Wilson, 2010). Feature-based interactivity refers to the interface functionalities that allow synchronization of communication, emphasizing the features as the drivers of interactivity (Steuer, 1992; Sundar, 2004). Perceived interactivity focuses on how users perceive features of technology during interaction (Liu & Shrum, 2002; Song & Zinkhan, 2008), emphasizing the perception as the crucial factor in understanding the user experience with technology (McMillan & Hwang, 2002; Cyr et al. 2009; Voorveld et al., 2011). This opposition precipitated strong dialogue in the media and marketing literature, producing numerous studies which focused on the phenomena (Sundar, 2004; Voorveld et al., 2011) and there have been only few attempts made to overcome the differences of the two approaches (Voorveld et al. 2011, Sundar et al., 2015).

Sundar (2004) and Sundar et al. (2015) argue that by focusing merely on the consumers' perception, the real impact of technology on consumer responses is neglected. Measures of perception are related to users' skills and their observations, but not to the medium features. To acquire more accurate measures of the media characteristics' impact, the features must be manipulated, thus allowing the causal effect to be examined (van Noort et al. 2012). Sundar et al. (2015) have developed models within the Theory of Interactive Media Effects (TIME) that, to some extent, allow these differences between the two approaches to be overcome. In the main TIME model, Sundar et al. (2015) emphasizes the role of *affordances* (Norman, 1999; Hartson, 2003) as the action possibilities provided by the technology's features (Sundar et al., 2012; Sundar et al., 2015). Affordances refer to the capacities of a medium that allow a set of actions and are represented by visual cues and interface features on a device. When using a technology, a user perceives the affordances to offer (or limit) the possibilities of his interactions. Such affordances thus have a psychological correlate (Sundar et al., 2015). For example, a visual cue of multiple buttons on a screen can suggest to a user that she has a choice, giving her the perception of having control over the displayed content. Another example is tools for content personalization that can elicit a sense of agency or self (Sundar et al., 2015). These psychological correlates then act as mediators for subsequent cognitions, affection and behavior (Figure 1). By underlining technology features as affordances that trigger users actions, TIME theory intersects both the media characteristics that can be manipulated or varied (which impacts user interactions, perceptions of one's own actions and related behavior) and the user's appropriation of a medium (Sundar et al., 2012; Sundar et al., 2015). While the characteristics are underlined as the independent variables, the TIME model does not suggest a deterministic approach, but instead emphasizes the active role of the consumer and investigates different types of his/her responses.

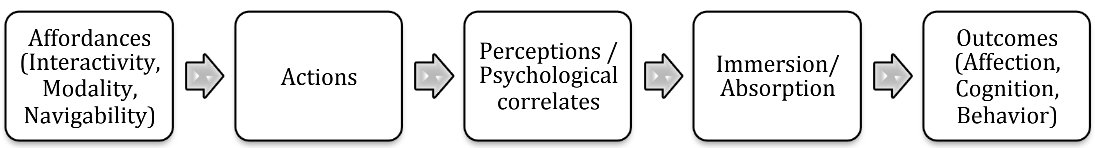


Figure 1: Model of Theory of Interactive Media Effects (Sundar et al., 2015)

We therefore follow this conceptualization by Sundar et al. (2015) where media characteristics elicit psychological correlates by the consumer that then translate into an immersive experience and finally affective, cognitive and behavioral responses. Sundar et al. (2015) distinguish between three main types of interactivity: modality or medium interactivity, message interactivity and source interactivity. Modality/medium interactivity – or functional view - is concerned with features and functions that a technology can offer to a user and allow them to take actions and initiate interactions with the medium. Message interactivity (or contingency view) is focused more on the medium as a tool which provides message exchanges between different parties. Finally, source interactivity emphasizes the source – the sender – as the starting point of interactions and investigates to which degree the technology establishes the user as the source of communication and the one in control, either through selection of content or its creation and customization. Most of the research on interactivity has been done in the context of web-related studies and it has not yet been investigated to which extent these paths are valid also in the context of AR.

Here, we focus on two types of interactivity: medium/modality interactivity and source interactivity. Message interactivity did not yet seem suitable to be investigated in the context of AR as it refers to the message exchange between different parties and to the ability of the medium to serve as a platform for the communication thread. AR marketing tools in their current form do not provide many functions for two-way communication through chats, mails or social media platforms. While this might be possible for future applications, it is currently not the case.

When investigating the AR medium interactivity, we were concerned whether users perceive AR tools to be more responsive than non-AR tools - does the presence of AR features on a website lead to greater medium interactivity? Our assumption is that the presence of AR does not establish an application or a website as a more interactive medium, because it does not provide features that would make AR more responsive in comparison to the normal website. AR does not differ from non-AR applications in higher responsiveness, but rather in other features that are unrelated to this aspect.

H1: Presence of AR in an application does not lead to higher interactivity in terms of perceived responsiveness in comparison to a non-AR application.

With regard to source interactivity, our focus was on determining whether or not users perceive higher level of control over the medium with AR features. A sense of control is related to the user's perception that she can freely choose the content and navigate the application. However, our assumption is that the presence of AR features does not significantly change the sense of control as the principle of choosing content in AR applications remains similar to the one on websites.

H2: Presence of AR in an application does not lead to higher interactivity in terms of perceived control in comparison to a non-AR application.

3.4 Perceived augmentation

As the AR environment substantially differs in some ways from websites and mobile applications, new insight is required to understand consumer responses to its unique features. AR technology, as the name suggests, *augments* or superimposes the physical environment with virtual features (Billinghurst & Kato, 2002). The augmentation can happen with different elements – with text, geo-location information, image, video or audio (Fitzgerald et al., 2013; Preece et al., 2015). Carmigniani et al. (2011) underline that the augmentation in its broader sense refers not only to the sense of sight, but also to hearing, taste, touch and smell. However, the definition of augmentation adopted in this article is linked to the visual annotations of AR technology as they represent its most salient and well-developed feature.

Some of the examples that we have seen so far in marketing are augmentation of the self (e.g. a virtual fitting room), augmentation of the surrounding space (e.g. furniture apps that virtually place items in a room) or augmentation of an object (e.g. image recognition of a product's logo unlocking content on a smart device). *Augmentation* (Preece et al. 2015) is hereby proposed and specified as a unique AR feature, while its perception - *perceived augmentation* - is the psychological correlate of this feature, following the paths of the TIME model.

Furthermore, it is important to understand whether augmentation can be understood as a specific type of interactivity. However, if we look at both modality interactivity and message interactivity (Sundar et al., 2015), they do not enclose interaction between the medium and the surrounding space as they refer to either the interaction between the medium and the user or to the interaction between the different users connected through a device. AR technology on the other hand, reacts to and interacts with the physical surrounding environment in real-time. Does augmentation actually represent a special type of interactivity or does it define a completely new category? Given that the superposition of visual elements happens when the medium reacts to stimuli from the surrounding space in real-time, augmentation does in fact represent a completely new category of media characteristic. It could only be included in the group of interactivity dimensions if interactivity was defined to exist beyond the screen. However, in the current definitions of interactivity that is not the case.

In this research we therefore aim to empirically test whether or not consumers perceive the commercial AR apps to augment physical reality in real-time. Our assumption is that use of AR app will correspond to perceived augmentation.

H3: Using an application with AR elements leads to perceived augmentation.

3.5 Consumer immersion through flow

This study is interested in understanding how the above-discussed salient AR media characteristic(s) affect consumer immersion in an experience and subsequent consumer responses. Flow is a particularly well-established concept from psychology, defining an immersion into an activity, initiated by a challenging task (Csikszentmihalyi, 1997). Its application in marketing led to important findings about consumer immersion in computer-mediated environments, as it was shown to mediate effects of interactivity, telepresence and vividness on exploratory behavior, brand attitude, purchase intentions and other relevant consumer responses (Hoffman & Novak, 1996; Nel et al., 1999; Agarwal & Karahanna, 2000; Koufaris, 2002; Novak et al., 2003; Mathwick & Rigdon, 2004; Nah et al., 2011; van Noort et al., 2012; Faiola et al., 2013). Flow is a multidimensional concept whose measures include immersion, curiosity, fun and control (Webster et al., 1993; Nel et al., 1999).

A study by van Noort et al. (2012) showed that the effects of a website's perceived interactivity on cognitive, behavioral and emotional brand-related responses are mediated by flow. Given that AR technology is based on a different core feature – augmentation – it is important to understand the effects of perceived augmentation. As effects of other salient media characteristics - such as telepresence, vividness and interactivity – on consumer responses have also been mediated by flow (Coyle & Thorson, 2001; Hoffman & Novak, 2009; Nah et al., 2011), this needs to be examined also for augmentation and its psychological correlate, perceived augmentation. We therefore hypothesize that when consumers use AR technology, the perceived augmentation has an effect on consumer affective, cognitive and behavioral responses towards the brand and that these effects are mediated by flow (Figure 2).

H4: Higher perceived augmentation leads to more intense flow, which further mediates effects on: a) affective responses, b) cognitive responses and c) behavioral intentions.

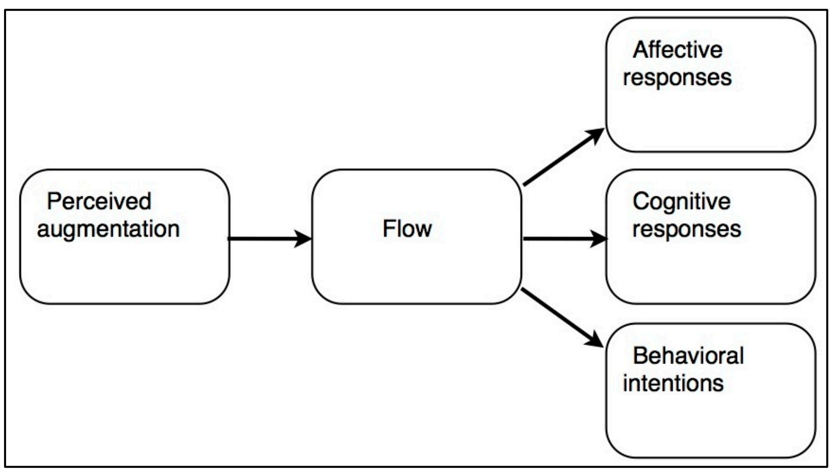


Figure 2: Proposed model

3.6 Methodology

The objective of the study was to examine the differences in consumer responses to media characteristics of AR apps and non-AR apps according to the hypotheses established above. Two experimental studies were conducted in order to investigate these differences through a between-subjects 2x2 design. A call for participation through the student and alumni network at a Swiss university yielded 60 participants. Demographics are summarized in Table 1. A convenience sampling method was adopted and no incentive was offered.

Age	21-25	11.7%
	26-30	58.3%
	31-35	23.3%
	over 35	6.7%
Nationality	Italy	31.7%
	Germany	18.3%
	Switzerland	11.7%
	United Kingdom	6.7%
	Other EU nationality	13.3%
	Non-EU nationality	18.3%
Gender	Male	38.3%
	Female	61.7%
Education	High school	8.3%
	Bachelor	65.0%
	Master	23.3%
	PhD	3.3%

Table 1: Participants' demographics

Participants were divided in two groups of size 30. In the first study, the main experimental group used the AR app, while the control group used an application of the same brand and with similar content, but without the AR features. The same procedure was adopted in the second study, but groups were now given a different stimulus (those that previously used an AR app were now assigned to the non-AR group and vice versa). To control for the impact of the first task on the second, the participants were randomly assigned to the groups. As both studies took place within one day, the participants took a short break between the two tasks. With each task, participants filled out a questionnaire.

The experiment replicated the study by Van Noort et al. (2012) with a few changes. Firstly, we developed and included measurement items for perceived augmentation. They were defined based on a) the study of marketing AR applications (Javornik, 2014) and b) the conceptualization of augmentation by Preece et al. (2015) and Billinghurst and Kato (2002). The final scale consisted of the following items: a) I felt I could enrich X, b) After I stopped using the site, I could still imagine Y, c) The virtual objects seemed completely real, d) I felt that the virtual objects did not add anything to X and e) Reality seemed richer (where X is the element that is being augmented and Y is the virtual element depicted in the application). In Study 1, the analysis was based on the first two measurement items, while in Study 2 all five were included in the analysis. All were measured on 7-point Likert scale.

Secondly, van Noort et al. (2012) considered dimensions of two-way communication and control (Song & Zinkhan; 2008) as measurements of perceived interactivity. Our definition for the perception of interactivity with AR also included perceived control, however, in alignment with our hypotheses, we included perceived responsiveness and not two-way communication. Just as in van Noort et al. (2012), measurement items were adopted from Song and Zinkhan (2008) who conceptualized perceived interactivity to be composed of perceived control, responsiveness and two-way communication.

As in the study by van Noort et al. (2012), the participants were asked questions that examined: a) their absorption into flow, b) their intentions to use the site / application again, tell their friends about it and their willingness to purchase the chosen items, c) their thoughts related to the experience and d) their attitude to the brand and the application. The measurement items used in the questionnaire are fully outlined in Appendix 1. All the measurements were done on 7-point Likert scale, except for the thoughts, which participants wrote with words. Two independent coders coded the number of brand-related and site-/app-related thoughts per participant. The Pearson r coefficient for inter-coder reliability was 0.95 for site-/app-related thoughts ($p<0.001$) and 0.90 for brand-related thoughts ($p< .001$).

3.7 Study 1

In this study, the participants were requested to choose the perfect chair for a working corner in their house. We used applications of a well-known furniture brand. The experimental group used a tablet application of that brand with AR features, while the control group used a website of that brand with virtual elements, but without AR. Both applications allowed zooming and rotating of the chairs - on the AR app this was achieved by touching the screen and on the non-AR site by clicking the mouse. On both the non-AR website and AR app, the rotation feature was sometimes difficult to perform and had some delays. The non-AR site had both front view and floor view of the virtual room, while the AR app showed the real room in camera view.

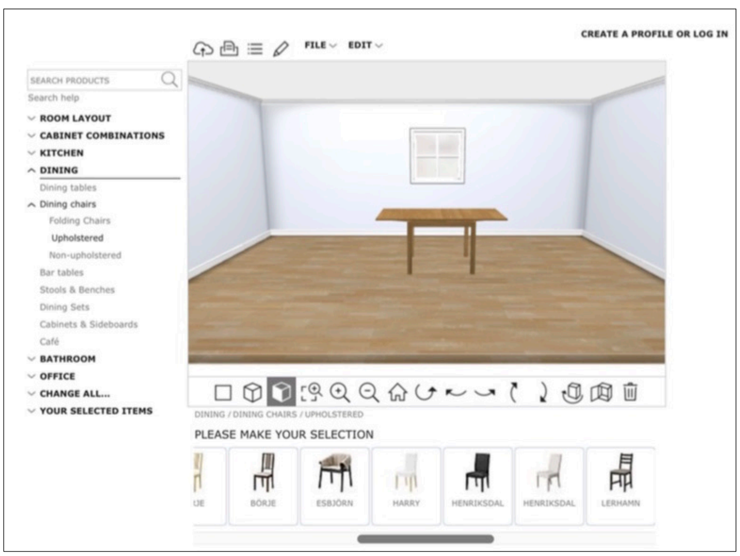


Figure 3: Interface of the virtual room for which a participant had to find a chosen chair

On the non-AR app site, more chairs could be put simultaneously in the room, while the AR app allowed one piece of the furniture at a time, but given that the task required users to find one perfect chair, that feature did not have an important impact. While the aim of the study was to keep the conditions as similar as possible across both groups (same task, same brand), the devices used in this study were different, as the AR app was only available on the tablet, while the non-AR website was used on a computer. The examples of the two sites are shown in Figure 3 and 4.

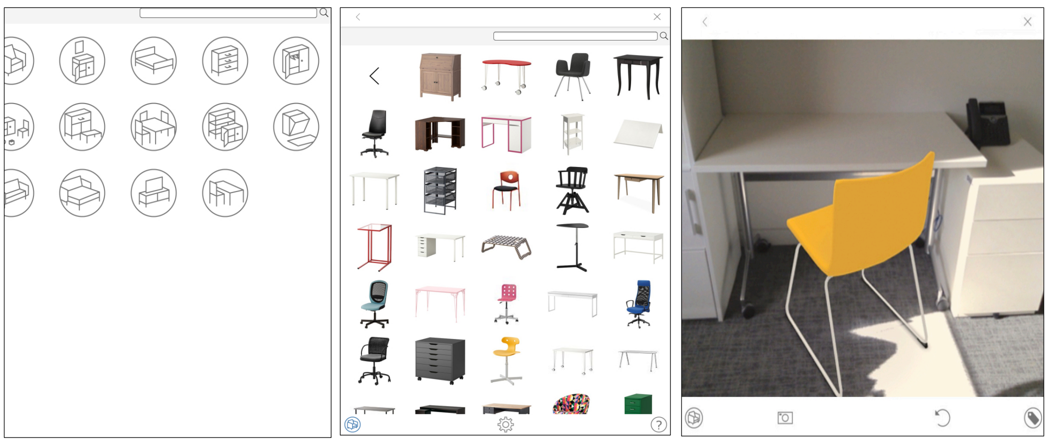


Figure 4: Interface of the AR app as displayed on a tablet screen (from left to right): a) categories of furniture, b) furniture pieces, c) simulation of chair in a real room

Both groups perceived the site to be controllable and responsive (all values above 5 on a 7-Liker scale). The AR group reported higher scores of perceived augmentation (Table 2).

	Perceived control Mean (SD)	**Perceived responsiveness Mean (SD)**	**Perceived augmentation Mean (SD)**
Non-AR application	5.20(1.08)	5.28(1.49)	4.93(1.21)
AR application	5.44(1.16)	5.04(1.59)	5.41(1.57)

Table 2: Reported values of perceived control, responsiveness and augmentation (1=don't agree at all, 7=completely agree)

Differences between the groups were tested to verify the effect of manipulation. Firstly, we examined normality of independent variables with a Shapiro-Wilk test, which was significant ($p<0.05$) and showed that the data is not normally distributed. The visualization of the data confirmed the same. We conducted nonparametric Mann-Whitney tests to examine the differences between the two groups.

There was no significant difference between the two groups in terms of perceived control and responsiveness ($p>0.05$), supporting hypotheses H1 and H2. The AR application was therefore not perceived to be more responsive or to allow more control than the non-AR application. However, there was a significant difference between the two groups in terms of perceived augmentation ($p<0.05$), which supported H3. Perceived augmentation was measured by two items: a) I felt I could enrich the room, b) After I stopped using the site, I could still imagine the chair.

The successful manipulation allowed us to conduct further analysis to determine whether perceived augmentation acts as a predictor for flow and, also, if flow acts as a mediator to consumer affective, cognitive and behavioral responses. Affective responses were represented by attitude towards the site/app and the brand, while purchase, revisit and recommendation intentions belong to the behavioral intentions category. Cognitive responses were counted as thoughts: in the non-AR group, there were 3 brand-related, 64 site-related and 77 thoughts in total, while in the AR group there were 8 brand-related, 89 site-related and 106 thoughts in total.

A regression analysis was conducted to test hypotheses H4a, H4b and H4c about flow mediating the effect of perceived augmentation on brand-related outcomes. As the independent variable was not normally distributed, we examined the normality of residuals and the dependent variable (flow) in order to not violate the assumption of normality for regression. A Shapiro-Wilk test confirmed that the dependent variable and residuals were normally distributed ($p>0.05$), so there was no violation of the normality assumption for regression.

The analysis procedure was the same as in van Noort et al. (2012). Regression analysis of perceived augmentation on flow was significant with p=0.00, unstd. β =.538 (SE=0.06), std. β=.762 and R^2=.58. Bootstrapping confirmed the results (B=.538, bias of .004 (SE=.055), sig. <0.001). At this point mediation analysis was conducted. We followed the procedure used by van Noort et al. (2012) that mediation has occurred when regression coefficients are significant and bootstrapping analysis shows that the bias corrected and accelerated (BCa) confidence interval does not include zero. The results for the paths from flow to brand-related responses are indicated in Table 3.

	Unstd. β coefficient	**SE**	**R^2**	**Std. β coefficient**	**B statistics for indirect effect**	**SE**	**BCa conf. interval (bootstrapping)**
Affective responses							
Application attitude	**.901**	**.102**	**.574**	*****.758**	**.210**	**.085**	**.053 to .382**
Brand attitude	.390	.097	.217	***.466	.082	.081	-.067 to .244
Behavioral intentions							
Purchase intentions	.820	.211	.206	***.454	.176	.175	-.132 to .523
Revisit intentions	**1.44**	**.140**	**.648**	*****.805**	**.521**	**.133**	**.291 to .820**
Recommendation intentions	**1.298**	**.179**	**.476**	*****.690**	**.324**	**.133**	**.047 to .585**
Cognitive responses							
Number of thoughts	-.093	.260	.002	-.047	.052	.211	-.328 to .553
Site related thoughts	-.252	.238	.019	-.138	-.027	.211	-.411 to .409

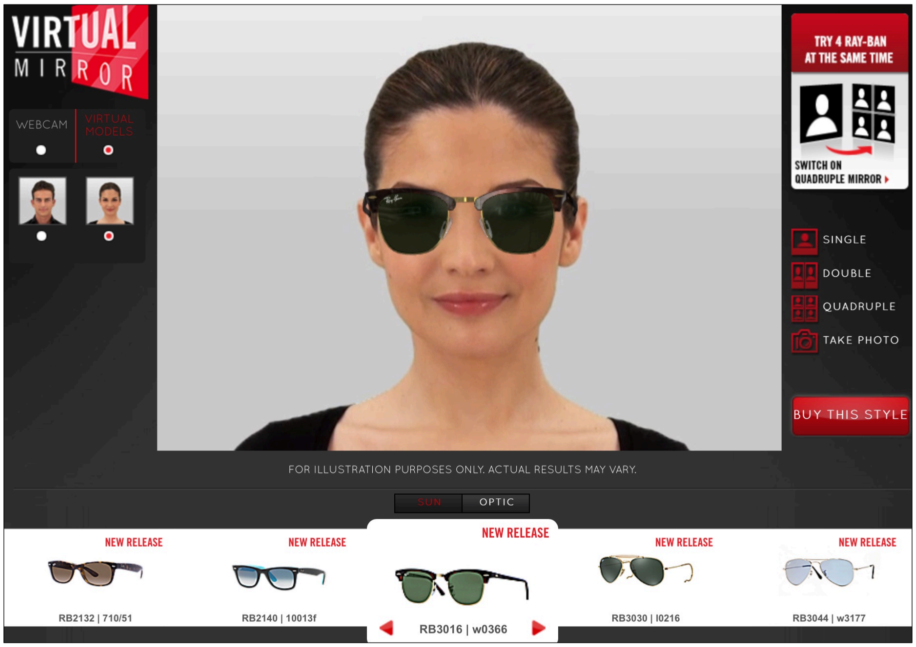
*Table 3: Regression analysis, followed by bootstrapping for mediation of flow on brand-related outcomes with perceived augmentation as predictor (*** p=0.00)*

The mediation analysis confirmed that the effects of perceived augmentation on application attitude, revisit intentions and recommendation intentions were mediated by flow. The 95% BCa interval did not include zero and these mediation effects were significant (van Noort et al., 2012; Preacher & Hayes, 2004). However, no mediation effect of flow was found for the path from perceived augmentation on brand attitude, purchase intentions or cognitive responses such as number of thoughts or site-related thoughts. H4b was therefore rejected and H4a and H4c were partially confirmed.

3.8 Study 2

In the second study, the participants were assigned the task of choosing the perfect sunglasses on websites of a famous sunglasses provider. The experimental group used a brand application where the sunglasses were placed on their faces through AR virtual try-on. The control group instead used a website of the same brand with some virtual elements but without AR – the site allowed the sunglasses to be placed on a static photo of the user (Figure 5 and 6). Both groups used a computer. For the sunglasses to appear and fit on the face in the camera mode on AR site, the computer performed calibration of the face, which took between 5-30 seconds. The fit of the sunglasses on the photo on the non-AR site was instantaneous. On both websites, the user could change the frames by clicking on other models displayed beside the picture (non-AR) or below the virtual mirror (AR). However, browsing through the frames on the AR site too quickly resulted in delays as the system required time to calibrate new sunglasses on the face. Participants noticed this delay and commented on it. On the non-AR site, the face and the sunglasses could not be rotated and viewed from any other angle than the front one, while the AR site showed the sunglasses from different angles, based on the user's movements. On both sites the user could take the photo of herself with the frames and compare it with others photos taken previously. The visual quality differed; the photo on the non-AR site was of lower quality than the camera view on the AR site.

First, we checked whether the manipulation of AR features resulted in different perceived interactivity and perceived augmentation. A Shapiro-Wilk test showed that the data was normally distributed ($p<0.05$), therefore parametric tests could be conducted.



Figures 5: Interface of AR application for trying virtual sunglasses

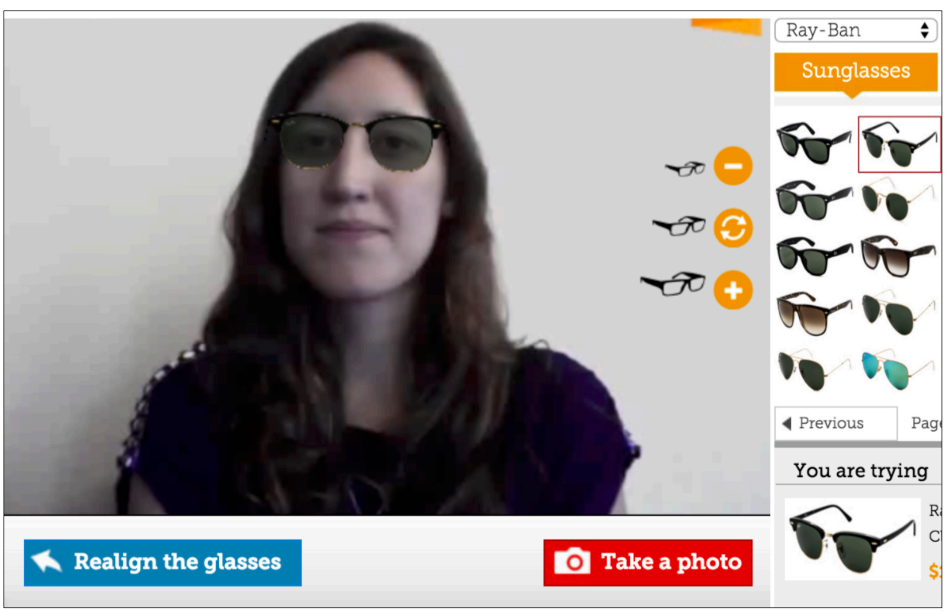


Figure 6: Interface of non-AR website for trying virtual sunglasses by uploading them on a photo

Firstly, we checked the values between the two groups in terms of perceived control and responsiveness. The analysis showed that users perceived the non-AR site to be significantly more responsive (M_{AR} = 3.38 (SD = 1.79); M_{nonAR} = 4.87, (SD = 1.32), p = .001) which rejected H1. There was no significant difference between the two groups in terms of perceived control ($p>.05$), which supported H2.

Before testing for perceived augmentation, we conducted additional analysis of the scale consisting of five items. Cronbach's Alpha of the scale was .854, Pearson correlations between the items were all significant at $p<.05$ level and the Spearman-Brown coefficient was .809. Factor analysis showed a significant Bartlett's test of sphericity (sig.=.00) and a satisfactory value for KMO measure (KMO=.837). All items loaded on one component which explained 64.274% of the variance. This analysis confirmed that the developed items represented an appropriate measurement tool.

The AR app again led to significantly higher perceived augmentation ($F(1,58)$ = 10.337, $p<0.05$, M_{AR} = 4.99 (SD=1.16) vs. M_{nonAR} = 3.93 (SD =1.37). H3 was again supported as participants who used the AR app reported significantly higher scores of perceived augmentation than those who used the non-AR app.

Further analysis also showed there was a significant difference between the two groups in terms of their application attitude (M_{AR} = 4.56, SD = 1.41; M_{nonAR} = 5.30, SD = 1.17; $p<.05$) and recommendation intentions (M_{AR} = 4.00, SD = 1.89; M_{nonAR} = 4.93, SD = 1.6; $p<.05$) in favor of the AR app. The number of written thoughts were as follows: in the non-AR group, there were 3 brand-related, 79 site-related and 108 thoughts in total, while in the AR group there were 3 brand-related, 75 site-related and 87 thoughts in total.

As in the first study, the mediation of flow for effects of perceived augmentation on affective responses and behavioral intentions was tested with indirect or mediation effects (Preacher & Hayes, 2004). The method was supplemented by bootstrapping, again following the procedure from the study by van Noort et al. (2012).

Regression analysis demonstrated that the participants who perceived a higher level of augmentation also perceived higher levels of flow (β=.709, t(58)=7.65, p=0.00, R^2=.502), which satisfied the first requirement for the predicted mediation effect. Regression analysis of flow on brand and application attitude (purchase, recommendation and revisit intentions and app-related thoughts) confirmed the effect of the mediator on the dependent variables (Table 4). However, the regression coefficient was negative in the category of cognitive responses, which indicated negative correlation between flow and number of thoughts (both total and site/app related). Further mediation analysis revealed that the effects of perceived augmentation on one type of affective response (application attitude), one type of cognitive response (application/site related thoughts) and two types of behavioral intentions (revisit intentions and recommendation intentions) are mediated by flow. In these cases the zero was not included in the 95% bias corrected and accelerated confidence interval of bootstrapping (van Noort et al. 2012) which confirmed a mediation effect. H4a, H4b and H4c were all partially confirmed.

	Unstd. β coefficient	**SE**	**R^2**	**Std. β coefficient**	**B statistics for indirect effect**	**SE**	**BCa conf. interval**
Affective responses							
Application attitude	**1.05**	**.122**	**.559**	**.748*** **	**.274**	**.130**	**.010 to .521**
Brand attitude	.541	.131	.227	.476***	.256	.128	-.045 to .467
Behavioral intentions							
Purchase intentions	1.082	.204	.327	.572***	.27	.153	-.079 to .527
Revisit intentions	**1.359**	**.177**	**.504**	**.719*** **	**.287**	**.122**	**.037 to .512**
Recommendation intentions	**1.248**	**.192**	**.421**	**.649*** **	**.362**	**.139**	**.097 to .657**
Cognitive response							
Site/application related thoughts	**-.540**	**.194**	**.123**	**-.351** **	**-.419**	**.199**	**-.795 to -.007**
Number of thoughts	-.343	-217	.041	-.204	-.332	.213	-.709 to .113

*Table 4: Regression analysis, followed by bootstrapping for mediation of flow on brand-related outcomes with perceived augmentation as predictor (*** p = .00, ** p <.01)*

3.9 Dimensions of perceived augmentation and consumer experience with both AR apps

In order to obtain indications for further development of the perceived augmentation concept, users' comments about AR application were analyzed. Sixty comments about AR applications were grouped into different categories according to their relative similarities in meaning (Braun & Clarke, 2006). Two categories emerged as being especially relevant for further examination of the perceived augmentation.

Many participants suggested that it is important for the virtual items to have a high level of realism, while another set of comments emphasized the importance of the virtual items corresponding accurately to the space in which they were situated, meaning that there should be a congruency between the changes in the physical environment and reactions to that on the screen (Table 5 and 6).

Fit of an item in the space in real time	**Realism**
"*I thought it was very useful because it really let me see the item inside the room" (Female, 30)*	"*I would like the chairs to look more real*." (Male, 25)
"Being able to see a 3D representation of the furniture made it very easy to get a feeling for how each item would fit into the existing décor." (Male, 28)	*"It was not clear if the way I resized the object was accurate and reflect the reality."* (Female, 32)
	"*I had the impression it was very realistic and fun to use."* (Male, 29)
"I wanted to see how the chair would go a bit under the desk, but the image of the chair was always over the desk, so I could not imagine exactly how it would fit in the room." (Male, 28)	*"Objects did not seem to be real. Difficulties in understanding the dimensions, given that you can also shrink the objects."* (Male, 29)
"It would have been nice to place the chair also "under" the table." (Male, 35)	*"The image was realistic and clear and I felt like the use of this app was actually making my choice easier."* (Female 30)
"I liked how the angle of view was changing when I was changing my standpoint - seemed real (in a way)."(Male, 28)	*"I had to size the chairs myself, which is unrealistic."* (Female, 34)

Table 5: Users' comments about furniture AR app from Study 1

Spatio-temporal fit between virtual and physical	Realism
I especially appreciated the fact that you can turn sides and not only see the image en face. (Female, 28) *It was great to see the glasses on my face and even being able to move around with them. (Female, 25)*	*This is a fun toy, but I would be concerned about the correspondence between the virtual glasses and the real ones (Male, 33)* *It was a very positive experience, because I felt like going to a real store without being annoyed by the salesman (Male, 62)*
I thought I liked that the application takes into account the shape of the face so that you can see how the glasses really fit on you with the right proportions. (Female, 26)	*I was surprised it was so real (Female, 26)*
The image calibration did not really work for me as the sunglasses sat a bit tilted on my face, so I think some improvements could be done in that. (Female, 26)	*I found out a consistent difference among augmented reality fit and real fit of glasses. (Male, 26)*

Table 6: Users' comments about sunglasses virtual try-on AR app from Study 2

For example a turn of the head should allow a user to see virtual glasses from the side or a change in standpoint should then show the furniture from a different perspective.

These comments, and the two emergent categorizations, provide useful insight into different dimensions of the augmentation and suggest that there are different levels of how much consumers perceive that an application augments physical reality in real time.

3.10 Discussion

The experimental studies confirmed that the concept of perceived augmentation captures consumer perception of the salient AR media characteristic and, furthermore, that effects of perceived augmentation on site-/application-related responses (application attitude, number of application-related thoughts, intention to use it again and to tell about it friends) are mediated by flow.

Furthermore, replicating the study of van Noort et al. (2012) led to findings that interactivity of AR tools in termsf perceived control and perceived responsiveness is not greater in comparison to standard websites, which is an important discovery as it emphasizes the fact that AR is not just another more interactive technology, but functions in a different way. This further implies that the marketing field should understand and deploy it in a different way and not treat it in only terms of features that facilitate value creation as a website does, but rather focus on AR's ability to add visual simulations in the physical environment and interact with consumers in real-time. Despite some minor differences between the two groups in Study 1 in terms of features on the site / app - such as using a different device - the perceived responsiveness and control were not significantly different. This indicates that if we have two similar sites or apps between which the main difference is the presence/absence of an AR, the AR app is not perceived more interactive in terms of perceived responsiveness and control. These results were confirmed only partially in Study 2, where users of the AR site reported lower interactivity in terms of perceived responsiveness than users of non-AR site despite the fact that the two groups had very similar settings (same brand, same task, same device) and many features of the AR and non-AR sites were the same. However, the participants viewed the non-AR site to be more responsive. That is most likely related to the face that the feedback of the AR site to the user's input is sometimes delayed and not instantaneous, as the system requires more time to fit the virtual sunglasses suitably in the camera mode. Such results can be further explained by the fact that AR technology is relatively immature at its current stage and thus an application with AR features still does not run as smoothly as an average website and does not display a well-finalized user interface which then influences the perceived responsiveness. These are, however, not necessarily inherent to the technology but merely a manifestation of its relative infancy and will likely be resolved as the technology matures.

In terms of consumer reactions to AR's most salient media characteristic, both studies confirm that flow mediates effects of perceived augmentation on affective responses towards the application and behavioral intentions in terms of revisit and recommendation intention, especially for the AR app with virtual try-on. This implies that augmentation of the self, but also of the surrounding space as in the Study 1, immerses consumers into flow (Csikszentmihalyi, 1997). Furthermore, study 2 showed that the flow mediates effects of perceived augmentation on cognitive responses in a negative way – those who were more immersed in the flow when using AR and perceived the augmentation to be high, reported significantly lower number of app-/site-related thoughts. The results on cognitive responses are the only ones indicating negative correlations. They suggest that higher levels of flow correlate with low number of brand-related thoughts. The results refer only to the number of the comments and not to the content (positive vs. negative). These findings differ from those presented by van Noort et al. (2012) and possibly relate to the differences in the technologies used and in the types of experience provided.

Moreover, the elicited consumer responses that are linked to perceived augmentation are all related to the application and not to the brand. The affective response supported by mediation is in both studies the application attitude and the behavioral responses supported by mediation are intentions to visit the site/app again and to tell about it to their friends. The lower number of cognitive responses that have been confirmed as a result of flow mediation are the application-related thoughts. Brand-related or purchase-related responses have not been proven in this study as an outcome of flow caused by perceived augmentation. That could potentially be explained by the fact that AR creates such an intense effect with its "looks-like-it-is-real" simulations that the parts of the experience that are not related to the application, are neglected.

3.11 Limitations of the study

The sample in the two studies was convenient and drawn from student population. Studies from other populations and with random sampling method are required for further generalization of the results. Also, the experiment was lab based. While that allowed high internal validity, the external validity of these results would be increased with for example "in-the-wild" studies (Rogers, 2012), common in the HCI field. Also, further extension and validation of the measurement items related to the concept of perceived augmentation is required.

Moreover, the basic 2x2 experimental design with the presence and absence of AR as the main manipulation does not provide insight about impacts of different types of AR features. For that, additional levels of manipulation would be necessary.

Finally, this study tests two types of AR. Examination of causal effects with other AR applications are required, especially given the aforementioned diversity of AR tools (Javornik, 2014), both in terms of tools (tablet, smart device, wearable, large fixed interactive screens), techniques of augmentation (e.g. virtual mirror, holographic projections, augmentation of products based on image recognition) and contexts of use (public, private). The technology is, as yet, at an early stage and is expected to change and be improved significantly. This study thus presents consumer responses to the early-stage AR apps, i.e. those that still exhibit considerable technological imperfections. Improved versions in the future will likely alter some aspects of the current consumer experience.

3.12 Conclusion

This study focused on media characteristics of AR technology in order to understand how their effects can be measured and which consumer responses they evoke. It underlines the fact that AR should not be considered as merely "another interactive" technology, because its main feature relates to another dimension – its ability to augment or modify the visual representation of reality in real-time. The two studies conducted showed that perceived augmentation corresponds to how consumers view and understand this particular AR characteristic. As consumer perception of media characteristics represent important drivers of consumer responses (Song & Zinkhan, 2008; Stewart & Pavlou, 2009; Sundar et al. 2015), perceived augmentation can serve as a useful concept in future consumer behavior studies of AR. Measurement items could assist both practitioners and academics when assessing the value of AR tools for marketing communication by further measuring its effect. The proposed conceptualization facilitates investigation of AR in consumer behavior and provides directions for further research to investigate the concept more in-depth and to test it in other contexts and with more complex manipulations.

Furthermore, the presented studies confirm that consumers become more immersed into flow when perceiving the visual augmentation to be more intense, an occurrence which, furthermore, relates to: their intention to engage with the AR application again in the future, positive attitude towards it and in some cases even the development of a significant number of related thoughts about it. Future research should investigate if and how this immersion changes when the context of use is modified according to the type of AR application (e.g. wearable, public interactive display, smartphone application).

Given that the HCI field indicated augmentation as a concept relevant for AR, other findings from this particular field may also prove useful. For instance, Azuma et al. (2001) emphasize that factors such as eye fatigue with AR, perception of realism and data density on the screen influence user experience with AR, which could have a direct impact on adaptation of AR in marketing. In general, HCI principles such as usability, functionality, aesthetics, content, look and feel and appeal to senses and emotions (Preece et al. 2015; Dix et al. 2009) could extend the examination of consumer experience with technology by providing a more complete picture of a consumer use of specific types of technology. On the other hand, the more technology-related challenges such as rendering, latency and calibration have less direct impact on marketing, however solving some of these issues would contribute to improved AR technology and reduce problems such as delay and inexact alignment of visual and physical elements.

Finally, this study opens questions for future research on consumer behavior when using AR. Further studies are needed to understand how the uses of this technology can yield stronger brand-related responses. More complex studies on consumer experience (Holbrook & Hirschman, 1982; Schmitt, 2010; Dennis et al. 2013) would be able to go beyond fragmented consumer responses and provide a more holistic understanding of the experiential value that AR features create for consumers.

3.13 Appendix:

Scale	Items
Perceived augmentation (own development) **α =.854**	1) I felt I could enrich X. 2) After I stopped using the site, I could still imagine Y. 3) The virtual objects seemed completely real. 4) I felt that the virtual objects did not add anything to X. 5) Reality seemed richer. (where X is the element that is being augmented and Y is the virtual element depicted in the application)
Perceived control (Song & Zinkhan, 2008) **α=.872**	1) While I was on the site, I was always able to do what I thought I was doing. 2) I felt I had a great deal of control over my visiting experience at this site. 3) This site is not manageable. 4) While I was on the site, I could choose freely what I wanted to see. 5) While using the site, I had absolutely no control over what I could do on the site. 6) While using the site, my actions decided the kind of experiences I got.
Perceived responsiveness (Song & Zinkhan, 2008) **α=.963**	1) The site processed my input very quickly. 2) Interaction with the site was very fast. 3) I was able to obtain information I wanted without any delay. 4) When I clicked, I felt I was getting an instantaneous information. 5) The site was very slow in responding to my request. 6) The site reacted to my interaction immediately.
Flow (Nel et al., 1999) **α=.877**	1) When I used the site I felt in control. 2) I felt I had no control while interacting with the site. 3) The site allowed me to control the interaction. 4) When I used the site I was aware of distractions. 5) When I used the site I thought about other things. 6) When I used the site I was totally absorbed in what I was doing. 7) Visiting the site excited my curiosity. 8) Interacting with the site made me curious. 9) The site aroused my imagination. 10) The site interaction bored me. 11) The site was interesting. 12) It was fun to explore the site.
Behavioral intentions **(Van Noort et al., 2012)** **α=.781** **Recommendation intention, reuse intention, purchase intention**	1) I would like to purchase the items I have chosen. 2) I have the intention to return to this site in the future. 3) I will tell my friends about this site.

Affective responses **Brand attitude (Li et al., 2002)** **α=.904**	Brand attitude: To which extent does the X brand mean for you the following things? Please tick one circle in each line that describes best your opinion about X brand. (7-Likert scale) 1) Bad/Good 2) Unappealing/Appealing 3) Unpleasant/Pleasant 4) Unattractive/Attractive 5) Boring/Interesting 6) I don't like the brand/I like the brand
Site/Application attitude (Fortin and Dholakia, 2005) **α=.953**	Site/application attitude: To which extent did using the X site/application mean for you the following things? Please tick one circle in each line that describes best your opinion about X site/application. 1) Not fun to see/Fun to see 2) Unpleasant/Pleasant 3) Not entertaining/Entertaining 4) Not important/Important 5) Not informative/Informative 6) Useless/Useful 7) Not curious/Curious 8) Boring/Not boring 9) Not enjoyable/Enjoyable
Cognitive responses (Cacciopo and Petty, 1981; Van Noort et al., 2012) **Number of thoughts** **Number of site-related thoughts**	Participants were asked to write down all the thoughts that came to their mind when they were using the site/app.

Table 1: Items in the questionnaire with reported reliability scores

3.14 Commentary on the 2nd Article

The 2nd Chapter is included in this thesis in the same format as it was accepted for publication in the Journal of Marketing Management. However, we would like to offer additional clarifications that either explain some parts in more detail or offer further perspective on it.

3.14.1 Definition of AR technology

The definition of AR by Azuma et al. (2001) has been well received since its appearance fifteen year ago and continues to remain valid with regards to the technical aspects of the technology. It does not, however, indicate the type of experience that AR brings about for its users in terms of reality representation, which is where the article aims to offer further contribution. In the beginning of the 2nd chapter, we for instance claim "*Augmented reality (AR) can create an enchanting experience for consumers as it visually transforms physical reality by superimposing virtual elements directly into the real-time environment through a screen or projector*." The type of experience that AR creates, and how this differs from the related technology of Virtual Reality (VR), is investigated further throughout the thesis.

By real-time environment we refer to the fact that virtual elements generated by AR systems are situated in the physical reality, both in terms of physical space and time, which is the main point that separates AR from VR. VR creates its own environment on the screen or on the head-mounted display (for example Oculus) that does not correspond to occurrences in the physical surrounding and is in general dissociated from it (Blascovich & Bailenson, 2011)

It is important to emphasize that AR does not directly transform physical reality in terms of its tangible, material objects, but rather changes the way consumers experience it because a virtual layer is added and situated in the physical reality.

How exactly the consumer experience of physical reality changes is one of the main interests of this thesis. It is explored from different angles, for instance by investigating the type of experience impacted by AR in retail and defining the impact of perceived augmentation on the affective and cognitive levels of experience.

3.14.2 Immersion

In the 2nd Article, we explore consumer experience with AR in terms of immersion by investigating the flow. In the introduction of the article we ask: "Do augmentation and interactivity of AR technology create an immersive experience for consumers?" We know from previous studies that both the interactive features and the perception of them can absorb consumers in flow when using interactive technologies (Hoffman & Novak, 2009; van Noort et al., 2012). The immersion in flow has been shown to have significant impact on a wide array of consumer responses, such as attitude, attention, future behavior and many others (Hoffman & Novak, 2009). When immersed in flow, people focus more intensely on the task at hand, spend more time with it, enjoy it more and are less easily distracted by other factors (Csikszentmihayli, 1997; Lee & Chen, 2010). Creating an immersive experience for a consumer thus implies being able to have more of his or her attention, which is of a high relevance to marketing as it directs consumer behavior towards purchase-related activities (Lee & Chen, 2010). It is therefore crucial to understand whether or not AR technology and its visual stimuli establish such immersion. This thesis offers some answers to that question by showing that when augmentation is perceived to be high, this also creates higher levels of immersion.

3.14.3 Interactivity

As proposed by Sundar et al. (2015), interactivity is a media affordance or a technological attribute of a medium. Affordance refers to permissible actions that are suggested by visual markers of a medium. Such affordance relates to the interaction between a user and a system and TIME theory (Sundar et al., 2015) indicates how they can act either as action triggers or as symbolic representations (Figure 1).

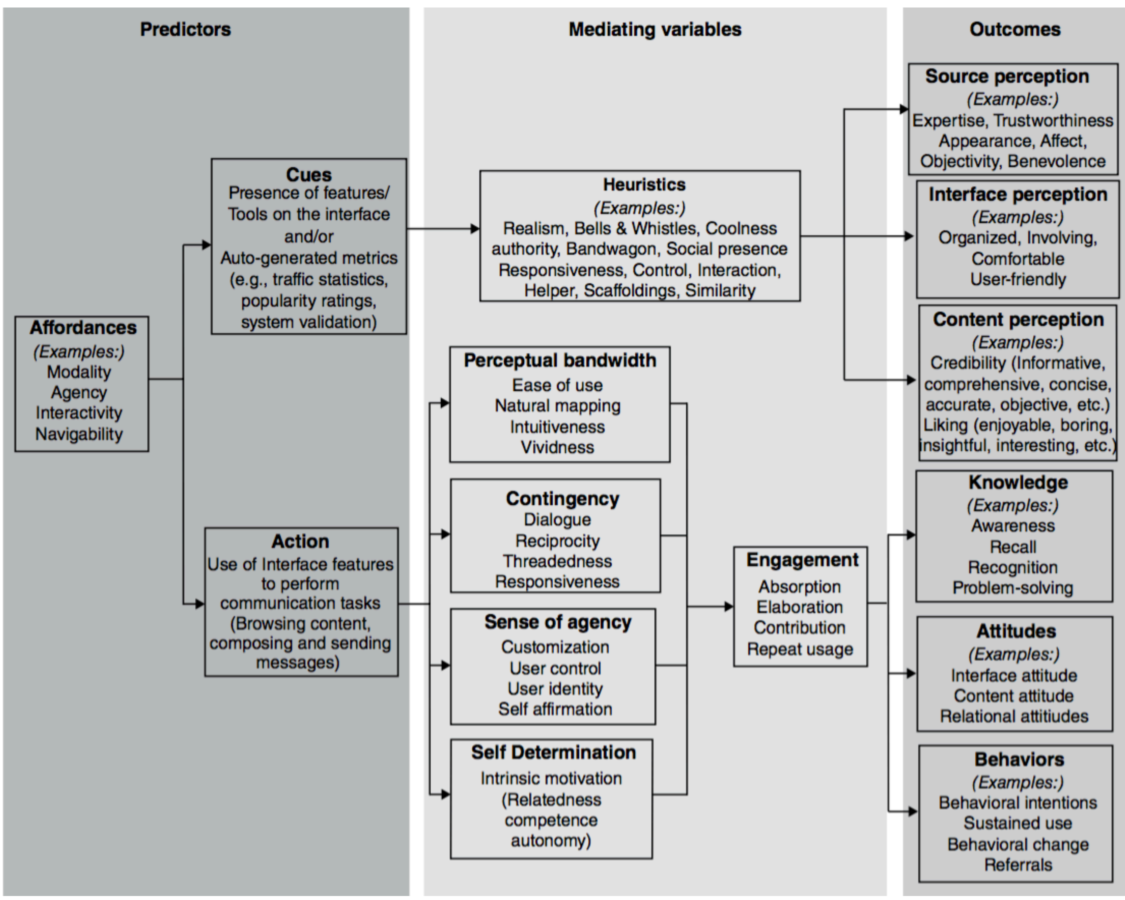


Figure 1: TIME model (Sundar et al., 2015)

The upper route of the model (Figure 1) indicates in which ways an affordance provides these symbolic representations or cues and the impact they have on perceptions without the user necessarily taking any action. The lower part of the model refers to the action route, i.e. to the activities that the affordances can trigger and the psychological correlates of these actions. Our study is concerned with the lower action route.

This is therefore the larger theoretical TIME frame within which interactivity is situated. The concept of interactivity is very complex and relates to three different levels: medium interactivity, message interactivity and source interactivity (Sundar et al., 2015). These three levels then have corresponding psychological correlates, such as perceptual bandwidth, contingency and sense of agency (Figure 2). In our study, we focus on one psychological correlate of source interactivity and one psychological correlate of medium interactivity. Taking into account all the correlates to which these types of interactivity refer would demand a more complex study, which would go beyond the aims of this thesis.

We wish to offer further understanding of different levels of interactivity and how they are applied in this study. Medium and message interactivity directly reflect two views of interactivity: *contingency* and *functional* (Sundar et al., 2015). The contingency view is routed in the ability of a medium to provide an ongoing reciprocity in the communication between the interactants. It developed from the earlier conception of interactivity (Rafaeli, 1988) which relied on interpersonal communication and referred to the messages a user receives as a direct response to his previous input.

The functional view or the medium interactivity on the other hand refers to features of the medium, such as interactive tools and functions, and is concerned with how these functions enable users to interact either with the medium or with users (Sundar et al., 2015). The psychological correlates of medium interactivity range from ease-of-use, intuitiveness and natural mapping and refer to a larger category of perceptual bandwidth.

The AR tools that were available at the time this study was conducted did not allow message exchange between different users and did not enable interpersonal communication. That was the main reason why we did not investigate the contingency view of AR interactivity and that the responsiveness to which we refer in the article is not responsiveness in terms of message exchange between users. Future AR applications will certainly allow this interactivity among users (an important example is the upcoming HoloLens head-mounted display) and at that point it will be important to examine the responsiveness of the medium in terms of its ability to exchange different messages between users. In our case, however, the focus was placed on medium interactivity.

It is important to note that Sundar et al. (2015) investigate medium interactivity with regards to how it promotes user engagement with the content and expands his/her perceptual bandwidth. However, in our research design, we chose to focus on understanding to which extent the system of AR apps responds to user input. General responsiveness is an underlying structure for medium interactivity as defined by Sundar et al. (2015) and a key condition for all the medium features of the system, such as clicking, tapping and rotating and so on. While on one hand such an approach requires a generalization and simplification of the medium interactivity as defined by Sundar et al. (2015), it allows a general comparison between current AR and non-AR systems in terms of their functionalities. Understanding whether there is a difference in the perception of responsiveness between two systems whose main difference is presence or non-presences of AR will allow further investigation of medium interactivity.

Future studies on medium interactivity should thus investigate how interaction with interface cues – for instance through tapping and clicking – impacts the sense of usability, intuitiveness and, especially relevant in the case of AR features, impact on the perceptual bandwidth.

We also investigate source interactivity from the point of view of the user's sense of control. There are other aspects of source interactivity that would also be relevant to investigate, but which we did not include in the study, such as how a user can customize or generate the content on his own, curate it in different ways or use it as a vehicle of self-expression by sharing the content on social media. Future research should investigate these aspects of source interactivity in relation to AR. However, at the time when this experiment was conducted, the AR apps that we had access to did not yet include such features, which is why we focused on one particular aspect of source interactivity, i.e. sense of control. Such an approach did not allow us to investigate the whole complexity of source interactivity, but it offered an insight to one dimension of it.

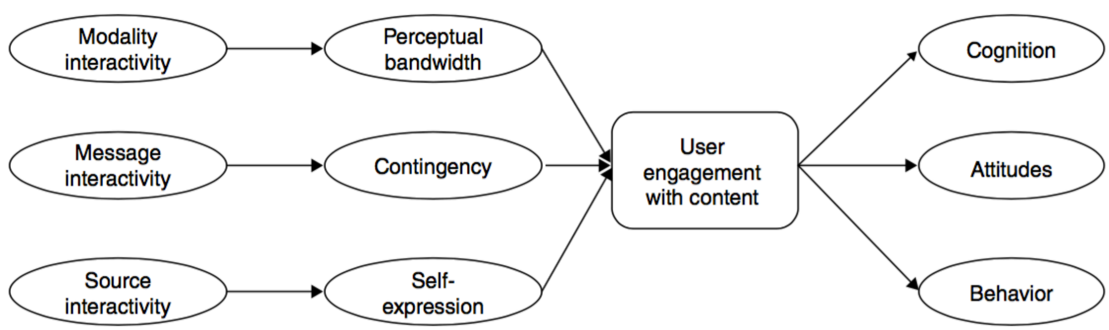


Figure 2: Model of interactivity effects (Sundar et al., 2015)

Van Noort et al. (2012) have proven that the inclusion of interactive features created higher perceived interactivity in the sense that consumers perceived more control and better two-way communication with the medium. The question that we asked was whether the addition of AR into the existing infrastructure of an application or website would enhance or diminish this interactive part of the experience. The results showed that AR did not increase the perception of interactivity in terms of control and responsiveness, which is a novel finding in the area.

We also emphasized that these results are influenced by the specific type of AR application and website considered, their functionalities and how well it works - given the early stage of the technology, problems related to functionality occur often. AR apps could thus potentially deliver different outcomes if the AR part of the applications were designed in more interactive ways and delivered better functionality. At the time this research was conducted the available AR apps did not possess as many interactive aspects as an average website. This might change with the development of future AR apps, which could then have an impact on increased perceived interactivity. However, in our study, we did not find that AR technology creates a significantly more interactive medium in the sense of being more responsive and offering more control.

3.14.4 Augmentation vs. Interactivity

Another crucial point with regards to the media features of augmented reality is the distinction (or similarity) between augmentation and interactivity. Are the two distinctly separated? Could augmentation be seen as another form of interactivity?

We see two possible ways for future conceptualizations. Firstly, augmentation can be seen as a feature that signifies a completely new aspect of a medium and is treated as a phenomenon that delivers a thoroughly new experience. Secondly, augmentation can be seen as a new aspect of interactivity, previously unidentified because it was not present in previous forms of technologies and is unique to AR. In our thesis we did not define augmentation in relation to interactivity, but rather investigated it in the sense of its relation to a user's psychological correlate, i.e. perceived augmentation. Future studies need to resolve this highly important question.

3.14.5 Choice of measurement instruments

While we have proposed the hypotheses based on the conceptualization developed by Sundar et al. (2015), the measurement items related to interactivity that we use are adopted from Song & Zinkhan (2008). Although the conceptualization of interactivity as proposed by Sundar et al. (2015) is the most thorough and accurate one, the scale of perceived interactivity by Song & Zinkhan (2008) offers a valid measurement instrument for psychological correlates of the two specific dimensions of interactivity, i.e. perceived responsiveness and perceived control. Furthermore, the measurement scales were adopted from the study by van Noort et al. (2012), as we replicated their research design.

3.14.6 Perceived augmentation scale

This study represents a first exploratory study on the concept and measurement of perceived augmentation. We developed a 5-item scale which was tested in two experimental studies. In the 1st study, there was a significant difference between the experimental and control group for only 2 items of the perceived augmentation scale, while in the 2nd study the groups differed significantly for all 5 items. While these results allowed us to conduct the analysis, such results also indicated that the scale of perceived augmentation needs further attention and item development and thus offers directions for further item development and validation, which we then conducted in the 3rd and 4th articles.

4. REVEALING THE SHOPPER EXPERIENCE OF USING A 'MAGIC MIRROR' AUGMENTED REALITY MAKE-UP APPLICATION

Article accepted for publication:

Javornik, A., Rogers, Y., Moutinho, A., Freeman, R. (2016). Revealing the Shopper Experience of Using a "Magic Mirror" Reality Make-Up Application. *Proceedings of Designing Interactive Systems conference*, 2016. ACM.

Abstract:

Virtual try-ons have recently emerged as a new form of Augmented Reality application. Using motion caption techniques, such apps show virtual elements like make-up or accessories superimposed over the real image of a person as if they were actually wearing them. However, there is as of yet little understanding about their value for providing a viable experience. We report on an in-situ study, observing how shoppers approach and respond to such a "Magic Mirror" in a store. Our findings show that after the initial surprise, the virtual try-on resulted in much exploration when shoppers looked at themselves on a display integrated in the make-up counter. Behavior tracking data from interactions with the mirror supported this. Moreover, survey data measured perceptions of augmentation as well as hedonic and utilitarian value of the app and suggested the augmented experience was perceived to be playful and credible while also acting as a strong driver for future behavior. We discuss opportunities and challenges that such technology brings for shopping and other domains.

Keywords: Augmented reality; virtual try-on; in-the-wild study; shopper experience; make-up.

"If we knew what it was we were doing,
it would not be called research, would it?"
(Albert Einstein)

4.1 Introduction

Augmented Reality (AR) has become increasingly available for end-consumers, mainly through smart device applications, but also through public interactive displays. Examples include apps for navigation, viewing property prices and tourist guides. Contextualized information (e.g. a restaurant, a direction arrow, a figure in $$$) is typically overlaid on a view of the real world shown on a device display and captured by its internal camera as the user moves through a street or city.

A new kind of AR technology that is starting to be used as part of smart device applications is the "Magic Mirror". The image of a person's face, which appears on a device screen via the in-built camera (typically used for videoconferencing), is superimposed with add-ons such as make-up or accessories (see Figure 1). In contrast to other AR apps that overlay the rear-facing camera image of the surroundings with digital information (Billinghurst & Kato, 2002), the Magic Mirror uses the front-facing camera. In so doing, it delivers a different user experience as it seeks to make the virtual appear as part of the real, rather than being superimposed over it. One kind of app using this technology is a virtual make-up try-on where the add-ons are created to realistically enhance the face; as far as possible giving the impression that one is truly trying on the make-up. When the user moves their head, so too does the make-up by staying in the same place on the mirrored face. This illusion works through the application of motion capture techniques that build up an internal 2D model of a person's facial features in real time. The effect is quite magical, as the virtual make-up appears very realistic. However, it is not yet known whether this technique is effective in terms of 'fooling' users into thinking it is genuine and whether they would use it when selecting make-up in a retail store. A question this raises is how convincing is the app

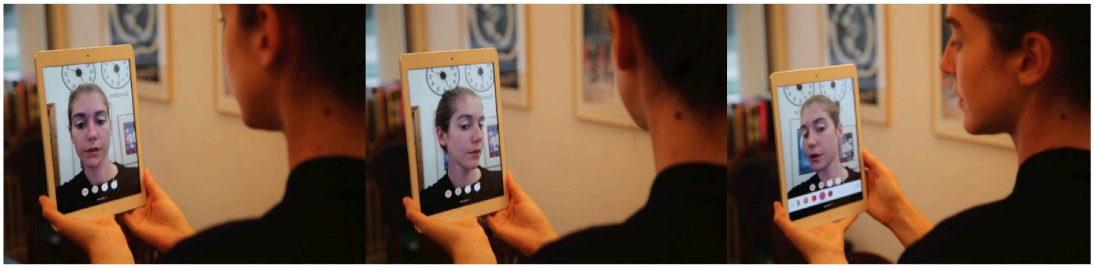


Figure 1: Captures of a face from different angles, showing the application's tracking and the make-up following the users' moves

to shoppers and does it entice them to try more or different kinds of make-up than they would otherwise?

Our research is concerned with investigating the uptake of this novel kind of AR technology in a real-world context. Specifically we ask: *how does Magic Mirror as a new kind of AR application affect the shopping experience when in a public retail space?*

We report here on an in-situ study which investigated how shoppers approached a make-up counter in a real store which had embedded the Magic Mirror AR technology as part of its display. The study was set up in a futuristic store in a large shopping center. A mixed method approach was used: in-situ observation and an extensive survey. Our findings showed that people did not simply walk up and use it but had to be talked through how to use it by an assistant or watch someone else before having a go. Those who did try it were initially surprised by the effect but then took it seriously and went on to experiment with a variety of features. We discuss how the success of these new kinds of AR technologies in a store depends on a range of factors, including whether the application is noticed, whether people feel comfortable trying it on, how long they use it for and what they do after using it. Finally, we examine the value of the Magic Mirror in a retail setting, in terms of its potential for enhancing the shopper experience versus the risk of it being perceived more as a playful gimmick. While this application was designed for a specific context, it is likely to have wider applications for other fields such as medicine, culture and education if shown that people react positively to the virtual face augmentation.

4.2 Background

Previous research on AR has predominantly focused on the technical challenges when using AR technology to superimpose the surroundings with virtual annotations (Azuma et al., 2001; Carmigniani et al., 2011, Van Krevelen & Poelman, 2010; Zhou et al., 2008). Issues such as how to improve tracking and rendering (Van Krevelen & Poelman, 2010, Zhou et al., 2008) or how to integrate AR when using wearables (Carmigniani et al., 2011) have been dominating the research agenda. These include investigating the complete visual hardware pipeline from image capture and processing through to rendering and display. The technological advances of the last decade have seen all of these components coming together in integrated mobile devices (Langlotz et al., 2012). Ever smaller processors with greater processing capabilities, increased storage capacity, ubiquity of wireless Internet, mass adoption of smartphones and tablets and effectively unlimited storage capacity of on-line information have all contributed to the opening up of AR development and its commercial possibilities. There are now software development kits (SDKs) available commercially that enable assembly of components within AR applications, such as AR recognition, tracking and content rendering (Vuforia, wikitude, D'fusion, ARToolKit or ARmedia) (Amin and Govilkar, 2015). Although these SDKs allow many companies to rapidly create novel AR apps, customized development of tracking and visualization components are often still required.

The areas where AR has seen most advances are tourism (Kourouthanassis et al., 2015, Specht et al. 2011), aviation (De Crescenzio et al. 2011), culture (Schnädelbach et al., 2002) and education (Cheng & Tsai, 2013; FitzGerald et al., 2013; Specht et al., 2011). Further opportunities exist in learning more about how AR affects the user experience in real world contexts, in terms of whether, and the extent to which, the additional information enhances the experience, how immersive it feels or whether it deepens understanding or learning (Preece et al., 2015). A question for all of these domains is how does the AR technology change the user experience? Does superimposing virtual information on a view of the real world on a display help people make decisions or enable them to understand better the context in real time? Is the way the information appears on the screen realistic enough and perceived as useful – in the way heads up display AR is commonly used in cockpits to help land planes?

The research investigating the user experience of AR has been emerging only recently (Chang et al., 2014; Cheng & Tsai, 2013; Huang & Hsu Liu, 2014; Olsson et al., 2013). A study by Kourouthanassis et al. (2015) investigated the role of emotions in the adoption behavior of mobile AR systems for personalized tourist recommendations. They found that affect and arousal, as evoked by a system's functional features, strongly impacted the user's willingness to use it. In the context of education, Chang et al. (2014) have shown that an AR application that augments an art object with additional information can increase knowledge retention and deepens appreciation of paintings.

AR has begun to receive attention in marketing (Olsson et al., 2014). There is much interest in its potential for delivering an amended consumer experience, by which we refer to user experience that relates to consumption activities, both in public (such as retail) or private contexts (such as online shopping). One of the first commercial applications was designed in 2008 for the car brand Mini, which presented a simulation of the car on a screen when a paper with corresponding trackers was placed in front of it (Carmigniani et al., 2011). The car appeared in 3D and moved when a user tilted the piece of paper it appeared on. That enabled the user to view a 3D visualization of the car model in any perspectives he defined with his moves, therefore not needing to click on the mouse to rotate the model. Since then, other simulations of products in a physical space have started appearing. Furniture brands, like Ikea, can now mimic pieces of furniture on a smart device screen as if it was literally placed in someone's living room. This is intended to help customers imagine how a three-piece suite or dining table would appear in their living room by superimposing the virtual furniture in an image of it. Huang and Hsu Liu (2014) have shown that when AR simulates products such as furniture in a surrounding space, it creates a strong experiential value, especially when integrated in the consumer journey.

Uses of AR in marketing have diversified in several directions (Javornik, 2014). Companies such as Aurasma or LogoGrab have developed applications that augment products with 3D pop-ups and other visual content that appear when using AR tracking on a smartphone. Other examples of AR in commercial settings include enriching surroundings with interactive displays or mirrors in a store. An example is an interactive wall display in a shop which shows snowflakes and gifts appearing as the shopper walks past it. However, very few user studies have been conducted to examine the efficacy and impact of AR technologies in this context (Olsson et al., 2013).

Another kind of AR app that has appeared for commercial purpose is the virtual try-on. Early types of virtual try-on technology comprised either a) avatar-based simulations where products are not tried on in real time on the users themselves but rather on a virtual proxy that resembles the user's features and that the user can then manipulate (Huang & Liao, 2015; Kim & Forsythe, 2008) or b) photo-based try-ons where products are tried on a user's photo, which provides a static 2D experience (Cho & Schwarz, 2012; Liu et al., 2013). The effect that both create is to show someone how they would appear with the product (make-up, glasses, apparel) on by placing the particular item on the uploaded user photo or on a customized avatar. Studies of such virtual try-ons using virtual jewelry, make-up and clothes found that both hedonic and utilitarian aspects play an important role in the user experience (Cho & Schwarz, 2012; Merle et al., 2012). However, in some cases the entertainment value can be a stronger cause for adoption of product virtualization technologies than usefulness, i.e. the more functional value (Kim & Forsythe, 2008). Personal characteristics of users, such as their openness towards novelty (typical for early adopters) (Huang & Liao, 2015) and body image (Merle et al., 2012), are important determinants of such try-ons' perceived value. The users that are more curious about innovative technology (typically early adopters) would, for instance, pay more attention towards functional features and the application's quality, while those with lower level of so-called cognitive innovativeness would be more likely to use it again if it was easy to use and playful (Huang & Liao, 2015). While one study has examined how users react to make-up being placed on a photo of them (McCarthy et al., 2006), there hasn't been any evaluation so far investigating how people react to using the Magic Mirror with its accurate real-time tracking, which differs from previous virtual try-on forms.

Here, we are interested in how people take to the Magic Mirror kind of AR, and more particularly, what they make of such an illusion. The goal of our research is to understand how it impacts the shopping experience, especially their initial perception, their willingness to experiment with products and the effect the experience of trying on different virtual make-up brands has on them. Building on previous work, we aim to investigate to which extent the levels of playfulness and convenience act as drivers for behavior when shoppers view the augmentation features to be credible. Most of the previous research related to virtual try-ons has been conducted in controlled settings. Here, we investigate the use of the application in the wild in order to offer insights from a real-life context.

4.3 Research aims and objectives

The aim of our research is to understand better the interplay between the new type of Magic Mirror AR technology in the retail context and reactions of shoppers towards it. In particular, we were concerned with addressing how such an experience fits into the consumer journey and shopping process. We were also interested in discovering whether there were any unexpected effects or modalities of use. For this purpose, we investigated the types of responses that a tablet with the Magic Mirror AR elicited when situated at a make-up stand in a store and examined the forms of interaction that emerge between shoppers, shop assistants and this type of AR technology.

4.4 The Magic Mirror Make-Up App

The Magic Mirror app, developed for a well-known cosmetics brand by a company specializing in AR technology, allows users to try on virtual make-up. It enables the user to try make-up from the following product categories: lipstick and glosses, foundation, eye shadow and blush. In addition to this, the app has a feature allowing pre-defined combinations to be tried where multiple products are assembled into complete looks. All of the products available in the make-up app are real products offered for testing or purchase in the brand's store.

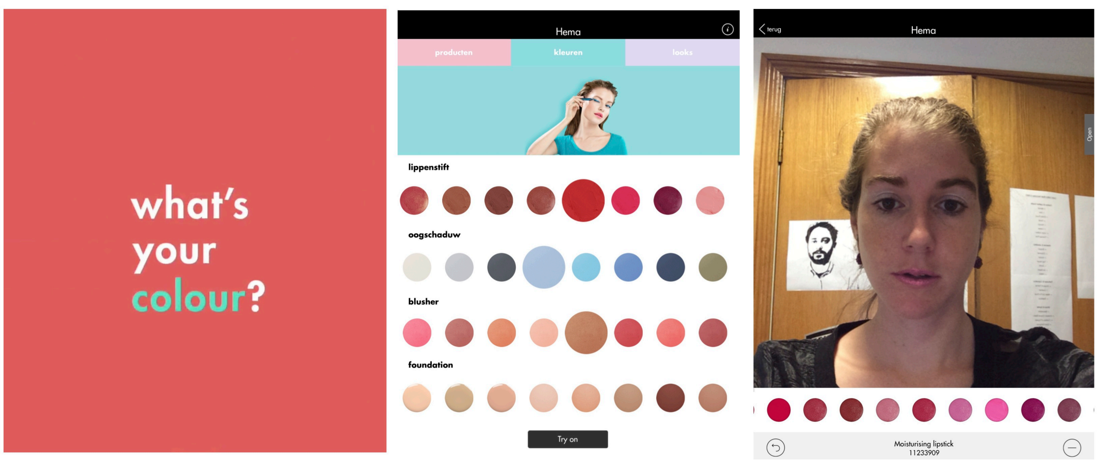


Figure 2: Screen shots of the app's content: screen saver (left), menu for choosing colors (middle) and virtual try-on mode (right)

To attract the attention of shoppers, a screensaver displayed the make-up brand logo and the question *'What's your colour?"* The rationale was that it would draw passers-by to the app, encourage them to start using it and try out the different colors of make-up. When the screen is touched, the main menu appears and the user can choose either the color menu or the product menu (Figure 2). Upon choosing a color or product, the virtual try-on mode is displayed, where the shopper can see his own face in the camera mirror with the addition of the selected make-up. When in the try-on mode, the shopper can change the colors of the product by flipping through circles with specific color tones on the bottom of the screen. When a color is tapped on, it appears on the person's mirrored face. The application is intended for individual use and cannot simultaneously track more than one face.

4.5 Setting

The Magic Mirror technology was placed in a large store located in a shopping mall in the center of a large European city. The store has been set up to provide a futuristic style of retailing where different areas present innovative products or interactive technologies intended to offer new kinds of consumer retail experience. Such a setting represents an opportunity to learn about innovation in retail, while at the same time enabling shoppers to browse and buy a variety of goods from the store.

In the store, the brand's retail area displays various product lines together with testers as in a typical beauty or cosmetics department. The Magic Mirror application was installed on two tablets that were placed at eye level in the make-up counter so as to be integrated with the process of product browsing.

4.6 Methodology

A user study was carried out alongside a larger evaluation of the make-up app that the cosmetics brand, the AR company and the store were conducting. We were invited to study the shopping experience by visiting the store after the make-up app had been set up. Hence our involvement was one of an independent research group that was to investigate the app being used in-situ. As such, we were free to come up with our own methodology but not able to shape the way the app was configured in the store.

We used a mixed methods approach where both quantitative and qualitative data were collected: initially we directly observed consumer behavior with the app *in-situ* for a week and afterwards collected visitors' comments about their experience. We also collected data about the interactions with the system. Moreover, during a period of three months, shoppers that had used the application were invited by the shop assistants to participate in a survey.

4.6.1 In-the-wild study

The observational study was conducted throughout the week during the nine-hour opening time. One of the researchers was present in the store where the make-up apps were running on two tablets. She observed approximately 120 people interacting with them. Each day there were between 30 to 40 people visiting the whole store, but not all of them came to the cosmetics counter or interacted with the app.

The researcher observed the visitors and made notes when they interacted with the application on their own or with others. Particular attention was paid to: a) how visitors approached and interacted with the make-up app, b) the most frequently used app features, c) visitors' comments and their bodily responses when trying out the app and d) the follow-up behavior.

4.6.2 Survey

Data was collected from 105 shoppers, first by the researcher during the observational study and then by the shop assistants for the remaining 3 months of the trial (who, after the researcher left, then themselves started inviting people to take part in the survey after using the app). 3 responses were eliminated as invalid, so the final sample consisted of 102 responses. In agreement with the store, the survey appeared through a link on the display after a shopper had used the app.

	Statements in the survey measuring different levels of consumer experience
Perceived augmentation Adopted from Javornik (2015)	a) The application added virtual make up to my face; b) The way the make up was placed on my face seemed real; c) The make up seemed to be part of my face; d) The make-up moved together with my face when I turned my head; e) The make up seemed to exist in real time.
Playfulness Adopted from Moon and Kim (2001)	Using the application a) was enjoyable for me; b) was fun for me; c) made me happy; d) made me curious; e) made me more creative; d) led me to exploration.
Convenience Adopted from Forsythe et al. (2006)	The application enabled me to a) virtually try on more products than I usually do; b) feel less pressure to buy the products I tried than if I had tried the real ones; c) search for product information on the application while trying the products.
Behavioral intentions Adopted from van Noort et al. (2012)	I have the intention to a) return to this application in the future; b) talk to my friends and colleagues about it; c) buy one or more of the products I've tried.

Table 1: List of statements included in the survey

To provide an incentive for completing the survey, users were offered a 15% discount for subsequent purchases. It took between 1-3 minutes for a participant to answer the questions. The survey asked questions about how the shoppers perceived the AR application when they tried it, the nature of their shopping journey and their future behavior intentions related to the application.

A 7-point Likert scaled was used for each statement, with 7 representing complete agreement with the statement and 1 complete disagreement. The sets of statements addressed: a) *consumer perception of AR features,* i.e. augmentation; b) *playfulness*; c) *convenience* and d) *behavioral intentions* (see Table 1). The initial objective of the survey was to obtain opinions from Magic Mirror users over a longer period of time than would have been possible to observe the behavior in the store. Secondly, we also aimed to analyze to which extent the perception of such augmentation coincides with the playfulness of the experience and, furthermore, if that leads to behavioral intentions. For this purpose we ran descriptive analysis as well as regression analysis, with the latter allowing us to evaluate the prediction power of different dimensions related to this shopping experience.

4.7 Findings

An initial concern was whether shoppers entering the store would notice the Magic Mirror app embedded in the make-up counter alongside the other make-up products. It seemed many people did not notice it at first or were not drawn by the brand logo and strapline "What's your colour?" appearing on the tablets. We also observed that those shoppers who did stop and look at the display did not subsequently interact with it. As the stand-alone approach did not work, the shop assistants tried to entice passers-by to try out the app by telling them about what the virtual make-up app did and how easy it was to try. When someone began to use it, other passers-by then looked on with interest. But often they, too, needed to be encouraged by the shop assistant to try it. The few times when visitors used the app spontaneously without the encouragement of the shop assistant was when they saw other people who were using it, laughing or expressing admiration, interest or satisfaction. This occurred just a few times a day. The majority of the passers-by who the shop assistants approached, however, were willing and curious to test it. The passers-by either observed the interaction, waited for a turn to try it out on their own or simply walked over to the other tablet and tried that one.

As expected, the majority of people who interacted with the app were female. More surprisingly, 33% of the men who were accompanying their partner or friends also tried it as well as five children, aged between 5 and 15, who were with their parents. Most of the visitors spent between 1 and 5 minutes using it with only around 10% of the visitors spending more than 5 minutes and less than 5% under a minute. On average, women used the application longer than the men did.

The level of interest from the shoppers who tried the application was very high especially once they realized what features the application offered. One third of the visitors said they experimented with trying on different kinds of colours that they would not have otherwise and some actually went on to buy the product. It appeared that they found the app a convincing tool for trying make-up, seeing if it suited them and searching for the products they liked.

4.8 Interactions with the Magic Mirror

Data from using the app features during the three months period were analysed in terms of duration using the app per visitor and different looks/products tried on. When in the virtual try-on mode (where the virtual colors of the different make-ups could be changed at the bottom of the image), a user spent on average 2 minutes without switching to another page. The average number of tried-on products and looks per visitor was 18. According to the shoppers, that represents a much larger number of trials in comparison to the trials of real make-up testers. This data indicate that users spent considerable time looking at themselves with the virtual make-up and experimenting with different looks. Next, we examine in more detail the way they approached and used the Magic Mirror make-up app in terms of the shopper experience.

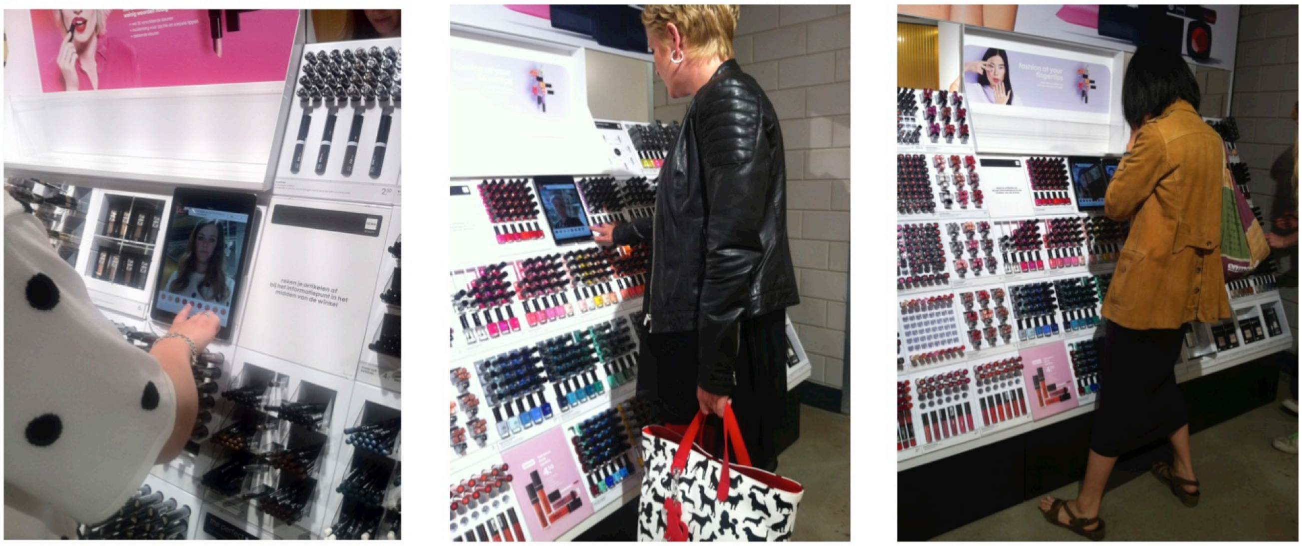


Figure 3: Female visitors trying on virtual make-up using the Magic Mirror application in the store

4.9 Shopper experience

Approximately 90% of the visitors were not sure what to expect or what to do with the make-up app, so the shop assistant told them to step closer, to touch the screen and then select the product category or a color. They also showed them how to use the app, which types of make-up it had and how to try on the different kinds. Many asked questions about the technology and about the features on the application. In general the visitors had no problems using the interface.

Initial surprise When the augmented make-up first appeared on a person's face, the majority (around 80%) showed surprise through their facial expressions, which turned into delight when seeing, for example, a virtual lipstick appearing on their lips or eye shadow on their eyelids – exactly where it should be placed. More than 50% gasped

or started laughing or smiling at themselves or their partners/friends/children. More than 70% exclaimed how amazing or cool it was and how much fun it was to use. Only one person said that she did not enjoy the experience. She also had negative remarks about all other technologies or products of the store. 10 people commented that they had seen similar technology beforehand, but most added that this form of augmentation appeared to be far more accurate and realistic than what they had tried before.

Convincing and realistic In most cases, it was found that the 2D tracking worked well: the virtual make-up appeared on the reflected face instantly, without delays, and persistently followed the person's movements. Around 75% of the shoppers who tried it mentioned that it was convincing. It did look like the make-up was actually on their face as it was being mirrored back to them, and not superimposed on their reflection. For example, some were impressed how the shape of the lipstick adapted when they pouted their lips. However, for some who had thin lips, the alignment was not quite right. Nevertheless, the extent to which this 'off-tracking' affected their interaction added to the experience rather than detracting from it. Occasionally, if someone moved their head too quickly, the tracking of the eyes or lips did not keep up, resulting in the eye shadow or lipstick appearing slightly off or left where it had previously been on the display. None of the shoppers perceived this misalignment to be annoying or disruptive, but rather had fun with observing what the application would do. 10% of visitors even tried to "trick" it by making sudden movements or grimaces with their face and then seemed pleased that they had fooled the application.

Between 75%-80% of shoppers were making facial expressions similar to the ones they did when wearing real make-up: pressing lips together, forming them in a shape of a kiss or lifting eyelids to see the color better. The way the make-up stuck to their eyelids and lips and moved with them as they made these changes to their facial features was what was considered most striking.

More than half of the women asked the shop assistant how similar or how different the virtual color was compared to the color of the real product. They wanted to know what the level of accuracy was compared to how the real lipstick would look on their lips. The shop assistant explained that the virtual colors were a very close proxy to how a color would appear on their lips or skin but that there was always a possibility of slight variation according to their skin tone.

Enjoyment The extent to which users enjoyed trying on the make-up seemed to play a role in their continued use of the app. More than 70% expressed their satisfaction with superlative comments, such as "*This is so cool!*", *"Wow, amazing",* "*Such a fun application*" and "*I really like it.*" One third said that they tried out colors that they would not have previously thought suited them, thus encouraging them to expand beyond their usual set of choices. When the researcher asked the women if they usually put the testers on their faces, almost all of them said they would not normally do that, mainly due to hygienic reasons. Lipstick or eye shadows would thus normally be tried on the skin of a hand, but not on the face, while the virtual try-on allowed them to see and experience a realistic representation of how a type of eye shadow would appear on their eyes or lipstick color on their lips really appear on their face.

Occasionally, two people wanted to look at the screen together. The tablet tracks only one face, however, and if two faces appear on the screen at the same time the tracking selects only one of them. This may appear confusing. However, groups or couples trying to use it at the same time mainly perceived it as humorous and responded with laughter when the make-up appeared on the person in the background instead of the one trying it on.

One shopper commented that she was disturbed by the large discrepancy between the images of the models that appeared on the posters on the walls and displays and how the make-up appeared on her own face.

Throughout the week, 33% of the shoppers asked whether the application was integrated with social media, as they wanted to share their photo with the virtual make-up with their social network. Because the option wasn't available, they took photos with their own phones in order to upload it to Facebook or Instagram.

Men and children Despite the make-up trial and purchase process being traditionally a female activity, the use of the app was not limited to women. The men who did try it on, however, had a quite different experience. Around 75% of them felt compelled to state at the beginning that they didn't use make-up or made a gesture that this is not for

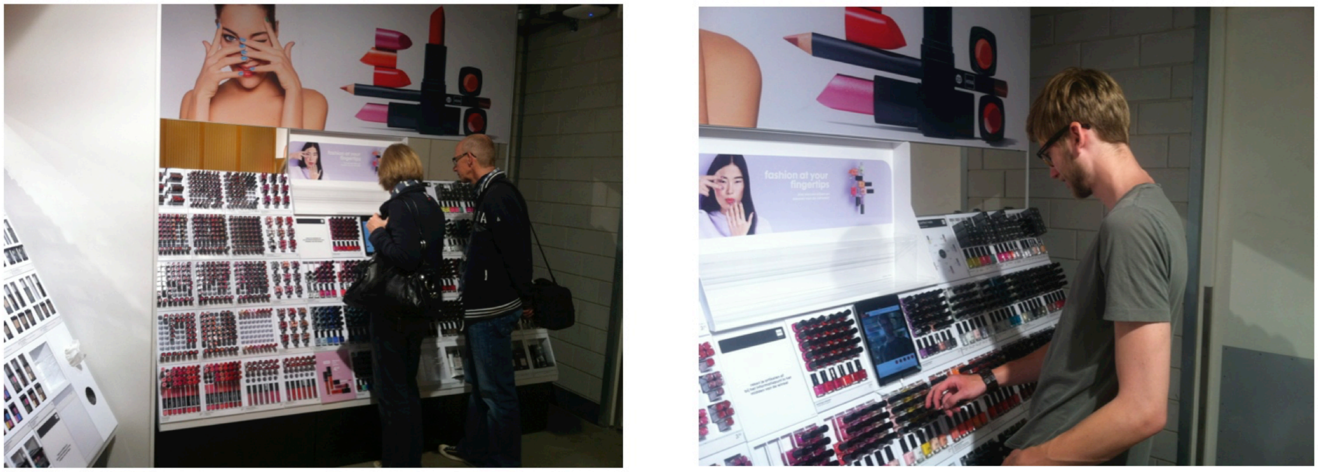


Figure 4: A couple using the application together (left) and a male visitor trying on virtual make-up (right)

them, but when the shop assistant remarked that many other men had already used it and that it was not real make-up, they became more open to the experience and more curious. In most cases they visibly enjoyed trying it on – the process being legitimized by their partners and the shop assistants. The more radical or dramatic the make-up looked on them, the more they laughed and the longer time they spent looking at themselves in the Magic Mirror app. They said that they would never try real make-up on but that the virtual one didn't seem so intimidating and didn't cause them to experience feelings of social embarrassment.

The few children who tried it on also showed a high level of curiosity and enjoyment. They laughed out loud and did not pay attention to anything else in the store – it appeared more like a playful app for them. They did not want to stop interacting with it until their parents (in most cases their mother) told them to stop as they were leaving.

While it was largely amusing for the men and children to use the app, it also provided a new set of circumstances for the women when they were shopping with their partners or children. Around 20% of the women commented that they felt less pressurized to finish browsing the make-up at the counter as it meant they were not keeping their family waiting. Hence, a side effect was to provide them with more time to browse the real make-up products.

Follow-up behavior During the observational study, 10 users of the make-up app then went on to buy the tried-on products. Three of them made a direct purchase of the products they had tried on without using a physical tester. Of the customers that made a purchase, 7 then subsequently tried out a color from the physical testers within that product category or color range. The presence of the shop assistant was important for follow-up behavior to occur. She was able to point out to customers where a particular product they had tried on using the app was physically located on the make-up counter.

4.10 Survey results

102 participants completed the online survey following interaction with the make-up app. 81 were female and 20 male (one person did not state their gender). 22 participants were between 18 and 24 years old, 16 between 25 and 34 years, 22 between 35 and 44 years and the remaining 42 participants were 45 or above.

Statements that were used in the scales were tested for reliability and validity in order to ensure that they could be used as appropriate measurement tools. We measured Cronbach's Alpha to see if it reached the required value of 0.7 and if the items correlated among themselves at a significance level $p<0.05$. As perceived augmentation represents a rather novel concept, we conducted factor analysis to see if all items loaded on one component and if other related measures are satisfactory.

The reliability measure for perceived augmentation was suitable (Cronbach's Alpha = 0.797) and all items correlated among themselves at the significance level $p<0.05$. Factor and principal component analysis showed that all items loaded on one component and the extraction sum of squared loadings on the first component explained 56.73% of variance. Bartlett's test of sphericity was significant at $p<0.01$ and KMO measure value was satisfactory at 0.788 which is above the required 0.7. These evaluations showed that the items of perceived augmentation measured the same concept and could be used as an appropriate tool for the purpose of this analysis.

Furthermore, the playfulness scale had a Cronbach's Alpha of adequate value 0.843 and all constituent items were correlated at $p<0.01$, confirming its reliability. When testing the convenience scale, it turned out that the Cronbach's Alpha was at an unsatisfactory level of 0.391. Removing the third item, which seemed to be the most problematic, resulted in factor analysis showing that the remaining two items loaded on only one component whose Eigenvalue was above 1 and the sum of squared loadings explained 61.72% of variance. Raw factor loadings were .657 and .707 for the two items, which is above the required 0.4 level. We thus took the two items as reliable indicators of convenience.

Based on this analysis, the survey items thus provided valid measurement tools to how the respondents rated the perceived augmentation, the playfulness, the convenience dimension and conclusion of the shopping experience. Overall, the results showed that shoppers thought the app realistically augmented their faces with virtual make-up in real time. They also evaluated the experience to be very playful and a large majority indicated intentions of future engagement, such as subsequent use and talking to others about the application.

The reported values of perceived augmentation were the following. The minimum reported value on a scale from 1 to 7 (7 indicating the complete agreement that the Magic Mirror augment the faces with make-up in real-time) was 4 (which reflected neutrality in terms of agreement) and the maximum value was 7. Value 7, indicating a complete agreement, was also the most frequently occurring value (mode), 5.7 (with SD =.975) was the average level of agreement and 5.8 was a median value. The histogram shows the high levels of agreement with the statements about perceived augmentation (See Figure 5).

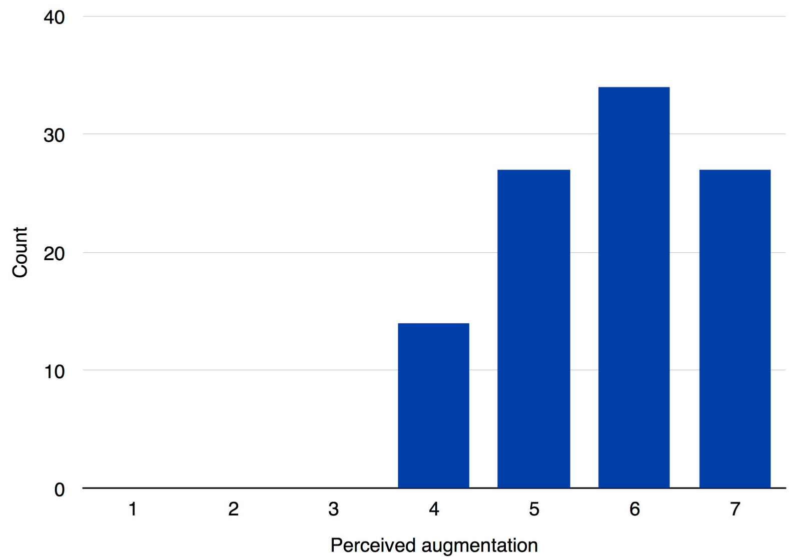


Figure 5: Histogram of frequencies showing how much the shoppers perceived the application to augment their faces (1 - do not agree at all, 7 - completely agree)

Furthermore, participants reported high values of playfulness (See Figure 6). The average level of agreement was 5.95 (SD=.868), while mode was 7 and median value was 6. A more detailed analysis of the playfulness showed that participants reported application to be fun (mean=6.30 (SD=.888), median=7, mode=7) and enjoyable (mean=6.10 (SD=1), median=6, mode=7) and that it made them curious (mean=6.31 (SD=.995), median=7, mode=7). They also agreed that the application led them to exploration (mean=5.68 (SD=1.33), median=6, mode=6) and to be more creative (mean=5.55 (SD=1.38), median=6, mode=7). The playfulness of the experience thus related both to the enjoyment as well as to the creativity and exploration.

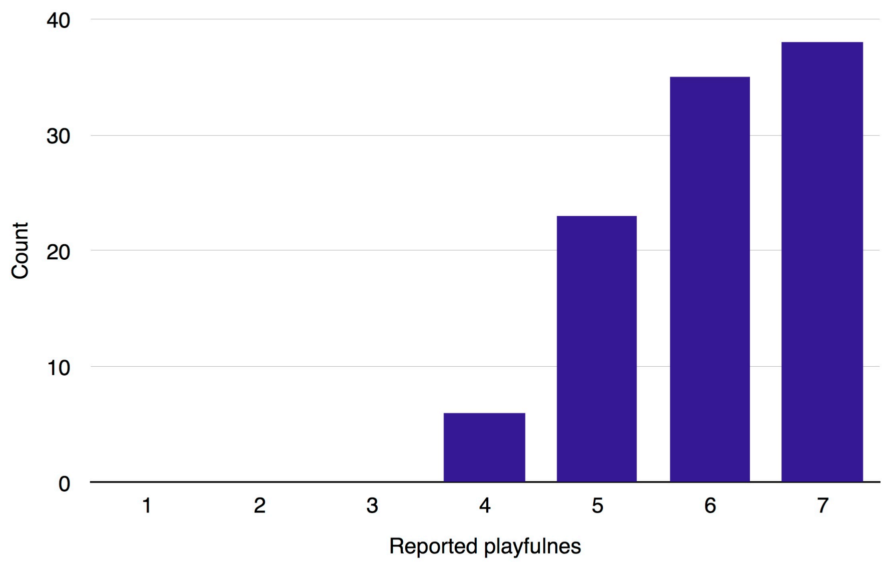


Figure 6: Histogram of frequencies showing how much the shoppers perceived the application to be playful (1 - do not agree at all, 7 - completely agree)

Reported values for convenience (See Figure 7) showed that respondents saw that the application allowed them to try on more colors than they would have otherwise been able to and that they felt less pressure to buy the products they had tried; the mean value of the agreement was 5.73 (SD = 1.13), mode was 7 and median value 6.

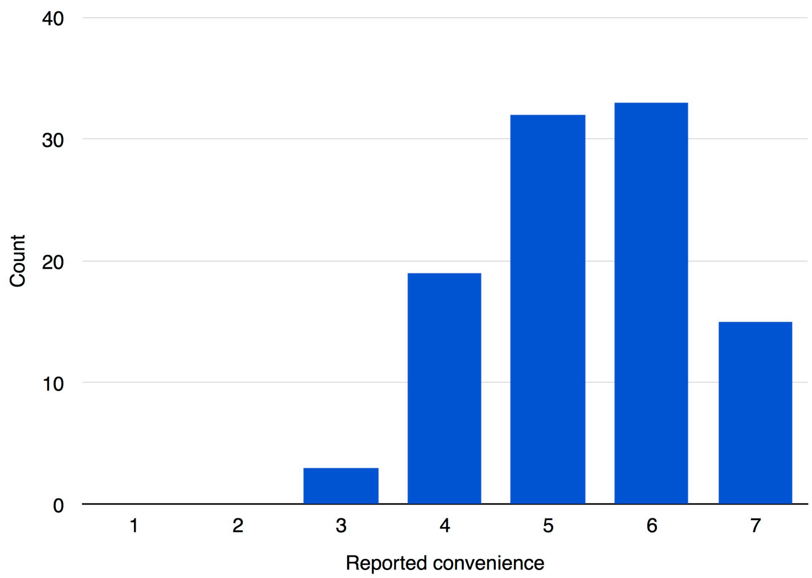


Figure 7: Histogram of frequencies showing how much the shoppers perceived the application to be convenient (1 - do not agree at all, 7 - completely agree)

The data collected about the shoppers' behavioral intentions were indicative of their intentions to use the application again (mean=5.82 (SD=1.22), median=6, mode=7), to spread word-of-mouth about it (mean=6.12 (SD=1.05), median=6, mode=7) and to purchase items that they had tried (mean=4.85 (SD=1.63), median=5, mode=4). Figure 8 shows that they had the strongest intentions when it came to spreading word-of-mouth (WOM) about the app and that they also reported high intention to use it again.

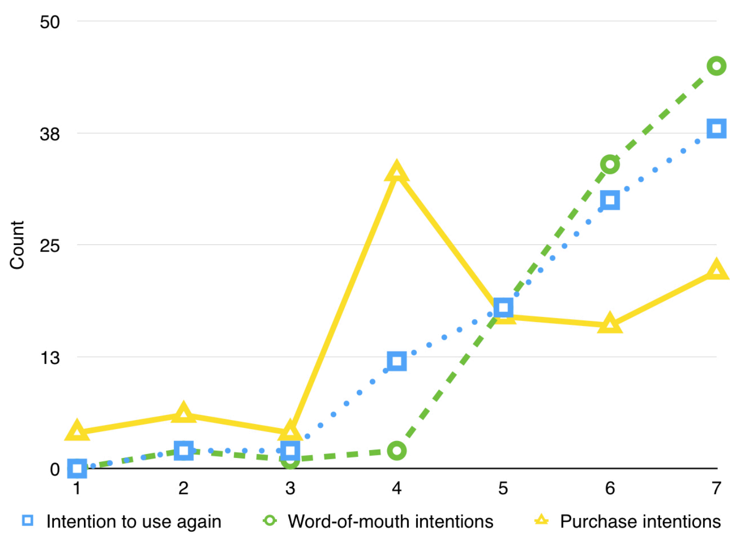


Figure 8: Histogram of frequencies for intentions to: reuse the application in the future; spread WOM (word-of-mouth) and purchase the tried-on make-up (1 - not at all, 7 - very much)

4.10.1 Regression analysis

We conducted a simple regression analysis to predict the following relations: the extent to which perceived augmentation predicts playfulness during application use and the convenience of it, as well as the correlations with behavioral intention. This type of analysis shows to which extent dimensions of experience are connected to each other and how much one dimension (e.g. playfulness) predicts another (e.g. behavioral intention to use the application again). The results are shown in Tables 2 and 3.

	F(1,100) (p value)	R square	Unstand. Coefficient (SE)
Perc. Augm =>			
Playfulness	41,596(p=.00)	.294	.482 (SE=.075)
Return intention	51,535(p=.00)	.340	.731 (SE=.102)
WOM intention	40,726(p=.00)	.289	.577 (SE=.090)
Playfulness=>			
Return intention	77,203(p=.00)	.436	.930 (SE=.106)
WOM intention	32,792(p=.00)	.247	.599 (SE=.105)

Table 2: Results of regression analysis with perceived augmentation and playfulness as predictors

From the first analysis (Table 2) we can observe that perceived augmentation acts a strong predictor of the playful experience that shoppers have with the application. Furthermore, both perceived augmentation and playfulness strongly correlate with visitors' intention to return to the application for further use and to talk about it to others.

With regard to the convenience and also purchase intentions, the values have lower predicting power, but are still significant. When respondents perceive the Magic Mirror to augment their faces, they also perceive the shopping experience to be more convenient, as the app allows them to try on more products than usual and they feel less pressured to purchase them. Both playfulness and perceived augmentation are relatively strong predictors of purchase intentions. Furthermore, convenience strongly correlates with intentions to return back for future use. It also associates significantly with intentions to tell others about the application or to purchase the tried items, however the associating power is weak, given the low values of both R square and coefficients.

	F(1,100) (p value)	R square	Unstand. coeff. (SE)
Perc. Augm => Convenience	10,143(p<.05)	.092	.352 (SE=.110)
Purch. intention	12,888(p<.01)	.114	.565 (SE=.158)
Playfulness=>			
Purch. intention	15,917(p=.00)	.137	.697 (SE=.175)
Convenience=>			
Return intention	26,426(p=.00)	.209	.495 (SE=.096)
WOM intention	4,851(p<.05)	.046	.199 (SE=.090)
Purch. intention	4,239(p<.05)	.041	.291 (SE=.141)

Table 3: Results of regression analysis for convenience, purchase and return intention

These results demonstrate that as the level of perceived augmentation increases, so too does the user's playfulness with the app and subsequently the likelihood that they will use it again, talk about it with others or purchase the tried-on products. The increased levels of perceived augmentation are associated also with perceived convenience, which further implies future behavior, but to a lesser extent in comparison to the playfulness.

4.11 Discussion

The observations, the tracked data and the survey data all indicate that the shopper experience with the Magic Mirror make-up app was engaging, often leading people to more experimentation with different colors for the make-up products. It also helped some with decision-making when choosing or purchasing products. However, because of the unexpectedness and novelty of the app, many passers-by did not notice it initially or appeared wary of trying it on in public. This suggests that simply placing a tablet with such an AR app in a store will not lead to people trying it by themselves. Moreover, when placed in a store (rather than being an app a user downloads on his own device) that implies it requires someone in authority (i.e. a shop assistant) to legitimize a person using it in the store. Having a shop assistant to explain the app can make the shoppers feel at ease with trying it out themselves. Also, seeing others using it can draw people closer and encourage them to take part. The role of the "honeypot effect" (Brignull & Rogers, 2003) is, therefore, even more critical for this kind of novel technology. Especially when in an already visually busy or cluttered space, seeing others engaging with a virtual mirror can encourage passers-by to have a go as well.

Once given the go-ahead, shoppers were happy to experiment and use it in the way intended. Even men and children – to whom the app is not targeted at – found it compelling. Hence, far from being perceived as a gimmick, our observations showed that the people who tried the app perceived it to be convincing and useful. This was confirmed in the survey by the high scores for perceived augmentation. Based on this data, it can be stated that the enhancement of the face through the Magic Mirror AR technology seems to create a strong perception amongst shoppers that the digital and physical elements are aligned and that the face is directly augmented with the virtual elements. The shoppers also said that the difference between seeing a real lipstick and a virtual one on their lips using the Magic Mirror app was small; it felt as if the virtual make-up applied to their face that was looking back at them was actually real. Some shoppers even tried rubbing their eyelids to smudge the virtual eye shadow.

Our analysis also showed that shoppers experienced high levels of playfulness, excitement and surprise when interacting with the app. In some ways it is akin to McCarthy et al.'s (2006) notion of enchantment, where the technology leads to a high level of absorption related to a state of concentration and attention.

For some of the shoppers, the app offered a different way of purchasing make-up. Firstly, such an app included playfulness in the activity of make-up purchase. Secondly, the virtual try-on allowed the potential customers to try on more products or colors because they could achieve this with a simple tap that takes considerably less time than trying on real products. The convenience allowed trying out colors that they would not otherwise have considered and thus permitted them to go beyond their usual set of choices. Thirdly, such an app has the potential to change the way make-up is bought as colors can be placed on the face more realistically, while usual make-up testing consists mainly of putting testers on the hand and not on the face.

Most of the users did not show or report any negative reactions and it would be interesting for future research to investigate the implications of disliking a virtual make-up on one's face. Would the perceived realism make them more averse to a brand than if they had tried the real make-up on their hand? Also, further research is needed to determine if people will use the app again once they are familiar with it and if new offers and novel product ranges can encourage such continuous use.

Moreover, in the current application, the make-up appears all at once on a user's face. While technically more demanding, it would be interesting to see the effect of make-up being applied gradually, as if someone really is putting it on their face, mimicking not only the end result, but the process as well. Such interactivity could then be used in a tutorial app for different types of looks. In terms of screen size, a tablet screen size actually offers an advantage, because fewer people appear in the camera view, thus making it less likely for the tracking to get confused and apply make-up to a person in a background. Also, switching between AR mode and an app with products menu appeared problematic for some people. An alternative would be to keep the AR mode on all the time and allow the shopper to do everything (product selection, colour changing) in the same mode.

This kind of Magic Mirror AR has much potential for other apps and settings, such as theatre, cinema, museums and art galleries, where dramatic, cinematic or historical looks could be experimented with. Further advances in using this kind of AR technology could provide a suite of tools for film and theatre artists, allowing them to try out looks without using expensive materials. Such a Magic Mirror could augment a visitor in an opera house, museum or other historic/cultural context, so they can appear with a wig, artistic make-up or clothes in the guise of a persona from the depicted period or context. With such tools, the experience could be expanded and lived more vividly. However, further research would need to be carried out to determine the extent to which people will suspend their disbelief in these other contexts.

In the context of health, enhancement with AR technology could show a predicted future image of the user, displaying potential changes that could occur due to healthy or unhealthy lifestyle choices. Similarly, virtual try-on could show potential outcomes of plastic or dental surgeries to patients. It could also be used in educational and training settings, providing make-up artists with a new tool to use when testing out their skills or perfecting new looks. It could introduce visitors to the art and design of make-up by giving them a chance to try to create the look of celebrities. There is much scope for introducing a new level of realism and engagement into virtual try-ons. With new advances in 3D motion capture, it may also be possible to model the whole body, opening up opportunities for adding other features, such as tails, ears and hair.

4.12 Conclusion

The findings from our in-situ study show much promise for future use of AR Magic Mirror apps that enable people to try on a virtual product. The technology is capable of creating an enchanting experience, whose multi-faceted character comprises usefulness, realism, playfulness and an element of surprise. However, in order for it to be successfully deployed, seamless integration of the app as part of the shopping journey is crucial. This requires the shop assistant to understand how to bring shoppers to the app and how to encourage them to use it. It also necessitates that the app be simple enough to use and the effect – while it need not be perfectly aligned - be convincing enough to evoke the fascination. While this study shows the positive reactions of shoppers to the app and builds on previous research about experience of virtual try-ons, future research can investigate how deployment and use of Magic Mirror changes outside a store or when shoppers become familiar with it as well as the value it can create in other domains.

5. “BEYOND THE WOW EFFECT OF AUGMENTED REALITY” – DEVELOPMENT OF PERCEIVED AUGMENTATION CONCEPT AND MEASURING ITS EFFECTS ON CONSUMER EXPERIENCE

Paper submitted:

Javornik, A., Marshall, P., Rogers Y. (2016): “Beyond the wow effect of augmented reality” – Development of perceived augmentation concept and measuring its effects on consumer experience. *Association for Consumer Research (ACR) Conference*, 2016, Berlin.

Abstract:

Augmented reality (AR) is a technology that is intended to virtually enhance the physical environment by augmenting aspects of it with digital overlays (Preece et al., 2015). This paper investigates how such augmentation can be firstly, perceived by users when they interact with AR and secondly, how such perception of this media characteristic can, following TIME theory (Sundar et al., 2015), be operationalized and conceptualized. Two exploratory studies, comprising expert groups and a focus group, were conducted to examine the perceived augmentation construct and its dimensions as part of a scale building process. A subsequent survey with 213 participants was conducted to validate the scale. The findings confirm the two dimensions of augmentation – virtual enhancement and virtual-physical congruency – and that the two differ in terms of their impacts on consumer affective, cognitive and behavioral responses.

Keywords: Perceived augmentation; Consumer experience; Scale validation; Augmented reality

"The most profound technologies are those that disappear.
They weave themselves into the fabric of everyday life
until they are indistinguishable from it."
(Mark Weiser)

5.1 Introduction

Commercial augmented reality (AR) apps display many characteristics of interactive technologies, including interactivity, different types of modality, virtual elements and mobility. However, they distinguish themselves from other interactive tools (such as social media, video calls, virtual worlds) in their ability to overlay the physical environment with virtual elements in real time. This characteristic is viewed as 'augmentation' (Billinghurst & Kato, 2002; Preece et al., 2015). Up until now, however, it has been given little attention in consumer research, especially in terms of how it impacts consumer behavior. More knowledge about how such augmentation works and the way consumers perceive it would offer insights into the unique perception of AR and its impact on main categories of consumer responses, such as affect, cognition and behavior. Studying different types of consumer responses would, furthermore, permit understanding of whether features of AR apps can enhance a consumer experience and, if so, what type of consumer experience do they relate to? Such findings would contribute to the body of literature on interactive technologies in marketing (Dennis et al., 2010; Varadarajan et al., 2010; Yadav & Pavlou, 2014) and consumer experience (Brakus et al., 2009; Dennis et al., 2014, Verhoef et al., 2009), but also to understanding the experience with AR in other, non-commercial contexts. While this study focuses predominantly on consumers, we sometimes refer to consumers as "users" when discussing processes related to use of technology. The main reason for this is that, firstly, we also rely on communication theory and HCI theory where "user" is an established nomenclature when referring to an individual using technology. Secondly, certain aspects of experience with AR as described in this research reach beyond the commercial context and can be potentially valid in, and applicable to, other contexts.

The theoretical framework for this study is underpinned by the Theory of Interactive Media Effects (TIME), in which Sundar et al. (2015) emphasize that when a user interacts with a technology, there is a distinction between the objective media characteristic and the user's perception of it (i.e. the corresponding psychological correlate). Such perception then impacts further engagement and consumer responses (Sundar et al., 2015), therefore making it an important area of investigating in marketing. In line with TIME, this work distinguishes between the AR's most prominent feature – visual alteration of physical reality, i.e. augmentation, and user's perception of it.

The focal questions that guided this study are: How can the complexity of perceived augmentation be understood and conceptualized? What is an appropriate corresponding measurement scale? And how does perceived augmentation impact consumer experience? The objective of the paper is thus to provide a definition and operationalization of perceived augmentation and examine the corresponding consumer experience.

An initial study of a conceptualization of perceived augmentation with a first set of measurement items has already been proposed (Javornik, 2016). However, the technology has been progressing steadily and more distinctive forms of AR apps are rapidly emerging, which is one of the reasons why we believe the concept needs further investigation. The work presented here builds on that initial conceptualization by developing the concept and the corresponding scale further, by proposing that perceived augmentation consists of different dimensions and by further examining its relations with consumer responses.

The structure of the paper is as follows. We begin by discussing how AR technology enhances the physical environment. The conceptual framework combines perceived augmentation and consumer responses in terms of specific types of affect, cognition and behavior, based on which the corresponding hypotheses are derived. To empirically test the propositions about multidimensionality of perceived augmentation, a quantitative scale is built, following the standard procedure of scale development. Exploratory qualitative studies were conducted with the purpose of item development, followed by item purification and refinement by applying exploratory factor analysis and confirmatory factor analysis, testing convergent and discriminant validity. Finally, the relations between perceived augmentation and consumer affective, cognitive and behavioral responses were tested with structural equation modelling. The results confirm that perceived augmentation is a multidimensional concept, composed of two dimensions that impact the experience that current commercial AR apps can offer.

5.2 Conceptual framework

5.2.1 Perceived Augmentation

Recently, studies have started to investigate the role of AR in marketing (Liao, 2014; Scholz & Smith, 2015), as it is gaining increasing exposure in different sectors such as beauty, fashion, retail, luxury branding and others. However, the features that differentiate AR from other forms of interactive technologies have been examined to a lesser extent in terms of how they are perceived by users, which represents an important gap in this body of literature. Numerous previous studies in communication and marketing have shown the impact of technological features and corresponding perceptions on consumer responses (Song & Zinkhan, 2008; van Noort et al. 2012; Sundar et al., 2015), but no research has really examined this in-depth in the area of AR.

AR is defined as an interactive technology that overlays the physical environment with visual elements in real-time (Azuma et al., 2001) and can appear in various formats or be supported by different types of devices (Carmigniani et al., 2011). Studies that examine consumers' perception of AR-related phenomena have started to emerge. Huang and Liao (2014) studied perceived presence when using an early version of an AR virtual mirror and showed that such presence impacts various aspects of experiential value related to the technology. A short study by Jung et al. (2015) showed that 3D mapping creates a higher spatial presence in comparison to a 2D projection. Furthermore, narrative and storytelling elements of AR applications have been proven to have stronger impact on affective responses, such as playfulness, or on behavioral intentions in comparison to the impacts of presence and media richness (Huang & Hsu Liu, 2015).

Such studies represent relevant steps towards understanding AR technology better and examine the important phenomena of how immersed a user feels in a computer-mediated environment. Immersion has been especially crucial when studying absorption of users in computer-mediated environments that are detached from the physical environment, such as virtual games (Jennett et al., 2008). Virtual reality is at the same time all-encompassing (Blascovich & Bailenson, 2011), thus creating a strong sense of presence, and also transporting a user away from physical reality (Milgram & Kishino, 1992). However, AR represents a different kind of technology in that sense – it is consumed as a part of physical reality, representing the content within the physical world (Milgram & Kishino, 1992). While the concept of presence is still relevant to investigate, it can not offer a complete insight of how the visual overlay changes consumer perception of physical reality and the integration of physical with virtual. Another concept is thus required to provide a better understanding.

We rely on communication theory when proposing the conceptualization of *perceived augmentation*. TIME theory (Sundar et al., 2015), derived from the MAIN model (Sundar, 2009), emphasizes the perception of media characteristics as one of the key variables that permit insight into how technology impacts different types of consumer responses. In order to understand that perception, Sundar et al. (2015) emphasize that it is crucial to distinguish between an objective feature of a technology and a related consumer perception and, consequently, the importance of including both of them when studying consumer experience with a technology. Such an approach allows avoiding the difficulties that appeared in the research on interactivity where literature streams discussed differences between technology's objective features and user perception of those (Sundar, 2004; Song & Zinkhan, 2008; Voorveld et al., 2011).

AR visually augments physical surroundings by overlaying it with virtual elements (Billinghurst & Kato, 2002; Preece et al., 2015). We propose that there exist two levels or dimensions of augmentation. The first level is the appearance of virtual elements over the physical environment, so the physical environment or one part of it is visually modified with virtual elements, which creates a *virtual enhancement*. Such types of AR apps, for example, show the camera view on a smart device with added visual features on the physical background (Carmigniani et al., 2011).

The second level is *physical-virtual congruency*, where the AR app aligns the virtual occurrences on the screen with physical surroundings. The virtual elements appear to exist in the environment and react to its changes as a real object would. For example, a virtual chair would appear to stand on the floor or virtual directions would be placed on exact spots in the camera view, suggesting where on a street a person should take a turn.

Perceived augmentation is thus hereby defined as a psychological correlate of AR ability to virtually alter consumer experience of physical environment. It refers to how users perceive the AR application to modify the physical environment with virtual annotations in terms of virtual enhancement and physical-virtual congruency. Virtual enhancement represents an overlay of virtual annotations over our view of reality. Physical-virtual congruency signifies the simulated fitting of virtual annotations in the physical reality, seemingly making virtual elements part of it.

5.2.2 Consumer experience

We examine the construct of perceived augmentation in the context of the consumer experience, which represents an overarching understanding of consumer responses to an encounter, or series of encounters, with a brand or brand-related activity (Brakus et al., 2009; Verhoef et al., 2009). Consumer experience has gained strong exposure as one of the fundamental concepts in the field of consumer behavior (Holbrook & Hirschman, 1982; Novak et al., 2003; Brakus et al. 2009; Zarantonello & Schmitt, 2010; Mollen & Wilson, 2010). Somewhat related is also the notion of user experience in the field of human-computer interaction, but with focus on the interactions with technology (McCarthy & Wright, 2004; Hassenzahl & Tracktinsky, 2006; Preece et al. 2015).

Numerous definitions of the concept have been proffered in the marketing field since Holbrook and Hirschman (1982) emphasized the importance of investigating the experiential side of consumer activities as a complement – or in some cases an antipode – to the research on information processing. Meyer and Schwager (2007) defined the experience as consumer subjective response to interactions with a company. Many definitions followed such an all-encompassing approach (Brakus et al., 2009; Zarantonello & Schmitt, 2010; Gentile et al., 2007; Rose et al., 2012; Verhoef et al., 2009). Gentile, Spiller & Noci (2007) and Rose et al. (2012) conceptualized it as a holistic psychological construct comprised of different components, such as sensorial, emotional, cognitive, pragmatic, lifestyle and relational. Experiences have been observed in the context of shopping, product, search, consuming and interacting with brand (Holbrook & Hirschmann, 1982; Brakus et al., 2009) and findings show that the experiential part of consumption activities carries a strong significance for consumers (Schmitt, 1999).

Consumer experience with technology has been subject to extensive research (Constantinides, 2004; Mathwick & Rigdon, 2004; Daugherty et al., 2008; Novak et al., 2000; Mollen & Wilson, 2010; Dennis et al., 2043). Telepresence and vividness are considered to be some of the core dimensions of consumer experience with the computer-mediated environment (Daugherty et al., 2008; Novak et al., 2010; Mollen & Wilson, 2010). Dennis et al. (2014) examine affective and intellectual experiential episodes with digital signage and show that evoked affective experience with higher hedonic component – in comparison to more intellectual, cognitive experience based on more utilitarian component - has a stronger impact on approach behavior, such as future behavioral intentions.

Verhoef et al. (2009) present one of the more complete models of consumer experience as they reach beyond the singular encounter with a brand or product. One part of their definition is aligned with the established conceptualization (Brakus et al., 2009) of experience as a composition of affective, cognitive, sensory and behavioral dimensions. They state: "*..the customer experience construct is holistic in nature and involves the customer's cognitive, affective, emotional, social and physical responses to the retailer.*" (Verhoef et al., 2009, p.32). They also emphasize other factors that impact the experience: social environment, service interface, retail atmosphere, assortment, price, other channels and brand (Verhoef et al. 2009).

This work adopts this part of definition by Verhoef et al. (2009) and also focuses on the technology, i.e. part of the service interface, and its impact on consumer experience with regards to affective, cognitive and behavioral responses.

However, Verhoef et al. (2009) also emphasize the dynamic part of the experience – one episode feeding into the next. "*Additionally, (...) the customer experience encompasses the total experience, including the search, purchase, consumption, and after-sale phases of the experience, and may involve multiple retail channels*." (Verhoef et al., 2009, p.32). The understanding of the experience as a journey of different occurrences influencing each other also represents a very relevant approach and has been receiving increasing attention, as for example by Mandelli and La Rocca (2014) in their study on the role of digital technology in augmented consumer journeys. In our study, though, we focused mainly on the first part of the definition by Verhoef et al. (2009), i.e. on separate consumer responses in order to examine some fundamentals of the consumer experience underlying structure.

5.2.3 Enjoyment as an affective responses

Numerous research studies have established the relevance of affective responses, such as attitude or emotions, with regard to their effect on consumer behavior (Ajzen, 1991; Madden et al., 1992; Bagozzi et al., 1999). Also in the context of interactive technologies, affective responses have been shown to play a highly relevant role for consumers and their experience with technology (van Noort et al., 2012; Voorveld et al., 2011). Voorveld et al. (2011) for instance showed that affect represents a frequently-occurring type of response towards websites when linked to websites' interactivity. In a model of e-consumer behavior, Dennis et al. (2009) state that the web atmospherics impact the emotional state and, indirectly, the attitude, which then in combination with situational and social factors further influence purchase intentions and actual behavior. Moon and Kim (2001) have extended the technology acceptance model by validating playfulness as one of the main determinants when interacting with technology and thus include an affective component in a model that had, prior to that, been based on cognitive factors (i.e. ease-of-use and usefulness).

Other studies have shown that features like interactivity lead to a more positive attitude towards a website (Chang & Wang, 2008; van Noort et al. 2012; Sundar et al., 2014) or advertisement (Gao et al., 2009). The positive evaluation i.e. the attitude, can then lead to an enjoyable experience (Cyr et al., 2009). In general, technologies with richer media content and more advanced visual features, such as 3-D product rotation, have been shown to elicit positive affective responses (Park et al., 2008; Jin, 2009; Hsieh et al., 2012), even though some studies have also demonstrated the opposite effect (Goel & Prokopec, 2009). Virtual reality (VR) has been found to have positive effects on enjoyment (Lee & Chung, 2008; Nah et al. 2011), more so than media without VR elements (Daugherty et al., 2008).

Attitudes represent a more evaluative affective response, while enjoyment embodies the hedonic facet of the experience (Childers et al., 2001) in the sense of how delightful and fun it was for a consumer. Given that interactive technologies with rich media content have been found to elicit enjoyment, we proposed that this effect will also appear in consumer experience with AR, more specifically evoked by the effects of perceived virtual enhancement and virtual-physical congruency.

Hypothesis 1a: Perceived virtual enhancement leads to enjoyment.

Hypothesis 1b: Perceived virtual-physical congruency leads to enjoyment.

5.2.4 Informedness as a cognitive response

Cognitive responses have a longer tradition in marketing research in comparison to emotions (Holbrook & Hirschman, 1982), being widely investigated in research on information processing and behavioral decision-making (MacInnis & Jaworski, 1989). They encompass a wide range of categories, such as awareness, memory, knowledge structure, beliefs and thoughts. One type of cognitive responses is informedness, also referred to as informativeness, and it is becoming increasingly relevant for online consumer behavior (Tsang et al., 2004; Pavlou et al., 2007; Clemons, 2008). While some refer to informativeness as a more objective measure of the degree of information that consumers have about products' availability, price range and attributes (Clemons, 2008), a more prevalent definition has been related to the sense of being informed (Goel & Prokopec, 2008; Li et al., 2002; Pavlou et al., 2007). It is thus defined as a perceptual construct, relating to how consumers perceive the information to be available, useful and credible (Pavlou et al., 2007) and is measured by consumer perception of being informed and having access to information (Li et al., 2002; Tsang et al., 2004; Park et al., 2008).

In general consumers perceive interactive technologies to allow them to be better informed about products or brands: for example, richer media seem to create better informedness because they give access to more information or they offer a better visualization of a product (Li et al., 2002; Park et al. 2008; Daugherty et al. 2008; Li & Meshkova, 2013). However, some research presents contrary evidence - Goel and Prokopec (2009) found that websites provided higher informedness to consumers than virtual worlds, which was possibly due to the fact that the websites in that study had larger amounts of textual information and the virtual world at the time of the study was still at a more early stage.

The construct of informedeness has not yet been explored in AR. Because virtual enhancement does not situate the virtual elements with reference to the physical environment and only overlays them, that can have a negative impact on the sense of informedness, as it does not offer a direct indication to the physical surrounding. However, we assume the ability of AR to situate virtual annotations as part of physical environment in real-time (i.e. virtual-physical congruency) would result in higher informedness.

Hypothesis 2a: Perceived virtual enhancement does not lead to higher informedness.

Hypothesis 2b: Perceived virtual-physical congruency leads to higher informedness.

5.2.5 Behavioral intentions

Numerous studies have demonstrated the effect of objective or perceived media characteristics on behavioral intentions related to future use or purchasing (Song & Zinkhan, 2008; Park et al. 2008; Jin, 2009). An example of such an impact is a demonstrated effect of higher perceived interactivity on purchase behavior (Song & Zinkhan, 2008) and future intention of website use (Chang & Wang, 2008; van Noort et al. 2012; Sundar et al., 2014). Both richer media and virtual environments with more sophisticated visual modality have been shown to lead to further behavioral and purchase intentions (Park et al., 2008; Kim & Lennon, 2008; Jin, 2009; Lin et al. 2012; Li & Meshkova, 2013; Daugherty et al., 2008). We hypothesize that will also translate to an effect of AR media characteristic and its perception on behavioral intentions.

Hypothesis 3: Perceived virtual enhancement leads to behavioral intentions related to future use of the app and purchases.

Hypothesis 4: Perceived virtual-physical congruency leads to behavioral intentions related to future use of the app and purchases.

Most often, however, the effects of interactive technologies' features on behavioral intentions are caused indirectly by cognitive and affective responses (Chang & Wang, 2008; Park et al., 2008; Li & Meshkova, 2013). We therefore propose that the cognitive (informedness) and affective (enjoyment) responses, as evoked in AR experience, also have the potential to elicit behavioral intentions of consumers.

Hypothesis 5: Enjoyment experienced during AR app usage leads behavioral intentions related to future use of the app and purchases.

Hypothesis 6: Informedness experienced during AR app usage leads to behavioral intentions related to future use of the app and purchases.

5.3 Aims and objectives

The aim of this study is, firstly, to test and validate perceived augmentation as a multidimensional construct with the following dimensions: virtual enhancement and virtual-physical congruency.

Secondly, the study tests the relationship of perceived augmentation with the construct of consumer experience. For this purpose, we investigated the effect of the two dimensions of augmentation on the consumer experience in terms of affective, cognitive and behavioral responses.

Thirdly, we intend to examine these aspects beyond the initial "wow" effect that is indicative of first encounters with AR or of first encounter with a new AR app not seen before. This should hopefully offer a better understanding of how consumer experiences AR through a more continuous use, thus when already familiar with the technology.

5.4 Methodology

While the conceptual part of the study allowed the proposition of perceived augmentation's multi-dimensionality and formulation of the hypotheses, the qualitative empirical part was dedicated to the re-examination of this multi-dimensionality and mainly, to the development of measurement items through literature review and exploratory studies. The quantitative empirical part aimed to validate the measurement items through the survey study. Before presenting each of these steps in detail, we will offer a short overview of the scale building process and model validation.

Based on previous studies (Javornik, 2015) and on a literature review, an initial set of measurement items was developed. In the first exploratory study, experts tried two AR apps and then discussed the perceived augmentation concept and the measurement items as those existed at that point. Secondly, a focus group was conducted where participants used and discussed features of three AR apps, which allowed re-evaluation of the multi-dimensionality and further development of the measurement items. To refine the items, the scale at the time was sent to four academic experts who revised them. Finally, a survey study with 213 participants was conducted to validate the scale and to test the hypotheses proposed in the conceptual framework.

The scale development process used is presented in the Figure 1. We followed the procedure based on the relevant literature on scale development and related methodology (Nunnally, 1975; Churchill, 1979; Hinkin, 1995) and also revised highly cited scale development studies in the area of digital marketing and consumer behavior (Forsythe et al., 2006; Kim & Moon, 2001; Hollebeek et al., 2014, Sprott et al., 2009) and in human-computer interaction (Jennett et al., 2008).

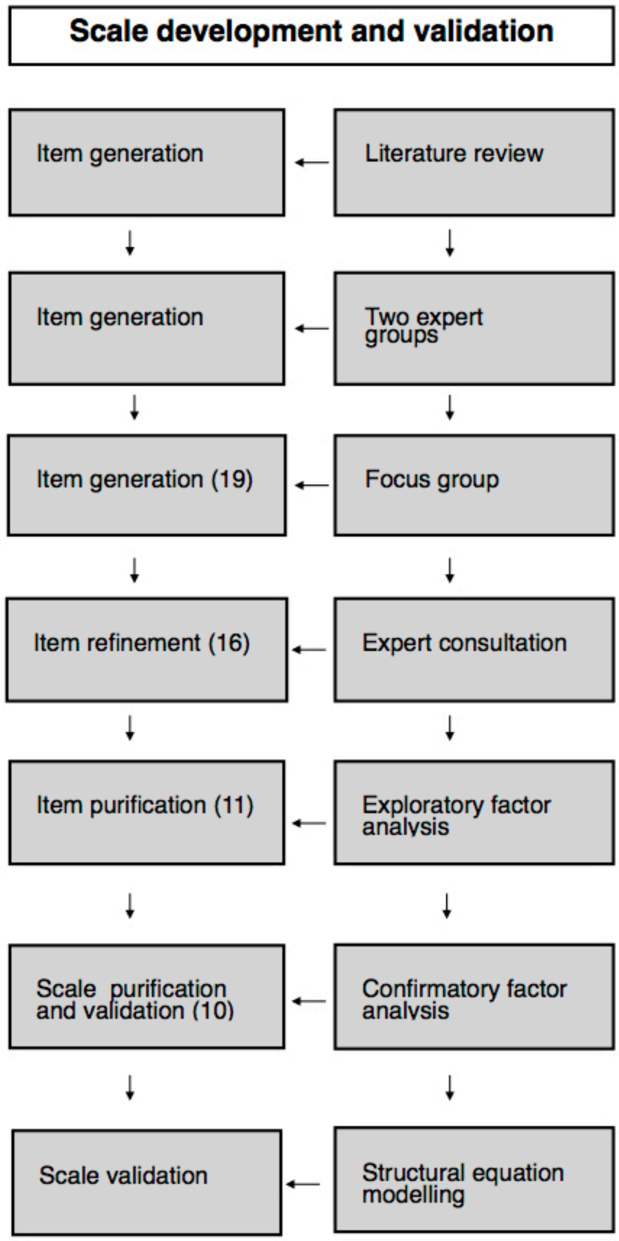


Figure 1: Process of scale building

Qualitative analysis was conducted for the data collected in exploratory studies (Braun & Clarke, 2006). Survey data was analyzed by first applying exploratory factor analysis, followed by confirmatory factor analysis with structural equation modeling. Through these studies, we were able to assess the following types of validity and reliability: internal reliability, convergent validity, discriminant validity, conceptual validity and nomological validity.

5.5 Item generation

5.5.1 Literature review

While literature on augmented reality relating to marketing is scarce, literature from human-computer interaction and computer science offers highly relevant insights into functioning of the technology and related consumer experience. We built on the conceptual framework presented above and on literature from these fields that allowed to gain an understanding of how the technology functions and in what ways it is applied. That allowed us to elaborate a set of items:

a) I felt the AR application enhanced my face;

b) I felt that the virtual objects did not add anything to my spatio-temporal context;

c) The spatio-temporal context I was in seemed richer because of using the application;

d) Virtual elements enriched the existing surrounding I was in beyond the screen;

e) Virtual and physical elements seemed aligned;

f) The screen seemed to interact directly with the physical environment;

g) Virtual elements reacted to the physical environment;

h) I had an impression that the virtual elements existed in real time;

i) The application did not make me feel detached from the physical environment;

j) It seemed that the virtual and physical elements together created a new environment;

k) Even though I was aware that the added elements are virtual, I still perceived them as a part of the physical surroundings;

l) After I stopped using the app, I could still imagine the virtual content / elements.

These items were then developed and expanded further based on the findings from the exploratory studies.

5.5.2 Exploratory Study 1: Expert groups

Two expert groups evaluated the items relating to perceived augmentation. The first one was composed of one highly experienced academic and two PhD students in the area of human-computer interaction, while the second involved 5 experts in AR technology (two highly experienced academics, one practitioner and two PhD students). The participants were asked at the beginning of the session to use two AR apps: a virtual make-up try-on mirror and a virtual sunglasses try-on mirror. One was a virtual mirror allowing sunglasses to be tried on through an app on a personal computer. In the app sunglasses appear on the user's face, which is displayed in a camera view on screen. The other virtual mirror is an application used on a tablet or smart phone that allows the user to try on different make-up in real-time. After trying the apps, the participants evaluated the measurement items and each item was discussed in detail.

In the first expert group, discussion revolved around the fact that the two apps had different levels of tracking in the sense that they differed in how much the virtual make-up or sunglasses really seemed to be situated on the face and moved along with it. The experts emphasized that such difference in the synchronization of the virtual elements with the physical environment has a significant impact on the experience with the application. This further supported our assumption about the two dimensionalities and suggested that the issue needed to be investigated in more detail. They also commented that the language of the measurement items was too sophisticated in places and phrases such as "spatio-temporal context" should be rewritten with simpler wording. They also suggested to remove item d), because the phrase "beyond the screen" did not reflect the experience with AR, given that the experience with the apps is strongly related to the screen. A final point of the discussion pertained to the issue of immersion into the AR experience and how it differs from experience with virtual worlds. The general agreement was that immersion - as defined for the experience with virtual worlds (Jennett et al., 2008) – is not valid for the AR experience and should most probably not be included in the questionnaire. As we wanted to verify this, we kept the two measurement items related to immersion to be discussed with the second expert group.

The comments from the discussion were analyzed following qualitative analysis to identify raised issues and themes (Braun & Clarke, 2008). The items were re-framed to reflect the following dimensions: the enhancement of the physical with the virtual (items a, b, c); the fit between the virtual and physical (d, e, f, g, h) and detachment or immersion into a different type of reality (i,j). The items were as follows:

a) I felt the AR application enhanced my face;

b) I felt like the physical world was directly altered by the virtual experience;

c) I felt the current context I was in changed because of using the application; d) I felt the virtual and physical elements were blended;

e) I felt the virtual elements were part of my face;

f) The application reacted to the movements I made;

g) I had an impression that the sunglasses were in "the here and now";

h) Even though I was aware that the added elements were virtual, I still perceived them as a part of the physical surroundings;

i) I felt the application made me feel completely detached from the world around me;

j) The application made me feel like I am somewhere else.

Repeating the same procedure in the second expert group, the 5 experts tried the same two apps and filled out the questionnaire with the measurement items. The discourse in the second expert group focused on the following issues: a) the meaning of the concepts in the items (such as experience, concept, reality); b) the relation between virtual and physical and realism and c) immersion. With the majority of the items, the experts suggested to use words that are less subjective and relate more to what the users perceive the application to do rather than how it made them feel in terms of experience. Precisely because the virtual interacts with the physical, phrases like "current context" and "the here and now" could mean both physical and virtual together and can thus potentially cause confusion. The suggestions for re-phrasing were proposed in the sense that the virtual and physical should remain separated in the items. Finally, the discussion on immersion re-affirmed that immersion as such does not represent an adequate concept for perception of augmentation, because the latter is concerned with the interplay between the physical world and virtual elements and not a process of transportation in a world that is separated from physical reality.

Based on the discussion, the following changes were made to the items. The items with parts such as "I felt", "I still perceived" and "I had an impression" were re-phrased and those parts were removed; physical reality and virtual elements were referred to more concretely and with less reference to the context and experience; the items i) and j) were removed.

5.5.3 *Exploratory Study 2: Focus group*

The two expert groups identified several issues related to the scale. As discussed in the previous section, the evoked themes did not saturate. The first group focused much more on the difference between two apps in terms of their abilities to align the virtual elements with the physical environment. The second group found more crucial the quality of the experience and how virtual related to the physical, in the sense of how such augmentation of reality was perceived. We therefore ran another exploratory study, but with one important difference. To re-evaluate the dimensions of perceived augmentation, we did not present the participants with the measurement items, but organized it as a focus group guided by semi-structured questions.

A focus group was conducted to further explore the way(s) in which the users perceive the apps to augment the physical environment (if at all). 7 PhD students from the field of human-computer interaction participated in a ninety minutes session. A small monetary incentive was offered to participants for taking part in the study. To begin with, pairs and a threesome of participants used various types of AR tools – two virtual mirrors apps and a picture augmentation app. Both virtual mirrors were the same as those used in the expert groups. The third app was used in conjunction with papers that had colored images on them whereby the app makes the images appear on a screen in 3-D, as if they are moving around in real-time.

After each participant had used every app, a discussion took place. The researcher conducted the session with the questions in a semi-structured way: when a discussion developed in an unforeseen direction, additional sub-questions were asked (Lederman, 1990). The analysis of the data was conducted in such a way that the statements were categorized within pre-determined categories, which is one of the valid approaches to analyzing focus group data (Lederman, 1990). The categories were the following:

a) Enhancement of the physical with virtual

b) Fit of virtual into physical

However, we also shortly discuss the comments that did not relate to any of the categories.

a) Firstly, the participants discussed the features of the augmentation and described how the application applies virtual elements on a physical entity, in this case a face or coloring images on a table. When they talked about the different apps, they referred to them as make-up app, sunglasses app and coloring app. The make-up and sunglasses app were also referred to as "virtual mirror" or "mirror". Comments included:

"*In the case of the make-up app, the make-up gets overlaid over your face or superimposed*."

"The sunglasses app allowed you to try on things, like products, on your face."

"One virtual mirror showed the products on your face and the other one enhanced the face, but they were fairly similar."

"Sunglasses sat on the face wrongly so it was really annoying to look at, because I wanted to correct it. But the tracking with the make-up app was really incredible."

"First you try to calibrate the image (with the coloring app) and after a few seconds there was a world appearing."

These types of comments showed that virtual elements appear in the physical world or environment as overlaying it, being added to it.

b) Secondly, participants discussed the fit between virtual elements and the physical world. This part of the debate yielded more vivid discussion. The connection between the physical and the virtual was discussed at length, indicating that the physical and the virtual worlds can at times reach a high level of synchrony.

"But that's different from a virtual mirror that blends them together – at some point I didn't know anymore if she was wearing the make-up or if it was virtual."

"On one hand the contact with the physical world got lost, but then you were connected to it, because you were confined by it. It encourages you to (interact) with physical space, but it doesn't allow it."

"The ways how to manipulate with them are different – do I have to step out of the experience or do it while I am in there. With the make-up that was easy, but with the coloring app I wasn't sure."

Comments of this type indicate that virtual elements are perceived to be part of physical environment, but there are also some points where this perception breaks down – because the virtual elements do not react or exist in the same way.

"There is also a disconnect because you see someone on the screen with the sunglasses and then you turn to him and he is without them, so you get a bit of a strange interaction."

"The virtual doesn't talk to user in the same way as the physical elements would – some things are missing."

Again, differences across the apps were mentioned:

"The connection between the virtual and physical is seamless (for the virtual mirror) while with the coloring app there is no real world analogy for it, so you feel less connected."

Furthermore, participants also emphasized how movements were viewed as part of the interaction with the app and that the relevance of the movements differed among the apps.

"When you moved the face around, you would get the impression they are moving with you."

"In comparison to other games one can play on the iPad, the coloring app is comparably bad, because when you move around, the reaction time slows down."

"With the coloring app you were more encouraged to move around, it was a different spatial experience, a different kind of physical experience of AR."

These comments confirmed our proposition about virtual-physical congruency. They postulate that in an AR app, virtual elements – while existing in a different way than physical elements because they appear on a screen and are computer-generated – are perceived in relation to the physical environment. The alignment between the two creates and reinforces the perception of augmentation. The impression that the virtual elements fit convincingly into the real world is further enhanced when the virtual elements reacts to the user's movements in the same way the physical elements would.

Finally, they emphasized that the type of interaction depends strongly on the purpose of the apps, saying that there are different purposes to these apps, which is why they would interact differently with them.

"If you are trying on sunglasses, the purpose is to just look at them because you would like to see how they look and not trying to play a game. With coloring you would like to play a game, but it's not clear if you can and how."

"In the virtual mirror, you would see exactly what you would see in the mirror, so you know what to expect – it's intuitive. It's a strong effect when you see the make up and sunglasses on your face and you can manipulate it."

However, this did not relate to the concept of perceived augmentation, but more to the purpose of the apps, thus we did not include any measurement items relating to this.

5.5.4 Content validity

Based on the findings from the two exploratory studies and the literature, measurement items were considerably modified and reframed. They were organized according to two main dimensions: virtual enhancement and virtual-physical congruency, as defined in our conceptual framework based on literature review and further re-affirmed and discussed in the exploratory studies. At this point, the scale consisted of 19 items.

The content validity of the items was then assessed by sending the scale to four experts in the field of computer science and/or user behavior for additional checks and comments. They each sent their comments via email. They suggested reformulation of some items as the wording did not seem clear to them. Also, they suggested that three items be deleted on the basis that they were a repetition of other items, leaving us with a refined scale of 16 items to be tested in the following survey study.

5.6 Scale validation in a survey of perceived augmentation and consumer behavior

The compiled scale and the proposed model were tested in a survey study which was developed and launched using the online survey system Qualtrics. Each participant was required to start the study by downloading an app of a famous make-up brand. This app has been used in previous exploratory studies. The reason for choosing this particular app for the study is related to the fact that the functionality of this app is better than many other existing AR apps, it can be used on smart devices and is thus easily accessible, is free to download, does not require the user to be at any particular location to activate the AR feature and offers a variety of AR content. The features available on the app were virtual lipstick, eyeshadow, blusher, eyeliner or complete looks, copied from the looks of celebrities. While too rapid movements or elements such as very strong light, a beard, very thin lips and glasses would for instance interfere with smooth functioning of the virtual make-up, the make-up was in most cases convincingly placed on a user.

The participants were asked to use the app three times during five days. This was a very important condition of the study as the survey aimed to measure responses after participants have used the app more than once. This condition was imposed because AR technology makes a strong sensory impression when first used and thus creates a "wow" effect. We aimed to capture responses to the apps that reached beyond this novelty effect and indicated responses of those who were familiar with the effect of the technology.

After signing up for the study and using the app for the first time, participants received two more reminders (sent two and four days after the sign-up) with instructions telling them which different app features to use. The second reminder included a link to the online survey, to which they were invited once they had used the app at least three times. As we did not have access to the app's analytics, we could not monitor directly to which extent the participants used the apps. The survey thus included a question about the app features to check whether participants had really used the app. We excluded 5 participants as they indicated they used features that did not exist in the app. Also, negative statements were included to control that participants had read the questions carefully. One participant was excluded as his answers showed the same default responses to all questions, even when they had the opposite meaning.

		Frequency	Percent	Cumulative %
Education	**Degree type**			
	Secondary	15	7.0	7.0
	Professional	23	10.8	17.8
	Bachelor	129	60.6	78.4
	Master	40	18.8	97.2
	PhD	6	2.8	100.0
	Total	213	100.0	
Age	**Age bracket**			
	18-24	155	72.8	72.8
	25-29	38	17.8	90.6
	30-34	13	6.1	96.7
	35-29	4	1.9	98.6
	40-44	3	1.4	100.0
	Total	213	100.0	
Gender	**Gender type**			
	Female	157	73.7	73.7
	Male	56	26.3	100.0
	Total	213	100.0	

Table 1: Demographics

Participants for the study were recruited through two participants pools, both used for data collection at major universities in European country. There was a monetary incentive offered to the participants. 219 completed the questionnaire. After checking the responses, 6 participants were eliminated. The final sample consisted of 213 participants. Demographics are shown in the Table 1.

5.6.1 Questionnaire

In addition to the items developed for perceived augmentation, we added measurement items related to other consumer responses from validated scales. Affective responses were measured by 3 items from a scale for enjoyment by Cyr et al. (2009). 3 measurement items for informedness were adopted from Smith et al. (2011). For behavioral measurements, we combined 5 items related to future use of the application (Nah et al., 2011) and to purchases of the items (Li & Meshkova, 2013). The 21 questions that were included in the final analysis are presented in the Table 3.

5.6.2 Exploratory factor analysis

To analyse convergent and discriminant validity, we performed exploratory factor analysis with oblimin rotation. We looked for items that had low factor loading (<.40) on the dimensions they were hypothesized to load, high cross-loadings (>.40) or low communalities (<.30) to further purify the scale (Netemeyer et al., 2003).

An item analysis was first conducted to acquire a scale with maximum internal consistency. Items that did not correlate strongly ($r < 0.5$) with other items within the corresponding dimension were eliminated (Nunally, 1967; Tian, Bearden, & Hunter, 2001; Forsythe et al., 2006; Sohn & Choi, 2014).

Based on these steps, 5 items were eliminated and we obtained a structure with 2 components (shown in Table 2 together with underlying pattern matrix with factor loadings). The two components with a) 5 items and b) 6 items corresponded to the hypothesized categories of virtual enhancement and virtual-physical congruency.

Together they explained 67.216% of variance, which exceeds the recommended 50% minimum (Hair et al., 2009). The correlation matrix (Appendix 1) showed that the items are significantly correlated. Both components also exceeded the suggested Eigenvalue of 1 and no other component above Eigenvalue of 1 was identified. The KMO test was of satisfactory value .896, indicating sampling adequacy and underlying correlation matrix and Bartlett's test of sphericity was significant (p =.000), indicating correlations among variables. These results also confirm convergent validity, given the high factor loadings on their respectful dimensions. We then assessed Cronbach's Alpha for scale reliability: for the overall scale, α = .889; for the items of the first dimension (virtual enhancement) α = .875 and for the items of the second dimension (physical – virtual congruency) α=.892. All of the values were above the required threshold of 0.7 (Santos, 1999).

	Component	
	1	2
Augm1a		.891
Augm1b		.840
Augm1c		.813
Augm1d		.776
Augm1e		.752
Augm2a	.793	
Augm2b	.719	
Augm2c	.846	
Augm2d	.826	
Augm2e	.892	
Augm2f	.771	
% of total variance explained	**18.753%**	**48.463%**
Cumulative % total variance	**18.753%**	**67.216%**

Table 2: Pattern Matrix, computed with Principal Component Analysis and with Rotation Method Oblimin with Kaiser Normalization

At this point we also computed discriminant validity between the constructs based on the Fornell-Larcker test (Table 3). The AVE of the constructs was higher than the correlation between the two constructs, showing adequate discriminant validity. Construct reliability for virtual enhancement with these factors was 0.908 and for virtual-physical congruency 0.919.

The correlation between the two constructs was significant at $p<0.001$, r=.403, showing that the two dimensions are not too closely correlated and further identifying discriminant validity.

These results indicated that perceived augmentation is a multi-dimensional concept with two different components and the purified two-dimensional scale of perceived augmentation now consisted of 11 items. With the purified scale we then conducted structural equation modeling which comprised both confirmatory factor analysis of the scales and evaluation of the model as a whole.

	Virtual enhancement	Virtual-physical congruency
Virtual enhancement	**0.666**	0.438
Virtual-physical congruency	0.192	**0.656**
Mean	6.17	5.44
Standard deviation	0.97	0.95

Table 3: In diagonal average variance extracted (AVE); above is the bivariate correlation between the two constructs, significant at $p<0.01$ and below is the squared correlation between the constructs.

We also examined the data for common method bias variance. Harman's single factor test showed that a single factor solution for all the measurement items would explain less than 50% of variance and that the questionnaire did not suffer from the bias of consumers following a pattern of giving the same answers to the questions because of the measurement instrument.

5.6.3 *Confirmatory factor analysis*

The software package Amos 23 was used for conducting confirmatory factor analysis and structural equation modeling. One further item of perceived augmentation was eliminated prior to reaching an adequate model fit. Five items were retained for the component *virtual enhancement* and five for *virtual-physical congruency*. The standardized item loadings are shown in Figure 1.

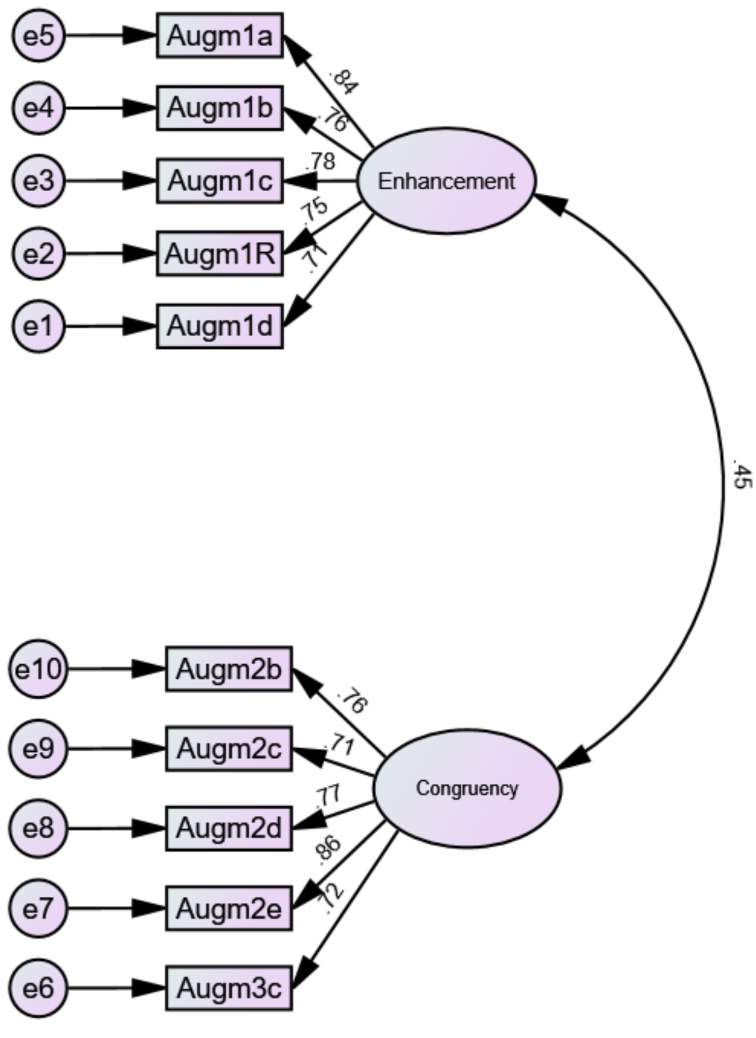


Figure 1: Confirmatory factory analysis model with standardized factor loadings and correlation between the two constructs (p=0.00)

The model fit was excellent: χ^2 was 62.015 (p=0.003), CMIN/df = 1.772, GFI = .950, AGFI=.921, CFI = .975, RMSEA = 0.60. (PCLOSE = .229), confirming that the scale represents a good measurement tool. The correlation between the two constructs was 0.45 and significant (p=0.00). All the factor loadings are larger than 0.7, which is above required level of 0.5 (Hair et al., 2009), further confirming convergent validity. The final scale thus consists of ten measurement items, five for each of the constructs. The two constructs displayed adequate discriminant and convergent validity.

5.6.4 Model test and nomological validity

Before running the test for nomological validity and estimating the relations with other constructs, we examined the construct fits of other scales (Table 4), namely of scales for enjoyment, informedness, sensory experience and behavioral intentions.

The scale for enjoyment consisted of 4 items and had an appropriate measurement model fit: χ^2 was 1.573 (p=0.210), CMIN/df = 1.573, GFI = .996, AGFI=.963, CFI = .999, RMSEA = 0.52. (PCLOSE = .323). The scale for informedness consisted of 3 items which did not allow an assessment of measurement model fit, however Cronbach's Alpha confirmed that the measurement items were appropriate.

The behavioral intentions scale had 5 items and an appropriate measurement fit: χ^2 was 4.437 (p=0.350), CMIN/df = 1.109, GFI = .992, AGFI=.969, CFI = .999, RMSEA = 0.23. (PCLOSE = .593).

We then validated the model. The fit indices showed an excellent fit (Hooper et al., 2008): χ^2 was 259.974 (p=0.000), df=178, CMIN/df = 1.461, GFI = .900, AGFI=.871, CFI = .970, RMSEA = 0.047. (PCLOSE = .667). The model together with its item loadings is shown in Figure 2.

	Cronbach's Alpha
Virtual enhancement The app shows visual simulation overlaying the real world. The app superimposes the virtual items on what I see in reality. The app places virtual elements over the physical world. The app does not add anything virtual to the physical world on the screen. The application visually changes the physical reality by adding simulation to it.	.875
Virtual-physical congruency The app blends the physical and the virtual. The connection between the virtual and physical is seamless when using the app. Virtual simulation fits in well with the real environment. The way the virtual elements are added to the physical seems real. When using the app, I feel I am interacting with virtual elements as if they are part of the physical environment.	.873
Enjoyment (Cyr et al., 2009) I found my use of this app entertaining. I found my use of this app enjoyable. I found my use of this app pleasant.	.918
Informedness (Smith et al., 2011) After using the app, I felt informed about… What the products look like. What the products look like on me. The objective characteristics of the products.	.726
Behavioral intentions (Li & Meshkova, 2013; Nah et al., 2011) I would consider this app the next time I need to buy make-up. I would recommend the app to my friends. I intend to use this app in the future. How likely is it that you would buy make-up when it is presented in this way? If you needed to purchase a similar product in the future, how likely is it that you would buy a similar product to the ones you have tried?	.914

Table 4: Measurement scales with internal reliability score

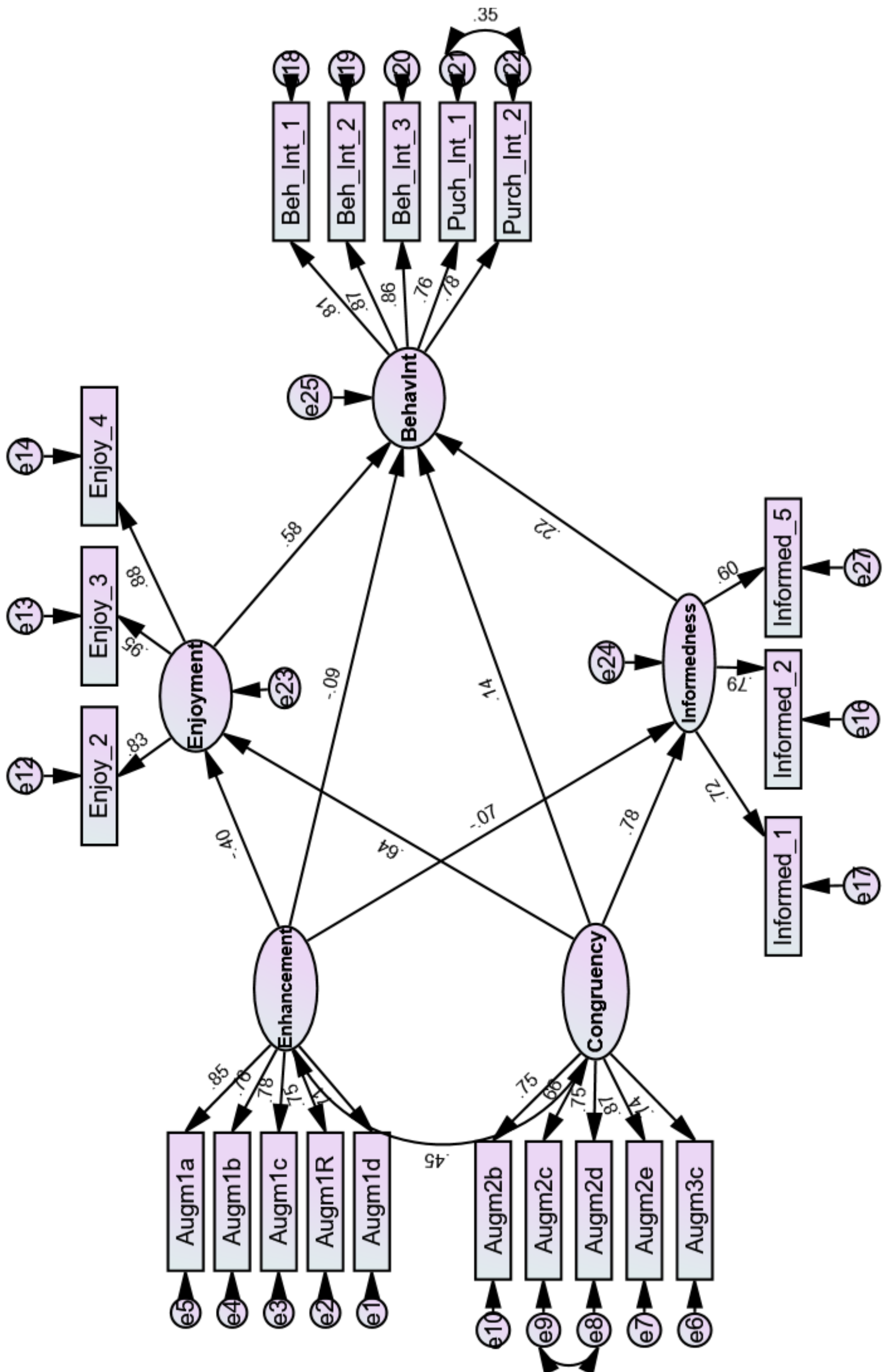


Figure 2: Model estimation with standardized factor loadings and path coefficients

Further analysis showed the following relations between the variables (Figure 3). Both virtual enhancement and virtual-physical congruency significantly predict the enjoyment which supports both H1a and H1b. However the relationship is negative for virtual enhancement (β= -.464) which means that such enhancement actually leads to decreased enjoyment. On the other hand, since the virtual-physical congruency was shown to strongly predict enjoyment (β= .654), when the virtual elements were perceived to fit well with the physical environment, participants experienced a correspondingly high level of enjoyment. Only the virtual-physical congruency significantly predicts the informedness (β= .756), while there is no significant coefficient between virtual enhancement and informedness. Both H2a and H2b were thus supported. Furthermore, neither virtual enhancement nor virtual-physical congruency significantly predict behavioral intentions, rejecting both H3 and H4. When looking at enjoyment and informedness, results show significant effects of both on behavioral intentions, with β= .707 for enjoyment and β= .381 for informedness, which confirmed H5 and H6.

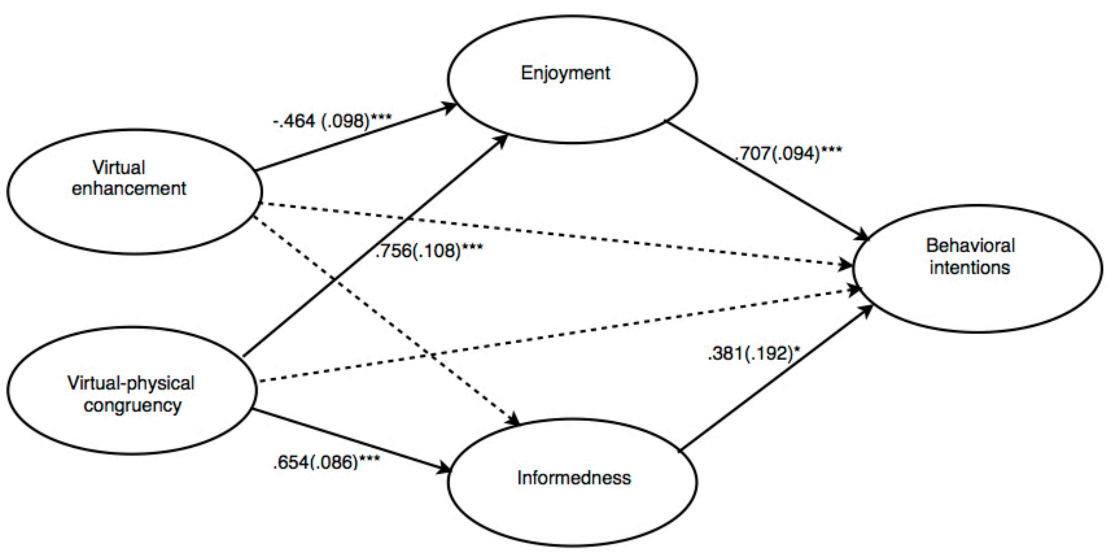


Figure 3: Path model

			Estimate	S.E.	C.R.	P label
Enjoyment	←-	Enhancement	-.464	.098	-4.749	***
Informedness	←-	Congruency	.654	.086	7.620	***
Enjoyment	←-	Congruency	.756	.108	7.004	***
Informedness	←-	Enhancement	-.061	.065	-.934	.350
BehavInt	←-	Enjoyment	.707	.094	7.510	***
BehavInt	←-	Informedness	.381	.192	1.989	.047
BehavInt	←-	Enhancement	-.123	.101	-1.223	.222
BehavInt	←-	Congruency	.205	.168	1.220	.222
Augm1d	←-	Enhancement	1.000			
Augm1R	←-	Enhancement	.804	.081	9.984	***
Augm1c	←-	Enhancement	.960	.090	10.615	***
Augm1b	←-	Enhancement	1.040	.101	10.269	***
Augm1a	←-	Enhancement	1.109	.099	11.147	***
Augm3c	←-	Congruency	1.000			
Augm2e	←-	Congruency	1.136	.093	12.178	***
Augm2d	←-	Congruency	.921	.088	10.522	***
Augm2c	←-	Congruency	.971	.105	9.256	***
Augm2b	←-	Congruency	.957	.089	10.796	***
Enjoy_2	←-	Enjoyment	1.000			
Enjoy_3	←-	Enjoyment	1.204	.066	18.112	***
Informed_2	←-	Informedness	1.169	.123	9.488	***
Informed_1	←-	Informedness	1.000			
Beh_Int_2	←-	BehavInt	1.101	.074	14.935	***
Beh_Int_3	←-	BehavInt	1.205	.082	14.618	***
Puch_Int_1	←-	BehavInt	.931	.075	12.385	***
Beh_Int_1	←-	BehavInt	1.000			
Purch_Int_2	←-	BehavInt	.855	.068	12.611	***
Enjoy_4	←-	Enjoyment	1.090	.066	16.404	***
Informed_5	←-	Informedness	1.049	.141	7.427	***

*Table 5: Regression coefficients with their significance levels; ***p<0.001*

We assessed an alternative model where there were no paths from enjoyment and informedness to behavioral intentions and the model fit proved to be worse: χ^2 was 325.665 (p=0.000), df=180, CMIN/df = 1.809, GFI = .871, AGFI=.835, CFI = .947, RMSEA =

0.062. (PCLOSE = .038). Such assessment additionally indicates that the specified model is both an adequate and parsimonious one.

5.6.5 Concept validity

Perceived augmentation refers to "user perception of augmented reality technology's ability to enhance visual representations of physical surroundings with virtual annotations". While the technological ability is considered a media characteristic or a media feature (Sundar et al. 2015), its perception represents a psychological correlate and the separation of objective media characteristic and user psychological response/correlate/perception is emphasized.

5.7 Discussion

The exploratory and survey studies show that the participants perceive the AR to enhance the view of the physical environment on at least two different levels. Firstly, AR is perceived to visually change the physical reality by overlaying the virtual annotations over it on the camera view. Secondly, the view is enhanced by the integration of the virtual elements with the physical environment, when the virtual part is perceived to be congruent and aligned with the physical, as if it is situated in it. The exploratory studies have also indicated that the perception of augmentation does not relate to any great extent to realism of the virtual – in the sense that the virtual is not perceived as a replacement of the physical or as an identical substitute. If in virtual reality the virtual elements represent a substitute for physical, in AR the virtual is a complement of the physical. Also, while in some cases the level of realism can be high (depending on the quality of the application, especially the rendering), the illusion is perceived for what it is – a virtual illusion. The main perception of AR is thus not linked to an established realism, but to the relation of virtual with the physical. The survey study of the scale shows that the two dimensions compose a scale of high internal reliability, both as an overall scale and as separate subscales, and represent a cohesive measurement tool in which the two subscales are significantly correlated. Furthermore, virtual enhancement and virtual-physical congruency were shown to represent two separate constructs, demonstrated by discriminant validity between them. Development and validation of this scale represents the first measurement tool of its kind that allows for investigating of the perception of AR features, pertaining specifically to the features of this novel technology.

Furthermore, the estimated model shows further interesting results, some of which were surprising. Firstly, the model shows that the two constructs have different effects on affective and cognitive responses. The virtual enhancement does not show significant impact on informedness and, unexpectedly, it shows negative predictive power on enjoyment. The virtual-physical congruency on the other hand shows strong positive impact on both informedness and enjoyment. This difference points out to a crucial element of the experience with AR: a simple overlay of virtual elements over a view of the physical environment does not bring an enriched experience, neither in terms of affective responses such as enjoyment, nor in terms of cognitive ones such as informedess. The fact that virtual enhancement was shown to have a negative effect on the affect suggests that a mere overlay of virtual annotations can decrease the enjoyment of an experience when interacting with the type of apps used in this study. Also, virtual enhancement has not proven to create added value in terms of being more informed about a product or the context. It is rather the fit of the physical and virtual where the main positive effect of AR on consumer responses comes to play: the more the virtual and the physical are perceived to be aligned, the more consumers experience a higher level of enjoyment with the app. In the same way, a high level of perception of the virtual and physical contribute to consumers being more informed about the products, both in terms of what they look like and how they are to be used.

When examining the impacts on behavioral intentions, neither virtual enhancement nor virtual-physical congruency displayed significant correlations with it. However, the effects of both dimensions on behavioral intentions are significantly mediated by enjoyment and informedness, both of which show significant impact on behavioral intentions. As seen also in previous studies, the impact of affective responses, i.e. enjoyment in this case, on behavioral intentions is stronger than the impact of cognitive responses, i.e. informedness.

These results demonstrate that for consumer experience with AR, the real-time fitting of virtual in the physical surrounding is of an utmost importance and that part of AR exhibits an impact on all three categories of consumer responses. In contrast to this, a mere overlay of the physical with the virtual without a correspondence to the physical environment does not create a valuable experience and can in fact decrease positive affective responses in terms of enjoyment.

5.8 Limitations

We aimed for the studies to comply with the scientific principles of scale development and model testing, however the presented research has certain limitations that should be addressed.

While we conducted numerous qualitative studies to explore the dimensions of perceived augmentation, the scale has been validated with only one quantitative study. Further quantitative studies would be required to offer a more complete validation.

In addition, the survey study asked participants to use one type of AR app. While this allowed for the same condition for all the participants, it is highly relevant that other AR apps will need to be included in future studies to validate generalization of the scale across different AR apps.

5.9 Conclusion and directions for further work

This study investigates consumer perception of AR characteristics and examines the existence of two dimensions in a scale related to the perception of AR's ability to virtually enhance the physical environment in real-time. The results of exploratory studies indeed indicate two psychological correlates of AR augmentation and the scale purification and validation process confirm this. Exploring the consumer experience related to the perception of augmentation, the survey study clearly demonstrates the superior importance of the *virtual-physical congruency* dimension in terms of impact on consumer responses in comparison to the dimension of *virtual enhancement*.

The results thus invite further studies to explore consumer perception of the AR media characteristic, which is a timely and relevant phenomenon. While important further developments in terms of the technology and its features are to be expected, the scale of perceived augmentation can offer a useful tool for determining to which extent a specific app is perceived to virtually enhance physical reality and to which extent such enhancement is perceived to be integrated with the physical environment.

5.10 Appendix

Correlation Matrix												
		Augm1a	Augm1b	Augm1c	Augm1R	Augm1d	Augm2a	Augm2b	Augm2c	Augm2d	Augm2e	Augm3c
Corr.	Augm1a	1.000	.651	.649	.666	.584	.453	.355	.183	.257	.214	.255
	Augm1b	.651	1.000	.609	.560	.539	.361	.331	.154	.229	.229	.277
	Augm1c	.649	.609	1.000	.557	.593	.451	.389	.208	.262	.302	.309
	Augm1R	.666	.560	.557	1.000	.494	.382	.422	.128	.362	.306	.282
	Augm1d	.584	.539	.593	.494	1.000	.435	.368	.191	.310	.283	.252
	Augm2a	.453	.361	.451	.382	.435	1.000	.609	.517	.642	.642	.569
	Augm2b	.355	.331	.389	.422	.368	.609	1.000	.522	.541	.652	.585
	Augm2c	.183	.154	.208	.128	.191	.517	.522	1.000	.590	.605	.504
	Augm2d	.257	.229	.262	.362	.310	.642	.541	.590	1.000	.678	.539
	Augm2e	.214	.229	.302	.306	.283	.642	.652	.605	.678	1.000	.619
	Augm3c	.255	.277	.309	.282	.252	.569	.585	.504	.539	.619	1.000
Sig. (1-tailed)	Augm1a		.000	.000	.000	.000	.000	.000	.004	.000	.001	.000
	Augm1b	.000		.000	.000	.000	.000	.000	.012	.000	.000	.000
	Augm1c	.000	.000		.000	.000	.000	.000	.001	.000	.000	.000
	Augm1R	.000	.000	.000		.000	.000	.000	.031	.000	.000	.000
	Augm1d	.000	.000	.000	.000		.000	.000	.003	.000	.000	.000
	Augm2a	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000
	Augm2b	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000
	Augm2c	.004	.012	.001	.031	.003	.000	.000		.000	.000	.000
	Augm2d	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000
	Augm2e	.001	.000	.000	.000	.000	.000	.000	.000	.000		.000
	Augm3c	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	

Table 6: Correlation matrix of exploratory factor analysis with significance levels

			Estimate	S.E.	C.R.	P	Label
Augm1d	<---	Enhancement	1.000				
Augm1R	<---	Enhancement	.804	.081	9.927	***	par_1
Augm1c	<---	Enhancement	.966	.091	10.616	***	par_2
Augm1b	<---	Enhancement	1.044	.102	10.249	***	par_3
Augm1a	<---	Enhancement	1.108	.100	11.074	***	par_4
Augm3c	<---	Congruency	1.000				
Augm2e	<---	Congruency	1.148	.078	14.641	***	par_5
Augm2d	<---	Congruency	.980	.078	12.541	***	par_6
Augm2c	<---	Congruency	1.068	.095	11.210	***	par_7
Augm2b	<---	Congruency	1.000				

Table 7: Unstandardized regression weights for confirmatory factor analysis

			Estimate
Augm1d	<---	Enhancement	.708
Augm1R	<---	Enhancement	.748
Augm1c	<---	Enhancement	.784
Augm1b	<---	Enhancement	.764
Augm1a	<---	Enhancement	.843
Augm3c	<---	Congruency	.724
Augm2e	<---	Congruency	.857
Augm2d	<---	Congruency	.772
Augm2c	<---	Congruency	.706
Augm2b	<---	Congruency	.764

Table 8: Standardized regression weights for confirmatory factor analysis

6. CONCLUSION

Predictions about the AR as the "next big thing" have been a constant over the last couple of years in many areas - notably tourism, education and industry. The field of marketing has been no exception and, consequently, studies about the role of AR in marketing (Liao, 2014) and about the available commercial AR applications have started to emerge (Scholz & Smith, 2015). However, despite this, no research in marketing has so far explained in detail the features of AR (and consumer perception thereof) as how these might serve as drivers for subsequent consumer experience. It is in precisely this area that the work in this thesis aims to make a contribution.

Why is such knowledge relevant? AR functions in a surprisingly different way than other interactive technologies. Unlike other forms of online or website-based communication, AR content is visually part of the physical environment, thus representing a novel way of displaying information or visual elements. Comprehending how users perceive such a visualization represents a crucial step towards understanding its potential, as well as the nature of consumer experience with AR.

This project set out a number of key objectives to be achieved and the realization of these has brought forward several important findings. The main motivation was related to developing our understanding of the media characteristics of augmented reality and in what way they shape consumer experience with this technology. Guided by this interest, the four conducted studies were devised as chapters of a coherent story.

6.1 Summary of the articles

1st Article

The first study focused on examining the different AR media characteristics and drawing parallels with other, more established interactive technologies. By conducting a literature review on consumer responses to media characteristics of interactive technologies, the theoretical framework of the project started to take shape. 8 media characteristics were identified as the main features of interactive technologies: interactivity, modality, hypertextuality, connectivity, location-specificity, mobility and virtuality. A review of the literature showed that affective responses such as enjoyment and attitude represented very frequently occurring and strong consumer reactions to these media characteristics (Jin, 2009; Calder et al., 2009; Nah et al., 2011; Huang, 2012; Sundar et al., 2014). The more rational, cognitive responses such as informedness and knowledge, in contrast, have been elicited by media characteristics to a more limited extent (Park et al., 2008; Gabisch, 2011; Li & Meshkova, 2013). As already proposed and tested in numerous theories and approaches (such as theory of planned behavior, TIME theory and the S-O-R approach), these affective and cognitive responses represent drivers for subsequent behavioral intentions or behavior, which this literature review confirmed to be the case in numerous studies. In the context of interactive technologies, the affective component represents a crucial part of consumer experience with interactive technology. In numerous contexts it is more effective than cognitive responses, and consequently a stronger driver for behavior such as purchase and subsequent use. Furthermore, richer media (or media with a wider array of interactive features) were shown to be preferred over less interactive forms of media – 3-D visual representations are perceived to be easier to use and more enjoyable than 2-D simulation (Kim & Forsythe, 2008; Nah et al., 2011) and more interactive media induced higher satisfaction and loyalty (Song & Zinkhan, 2008). These and related findings were suggested to have strong implications for future studies of AR, which was then elaborated in the proposed research agenda for further studies. Finally, the study emphasized that AR technologies possess a feature that has not been discussed before in the literature and demands further attention, thus leading into the following three empirical studies.

2nd Article

TIME theory (Sundar et al., 2015) suggests that, in order to investigate the impact of media characteristics, experimental methodology is required to prove a causal effect of such characteristics on consumer responses. This chapter follows this requirement and focuses on two media characteristics: interactivity and augmentation, the former representing the most focal characteristic of interactive technologies (Sundar et al., 2015) and the latter being proposed as a core AR characteristic (Preece et al., 2015). Two findings are central to the study. Firstly, comparing interactivity across two applications – one with and one without AR features – revealed that the presence of AR did not make consumers perceive an app as more interactive and therefore indicated that AR did not inherently create a more "interactive" experience. While interactive can relate to various dimensions of interactivity within the system, we tested it with regards to two types of interactivity (as outlined by Sundar et al., 2015): a) "medium interactivity", referring in this case to the responsiveness of the application or website; and b) "source interactivity", referring to a sense of control over the displayed content. The finding that AR apps are not significantly more interactive than non-AR websites was confirmed in both experimental studies with two different types of applications.

When testing the difference in augmentation, the results revealed that the concept of perceived augmentation much more accurately captures the difference in consumer perception when comparing AR visual systems to non-AR systems. Furthermore, both studies confirmed that the participants who reported strong perceived augmentation, became immersed into flow, referring to user absorption in an activity (Csikszentmihayli, 1996). In general, such immersion also depends on a combination of challenge and skills, which then evokes a certain arousal and sense of control, allowing the user to be focused and experience a sense of contentment with the activity (Hoffman & Novak, 1996). The flow in both experiments, furthermore, mediated the effects of perceived augmentation on attitudes towards the application as well as intentions to use it again and tell other people about it. It did not, however, mediate the effects of perceived augmentation on purchase intentions or attitudes towards the tried products. That is a particularly interesting finding, given that it contradicts the outcome of the study whose model it was replicating (van Noort et al., 2012).

Our study showed that the affective and behavioral responses were all directed towards the application, but not really towards the brand or purchase intentions. One of the possible explanations for such an outcome is that AR technology, when used in such an isolated context, can overshadow the brand and the products that it is presenting, although such assumptions obviously required further investigation.

While both the conceptualization and the measurement items of perceived augmentation at the time represented the very first attempt to study the concept, the results confirmed in the two experimental studies indicated that the concept is worth pursuing and investigating further. With this finding in mind, we conducted the following two studies.

3rd Article

Based on the results and comments obtained in the experimental studies presented in the 2nd Article, we were able to refine the measurement items of perceived augmentation and conduct further testing of the concept. This was done in the context of an "in-the-wild" study (Rogers, 2012) as we had the opportunity to conduct data collection in a physical store in the Netherlands. By studying user interaction during a week-long in-store observation, and by collecting survey responses from visitors who had used the apps, we were able to examine consumer experience with make-up virtual try-on in real-time. Thanks to this real-world context, we were able to increase the external validity of the study. Furthermore, the data was collected from participants who belonged to a different demographic group than the student population from the 2nd Article. This represented a further methodological advantage, as non-student subjects are too rarely included in the academic marketing research (Voorveld et al., 2009).

The observational data showed a plethora of different responses and reactions towards the application. Surprise and fascination were frequently observed, as well as laughter and a playful attitude. Despite make-up being predominantly of interest to females, both genders tried the app to observe themselves in the virtual mirror with simulated make-up. The app's analytics also demonstrated that the number of tried-on lipsticks and other products per person was very high, indicating that such an app allows users to try on more products than physical testers. Most importantly, observations indicated that it is the fit of the virtual product with the physical movement and physical environment that creates the most fascination. Face movements, pouting, eye blinking and head turning were frequently observed among users, indicating their interest in exploring the synchronicity of the virtual make-up with the physical surroundings.

While such observations provided understanding of how users were reacting to the application, the survey offered insights into how consumers perceived the experience in the retail context. Exploratory factor analysis and measurement of internal reliability showed that items of perceived augmentation represented a suitable measurement tool and thus allowed the analysis to be continued. Perceived augmentation of the virtual try-on app was reported to be very high and regression analysis showed that high levels of perceived augmentation corresponded with high levels of playfulness and also perceived convenience, further related to behavioral intentions. These results demonstrated that consumer interaction with an AR virtual try-on app is playful when the augmentation is perceived to be high. Furthermore, both playfulness and convenience were shown to drive further behavioral intentions towards both the app and the products. The difference in comparison to the results of the study in the 2nd Article, where the reported responses were not related to further purchase of the products, are likely due to the difference in context. The retail environment creates a stronger link between the technology and the purchase-related activity and situates the app more clearly in a shopping environment. Given the fact that AR still represents a rather new technology, such context offers more cues of how to use AR as a shopping tool. In the study presented in the 2nd Article, the use of AR was not integrated in a wider commercial context, which likely directed the user's attention towards the technology, but not towards the products.

These results represented an important further step from our previous findings in the 2nd Article as they re-affirmed that perceived augmentation represents a relevant concept and that the affective and cognitive responses were not only related to interaction with the technology, but also to the products. This was shown both through qualitative and quantitative data. The findings offered tools for more complete conceptualization of perceived augmentation and directed the research towards the final study.

4th Article

Based on related theory and previous findings, in this chapter we defined perceived augmentation as a two-dimensional construct, composed of perceived virtual enhancement and virtual-physical congruency. Furthermore, we hypothesized that perceived augmentation related to enjoyment and informedness, which further impact behavioral intentions. After further item development, we evaluated the validity and reliability of the concept's measurement scale.

The validation study comprised exploratory factor analysis, confirmatory factor analysis and structural equation modeling. The results offered a strong confirmation of our propositions with regards to the construct, validating the measurement items within the scale and confirming the perceived augmentation as a two-dimensional construct. Finally, the concept was tested within a nomological net in structural equation modeling, which affirmed its validity, showing that perceived augmentation relates to the other concepts as hypothesized.

One of the most interesting findings is the difference between the two dimensions in terms of their impact on consumer experience. Virtual enhancement was shown to have a significant *negative* impact on enjoyment, while virtual-physical congruency showed a significant *positive* impact on both enjoyment and informedness. Enjoyment and informedness further impacted behavioral intentions to use the app and purchase the products, enjoyment showing stronger impact than informedness. This again confirmed the important role of the affective component in consumer experience as the more powerful driver for behavioral intentions when using AR. Importantly, in this case the behavioral intentions were confirmed to be directed towards both future use of application as well as towards purchase activities, which represents different findings from the results of the 2nd Article and confirms the results of the 3rd Article.

It is possible that the different settings across the studies have had an impact on such outcomes. In the study of 2nd Article, participants' use of AR was not contextualized in a consumption environment and was not referring to other possible episodes of purchase; it rather existed as an isolated trial of a novel technology. In the 3rd Article, the participants were situated in a real shopping environment, which evoked consumption context and made AR a part of the commercial environment, which is most likely why the results showed a significant relation between perceived augmentation and purchase intentions. Furthermore, it is crucial to recognize that in the final study, the participants were engaged in a more continuous use of the app, with which we aimed to avoid the novelty effect demonstrably impacting the experience. This use of the AR app over a five-day time period created a sequence of episodes that possibly allowed users to develop an appreciation of the app beyond its fascinating technological features and thus start seeing it as a tool for possible future purchases.

Finally, the last study shows that the visual fit between the physical and virtual, and their correspondence in real-time, represent the key driver or determinant of consumer experience in comparison to a mere overlay of visual elements on the physical surroundings. If such a level of fit is not achieved, then the related consumer responses would thus be expected to be less prominent or missing.

6.2 Theoretical contributions

We identify the three main contributions of this thesis to be the following. Firstly, the thesis brings attention to the AR-specific media characteristic called *augmentation*, which is what sets it apart from other interactive technologies. While media characteristics of other interactive technologies are relevant for further investigation of AR, and should be placed high on the research agenda, perceived augmentation seems to hold the key to understanding how this technology impacts consumer responses. Perceived augmentation contributes an explanation of consumer perception of the visual overlay of physical surroundings with virtual annotations on the screen. The series of studies show that perceived augmentation consists of two dimensions: virtual enhancement - relating to the overlay of the physical world with virtual annotations; and physical-virtual congruency - the dimension related to the fit of the virtual elements in the physical surroundings, making them seem a part of it. The conceptualization of perceived augmentation relied on the framework of TIME theory and contributed to it by defining this new media characteristic and the corresponding psychological notion, i.e. user perception of the augmentation.

Secondly, while the 2nd and 3rd articles of the thesis explored the concept of perceived augmentation, the final chapter developed a more complete list of related measurement items, which were then systematically evaluated throughout the required stages of scale validation. The methodological confirmation of the scale proved that the proposed items together constitute an appropriate measurement tool for assessing the user perception of augmentation when interacting with AR technology. The contribution of such a scale can ensure that an evaluation of user perception of AR's most prominent feature is conducted with appropriate tools that correspond to the specific affordances of the technology. With the validated scale at hand, future research can also avoid using tools that were conceived and designed for other types of technology – such as a scale for perceived interactivity, as discussed in the 2nd Article. Evaluating AR with such tools only brings insights with regards to the features that existed prior to AR, but not to the novel AR features.

Thirdly, this research has observed perceived augmentation throughout all three empirical studies in relation to consumer experience and brought forward some novel observations and explanations. The first empirical study showed that perceived augmentation only yielded affective, cognitive and behavioral responses pertaining to the application, but not really with the brand and that affective responses (notably attitude) were confirmed to a larger extent than the cognitive ones (i.e. application-related thoughts). The second study confirmed the findings that affective responses play a crucial role in consumer experience with AR and found evidence that the cognitive response (i.e. perception of convenience offered by an AR tool) also constitutes a significant part of the consumer experience. Furthermore, it showed that an AR tool, when perceived to deliver a high level of augmentation, leads not only to application-related behavioral intentions, but also to purchase intentions. These findings were further confirmed in the model in the final study. While both the affective (i.e. enjoyment) and cognitive (i.e. informedness) parts of the experience had a significant impact on behavioral intentions, enjoyment again showed a stronger effect. Also in this case the behavioral intentions were not only application-related, but also purchase-related. Given these results, we conclude that consumer experience with AR – based on the perception of the delivered augmentation – is of a highly affective nature, where positive attitude, enjoyment and playfulness are formed during the interactions. This is complemented by more cognitive responses such as having a sense of being informed and perceiving the app to offer additional convenience. Consumer intentions to engage with the technology in the future and to consider the tried products are to be expected as the behavioral part of the responses when AR is situated in an appropriate consumption context. Such findings prove that AR - with its ability to augment physical surroundings in real time - holds strong potential as a tool for building an experience that is both pleasant and useful for consumers and can evoke an intention to purchase the product(s) it simulates.

Finally, the project has been interdisciplinary in nature from the very start and built the studies on concepts from communication and human-computer interaction fields. By combining literature from these fields, we brought attention to the concepts that are less considered in consumer behavior, but can nevertheless offer valuable theoretical and methodological tools in our field. On the other hand, some findings from these studies potentially carry significance to improve understanding of the user experience in non-marketing contexts, such as education, culture, tourism, health and similar. This knowledge about how consumers perceive the augmentation and how that affects their experience with technology can feed into understanding of general user interaction with AR, which is main subject of interest in HCI. One of the main findings of the three studies is related to the fact that the context is of particular importance in AR. Regardless of how mesmerizing the augmentation proves to be, AR will offer a valuable tool to a user only when suitably integrated in the environment. If use of AR is conducted in a sort of isolated way, as it was the case in the study presented in the 2nd Article, it can prove to be enjoyable, but the user would not perceive it as a tool that supports the brand or as a driving tool for purchases. On the other hand, if AR is integrated in the environment (3rd Article) or has been used continuously and thus not merely as a one-off episode (4th Article), it can prove to offer a strong support to the activity. These assumptions are to be tested in other contexts and can offer a strong guidance for designing user experience with AR in different contexts.

6.3 Some methodological contributions

We believe that a valuable element of the final study was the condition that participants had to engage in continuous use of the app. Since AR is still somewhat new as a technology, it is important to make attempts to mitigate the initial fascination that it may produce and evaluate the experience as one that is not related to the novelty, but predominantly to the objective features of the app. The condition of multiple use of the app in the final study assures, to at least some extent, that this is was the case.

Furthermore, we believe that the work conducted for the 3rd Article generated especially valuable data, given that they were collected in the store and, therefore, in real-world context. This represents data of a different quality in comparison to the lab experiments with a student population, which is one of the most common methodological approaches in the consumer behavior field. While this common approach guarantees a high level of internal validity by being able to control the different conditions that could have an impact, it can neglect or fail to observe the factors that determine the "true" experience with technology in a realistic setting. Our observational study, following the "in-the-wild" approach (Rogers, 2011), was thus able to complement the findings from the lab studies with real-world findings and ensured data triangulation, leading to higher validity of the results.

6.4 Limitations

Almost every piece of work could, conceivably, be improved upon in certain aspects and it can be instructive to recognize such limitations.

While we tried to provide as all-inclusive an overview as possible in the 1st Article, there are papers that we did not include in our selection of reviewed literature. We reached a certain level of saturation with the findings, but we allow for the possibility that other studies could also have brought relevant insight and important emphasis to the review.

In the 2nd Article, we present two experimental studies in which the effects of an AR app were compared with effects of a website with similar features, but without AR. Additional, more complex manipulation of the augmentation would offer additional strength in exploring the causal effects and provide stronger evidence of the tested hypothesis.

The final study validates a scale with one quantitative study. While some other studies have also conducted scale validation with one large study (Moon & Kim, 2001), it is in general perceived as good practice to conduct additional validation with new samples and in new contexts in order to increase the generalizability of the scale.

Furthermore, our approach to consumer experience focused more on the separated consumer responses within consumer experience than on the holistic character of the experience. While such approach is well established (Brakus et al., 2009), study and analysis of other elements, such as channel atmosphere, pricing, social environment and situation moderators (Verhoef et al., 2009) would shed more light into the complexity of consumer experience with AR. Verhoef et al. (2009) also emphasize the importance of the *total* experience comprising of different pre- and post-purchase activities. Some of this complexity was presented in the 3rd Article, where consumer interaction with AR app was observed in a more holistic approach, including factors such as approaching the app, interaction with sales assistants during the app usage and integration of the app with the products in store. Nevertheless, further studies about how AR is integrated in consumer experience *as a whole* are undoubtedly required.

AR apps exist in various formats and can be combined with many technologies (Carmigniani et al., 2011; Javornik, 2014). We included three different devices in our studies (computer, tablet, smart phone) and three different formats – virtual mirror, furniture simulation app and a coloring app that augmented colored material to appear as 3-D simulation with movements in real-time. While including even more variety in terms of both the app types and the devices with AR technology would have served to further increase the validity of our results, we were bounded by the availability of the apps and their quality. The applications and websites used were some of the best currently available AR commercial apps and thus guaranteed, to some extent, a consistent experience for different users under different circumstances. Such limitations will be ever increasingly smaller in the future, posing fewer issues for further investigation.

Finally, most of our studies examined the interaction with AR and the related experience on a purely individual level. The reason for this is related to the design of commercial AR apps, which calls at this stage for more individual use, even though many trends of AR apps are directed towards developing collaborative AR (Billinghurst & Kato, 2002). However, social presence and social use could significantly change AR experience and, while not discussed in this project, it is an important determinant to keep in mind.

6.5 Directions for future research

These are certainly exciting times to be conducting research on AR in marketing. The phenomenon is as yet young and relatively unexplored and the opportunities for further investigation are, therefore, vast.

To start with, the heterogeneity of the different AR apps calls for further studies investigating the different effects across these formats. Do large interactive screens placed in public spaces create a more enchanting consumer experience because they offer a larger screen that allows for more impressive augmentation? How will wearable AR, currently not yet available on the market, be used in commercial contexts? Many answers pertaining to AR formats need to be addressed with further empirical investigation.

Beside the formats, the contexts of use also deserve further attention. AR cannot be deployed and distributed as a ubiquitous media, or at least that has not been the trend so far. Rather, the appropriate contexts for it need to be sought. Are public and semi-public spaces an appropriate context for a virtual mirror, given that people who pass by can observe the user trying on different apparel, thus introducing the potential risk of social embarrassment (Akpan et al., 2013)? Will private space prevail as the most appropriate context as it offers the most privacy for experimenting with different augmentation features and the greatest flexibility for customized use? These and other questions about appropriate AR deployment call for further studies.

From a theoretical point of view, aspects of immersion and presence have been touched upon in this project, yet they deserve further attention. To which extent does the perception of virtual annotations yield real impact on consumer gestures and behavior? Does someone who has tried on virtual make-up or apparel in AR mirror, behave as if these products are really worn by him or her? Our research demonstrates that a well-designed AR app makes a consumers perceive the virtual to be part of the physical. However, does that mean that virtual is perceived to be the same as physical or do they rather co-exist side-by-side? Most cases so far have shown that consumers for most of the time remain aware of the fact that virtual is not physical – and yet, they react to it as they would react to a physical object. To which extent can the virtual part of AR thus substitute the real-world objects and which physical entities remain irreplaceable? More light needs to be shed on these subjects. Also, since AR is quite closely related to virtual reality (Blascovich & Bailenson, 2011), comparative studies of the two are required to better understand the differences between them, consumer reactions to them and in which situations each is most suited.

From a methodological point of view, more research is certainly needed to further validate the perceived augmentation scale. We thus call for other quantitative studies that would employ the scale in other contexts with other AR apps and examine both the concept of perceived augmentation as well as its further connection with consumer experience.

Finally, the consumer responses that we studied in this project represent only a selected set of insights into how AR can impact consumer behavior. The opportunities for further investigation of this aspect are very inviting: what are the motivational structures that entice users to use AR? What value does this technology provide for consumers and to which extent are users likely to adopt it, for which demographic or psychographic groups does it engender the greatest effect?

All these and numerous other questions wait to be answered and the work presented in this thesis provides hopefully some basis from which to construct this future research.

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8. APPENDIX

8.1 List of publications

Key publications:

Javornik, A., Rogers, Y., Moutinho, A., Freeman, R. (2016) Exploring the Use of a Make-Up Augmented Reality App in a Store. *DIS '16 - Designing Interactive Systems 2016*, July, Brisbane. (26% acceptance rate)

Javornik, A. (2016) "It's an illusion, but it looks real!" Consumer affective, cognitive and behavioral responses to augmented reality applications. *Journal of Marketing Management*, Special Issue – Magic in Marketing, Academy of Marketing 2015

Javornik, A. (2016). Augmented reality: Research agenda for studying the impact of its media characteristics on consumer behaviour. *Journal of Retailing and Consumer Services*, 30, 252-261

Javornik, A. (2016). What marketers need to know about augmented reality. *Harvard Business Review* (online) https://hbr.org/2016/04/what-marketers-need-to-understand-about-augmented-reality

Journal publications and conference proceedings

Javornik, A., Rogers, Y., Moutinho, A., Freeman, R. (2016) Exploring the Use of a Make-Up Augmented Reality App in a Store. *DIS '16 - Designing Interactive Systems 2016*, July, Brisbane (26% acceptance rate)

Javornik, A. (2016) "It's an illusion, but it looks real!" Consumer affective, cognitive and behavioral responses to augmented reality applications. *Journal of Marketing Management*, Special Issue – Magic in Marketing Academy of Marketing 2015

Javornik, A. (2016). Augmented reality: Research agenda for studying the impact of its media characteristics on consumer behaviour. *Journal of Retailing and Consumer Services*, 30, 252-261

Javornik A. (2015) "“Wow, I can augment myself?” Measuring effects of perceived augmentation and interactivity on affective, cognitive and behavioral consumer responses. Conference proceedings of Academy of Marketing 2015. Limerick, Ireland. July 2015

Javornik A. (2015) “Wow, it looks like it's real! But can you fix it a bit?” Measuring effects of augmented reality on affective, cognitive and behavioral aspects. Proceedings of EMAC - European Marketing Academy Conference. Leuven, Belgium. May 2015

Javornik, A. (2014). Classification of augmented reality tools in marketing. Conference Proceedings of ISMAR – International Symposium for Mixed and Augmented Reality.

Javornik, A., & Mandelli, A. (2013) Research categories in studying customer engagement. Conference proceedings of Academy of Marketing conference 2013, Cardiff, UK

Javornik, A., & Mandelli, A. (2012). Behavioral perspectives of customer engagement: An exploratory study of customer engagement with three Swiss FMCG brands. *Journal of Database Marketing & Customer Strategy Management, 19*(4), 300-310

Javornik, A., & van Kaldekerken, I. (2010). LSF 2010 - Lugano sustainability forum 2010: Competitive advantage when going sustainable. *Zeitschrift Für Wirtschafts- Und Unternehmensethik, 11*(1), 82-86

Other conference presentations

Javornik, A. (2015). Impact of AR media characteristics on consumer responses. PhD Showcase, University College London Interaction Centre. June 2015.

Moutinho A., Javornik A., Koutsolampros P., Aitor R., Blume P., Julier S. (2015) A collaborative process of creating local memory though augmented reality. Media City '15. Plymouth, UK, May 2015

Javornik, A. (2015) “Reality is in the air” - Consumer responses to features of augmented reality technology . Consumer Research Doctoral Colloquium . Chester, UK, March 2015

Javornik, A., & Mandelli, A. (2013). Customer experience of augmented reality at brands’ events. Poster presented at Conference of Association for Consumer Research – ACR, Chicago, October 2013

Fuduric, M., Javornik, A., & Mandelli, A. (2013). Empirical bias in digital marketing research. Marketing Science 2013, Istanbul, July 2013

Javornik, A., & Mandelli, A. (2013). Customer experience of augmented reality at brands’ events. Presented at ICA 2013 Doctoral consortium Communication and Technology Division, London, 2013

Invited talks

Consumer experience of augmented reality. MediaEffects Research Lab, PennState University, invited by institute director, prof. Shyam S. Sundar. August 2013, Pennsylvania, USA

Research agenda in digital marketing. Presentation at BIT (Business and Information Technologies) annual meeting, Università della Svizzera italiana, July 2013, Lugano

Consumer experience of augmented reality. Presentation at HP (Hewlett & Packard) Innovation Center, invited by center's director Paul Jeremaes. April 2013, Genève

Enriching the moment – Augmented reality technology at brand events. Digital Marketing Group Genève, April 2013, Genève

Industry collaboration

Virtual Try-On at English National Opera. Holition 2016. http://www.holition.com/portfolio/investigating-digital-anthropology-at-the-english-national-opera

The Store of the Future – Make-Up Virtual Try-On. Holition 2015. http://www.holition.com/portfolio/the-store-of-the-future-hema

Future talent meets the industry. ESOMAR 2012. https://www.esomar.org/career-development/students-and-academics/future-talent/participating-students-and-testimonials/students-2012/ana-javornik.php

8.2 Classification of Augmented Reality Uses in Marketing

Javornik, A. (2014, September). Classifications of augmented reality uses in marketing. In *2014 IEEE International Symposium on Mixed and Augmented Reality-Media, Art, Social Science, Humanities and Design (ISMAR-MASH'D)* (pp. 67-68). IEEE.

Abstract *This research investigates which uses of AR have emerged so far in marketing and proposes classification schemas for them, based on the intensity of the augmentation, different contexts of consumption and on marketing functions. Such differentiation is needed in order to better understand the dynamics of augmentation of physical surroundings for commercial purposes and consequently to distinguish between consumer experiences.*

Introduction

Interactive technologies in marketing have been defined as various tools that allow different parties to engage in mediated communication to facilitate exchange between them [1]. They have proven relevant for marketing due to their ability to establish innovative, more functional and enjoyable interactions [2], to engage consumers with brands [3] and to expand the possibilities for both consumers and brands in terms of promotion, market research, prices, product customization, customer service and customer relationship management. Along those lines, augmented reality (AR) technology has started to be implemented in the last six years and represents a steadily growing area of interactive technology for commercial purposes. AR in its different formats accessible through various devices offers tools to upgrade consumer experience and provide new options for delivery of offerings.

However, the existing literature in marketing has yet not provided a clear distinction of different augmented reality formats and there currently exists no definition or explanation in which manner augmented reality applications support marketing functions. This paper provides three types of classification. Firstly it looks at the existing augmented reality uses in marketing based on their characteristics and contexts of consumptions. Secondly, it classifies the existing uses based on the marketing functions these uses are trying to fulfill. Thirdly, it categorizes how the AR tools engage consumers based on their utilitarian and hedonic needs.

Theory

The novelty that augmented reality brings to marketing is linked to at least three factors. Firstly, advanced AR tools are able to establish real-time interactivity between products, physical spaces, brands and consumers. It aligns the digital environment on smart devices with the real time surrounding in such a way that the boundaries between them disappear. This creates a stronger physical-virtual proximity between the brand and the customer.

The online and mobile interactivity that was previously based on exchange of textual, visual, video and geolocation information across platforms is now seamlessly incorporated into existing physical environment. Secondly, AR's capability for simulation enables marketers to digitally promote and present their products in a much more efficient way than before. Consumers' risk of uncertainty, linked with online purchases of products they haven't tried or seen before, diminishes due to product simulations and virtual try-ons. Thirdly, AR advanced visual representations create superior customer experience, offering powerful tools to break through the advertising overload and immerse customers into a radically different experience. Given its relative newness, AR marketing often elicits "wow" effects from customers.

The novelty of AR in marketing can be analysed through: technological advancements and applications, marketing functions and customer needs. Firstly, from the user experience / context point of view, we propose a classification of the marketing AR tools following the division of *outdoor* and *indoor* AR tools by [4]. In the context of marketing, outdoor would thus refer to the AR technology and applications, which are provided and used in public places for marketing purposes. Indoor AR technology refers to applications and tools that consumers can use in their private space, without the need for an additional content or technological input from public spaces. Secondly, from the firm's perspective, it is relevant to recognize which marketing functions can be supported through AR and how. Marketing functions are defined as involvement in the following areas: sales force, advertising, customer service, product management and marketing research [5]. Thirdly, when taking the position of the consumer's experience, we can distinguish two basic categories of needs that a consumer aims to satisfy through consumption: utilitarian and hedonic [6]. The utilitarian needs are linked to functional use of certain product or media, while the hedonic is connected with the experiential part and has to do with enjoyment. Quite often, media experience or content can represent a mixture of both.

Empirical part

51 cases of AR marketing tools were collected through an online search. The process of collection included: a) collection AR campaigns available on the websites of market leaders in production of AR marketing campaigns; b) search of the most popular AR campaigns through search engines and YouTube (since the latter is the most often used

channels for display of AR campaigns due to its multimedia content); c) search for as many different formats of AR marketing as possible.

Methodology

We analyzed the following dimensions of these campaigns: a) types of indoor and outdoor AR tools and characteristics of the augmentation; b) marketing functions that these AR tools support and c) how the content of these AR applications aims to satisfy consumer needs.

Analysis

When defining the different types of augmented reality tools and the spatial context of their consumption, we analyzed them through the premise of augmentation of marketing offerings. Most of the analyzed cases (70.5%) were those for which individual smart devices are needed. Less often, public AR technology was adopted (33%), such as fixed public interactive screens, interactive stores and 4D projections.

	Public spaces	**Private uses**
Low augmentation	Public content augmented through smart devices or fixed interactive screens, Augmented advertising	Static content augmentation through image recognition
Medium augmentation	Personalized and gamified augmentation through static screens	Personalized and gamified augmentation through personal devices
High augmentation	4D projections, Interactive stores, Virtual try-on displays	Spatially dynamic augmentation with personalization (customization; e.g. IKEA, RayBan Mirror)

Table 1: Classification of AR augmentation level and usage space

In two cases, the same application was available through both fixed public interactive screens and smart devices. It could be assumed that the reason for the higher number of private AR applications is its lower production cost. Based on the analysis, we propose that augmentation can occur on different levels. Low augmentation is linked to image recognition through which a smart device unlocks the content and augments it with additional informational, visual or video material. More advanced levels of augmentation can include personalized content and gamification content, where interactivity between the user and the augmented content occurs on multiple levels. The highest level of augmentation includes interactivity among the user, augmented content and the space - real time simulation aligns digital content with the spatial surrounding and adapts commercial content in a functional or experiential way.

In terms of marketing functions, the analyzed cases show that most often AR technology supports advertising/promotion, customer service and product management.

	Marketing functions		
	Advertising / Promotion / Branding	**Product management**	**Customer service**
AR tool	Promotion / advertising through augmented content, gamification, 4D projections; Interactive stores	Personalized augmentation and simulation (virtual try-on); Interactive stores; Augmented content	Technical assistance through AR apps (e.g. car assistance); Wearable technology

Table 2: Prevalent marketing functions supported through AR

In most of analyzed cases, AR tools provided content augmentation for the purpose of advertising, promotion and branding (72.5%), most often by the use of smart devices. 4D projections, where projected content augmented store openings, also belong to this category. Further on, products are managed through augmented personalization; for instance customers can assemble their own jewelry and try items on through simulation. This also represents a very popular use of AR (33%). Finally, some applications focus on the post-purchase phase and offer customer assistance through the augmented application (7.8%). Certain AR applications fulfill multiple functions (e.g. interactive stores).

	CONSUMER NEEDS		
	Utilitarian	**Hedonic**	**Both**
AR tools	Wearable, Content augmentation with functional information	Augmented advertising; Gamified augmentation; 4D projections	Virtual try-on, Edutainment

Table 3: Consumer needs satisfied through content engagement

We also investigated what type of content engagement do the existing AR tools offer. The purely hedonic, entertaining content occurs in highest number of AR applications (45%) in our sample. Prevalently utilitarian content appears in 27.5% AR apps. 27.5% of cases present both utilitarian, functional content in combination with hedonic (edutainment campaigns, virtual try on).

Limitations

These typologies and initial research are based on the data available on the Internet. To further confirm the categories, it would be necessary to investigate firms' and users' perspective through bigger samples and primary data collection. An additional marketing function that AR could support, but was not available for analysis, is marketing research, as it collects important additional information about consumers.

Discussion and conclusion

The provided classifications can serve as first orientations of possible opportunities that this technology offers for augmented interactions between brands and consumers. It can lead to clearer distinction of AR marketing in terms of its link to space, customer engagement and purposes for marketing and enables marketing community to investigate more in-depth the characteristics of augmented touchpoints and their relevance for marketing offerings and for users. Besides its findings, it also opens many questions to be explored. Firstly, classifications can further develop more precise distinction of different AR tools based on types of interaction, virtual content and touchpoints. Further research about AR in marketing should also focus, among others, on understanding how utilitarian and experiential value can be most successfully combined, in which contexts one is preferred over the other and why and to which extent these practices differ from other marketing activities. Moreover, it would be crucial to understand how effects of AR campaigns change when they are synchronized and combined with other marketing channels.

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