“I see myself, therefore I purchase”: factors influencing consumer attitudes towards m-commerce AR apps

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Abstract

Mobile commerce (m-commerce) is starting to represent a significant share of e-commerce. The use of Augmented Reality (AR) by brands to convey information about their products - within the store and mainly as mobile apps – makes it possible for researchers and managers to understand consumer reactions. Although attitudes towards AR have been studied, the overall effect of distinct aspects such as the influence of others, the imagery, projection and perceived presence, has not been tackled as far as we know. Therefore, we conducted a study on 218 undergraduate students, using a pre-test post-test experimental design to address the following questions: (1) Do AR media characteristics affect consumer attitudes towards the medium in a mobile shopping context? Also, (2) Do the opinion and physical presence of people influence the attitude towards an m-commerce AR app? It found that AR characteristics such as projection and imagery positively influence attitudes towards m-commerce AR apps, whereas social variables did not have any influence.

Keywords: MAR; m-commerce; consumer psychology; AR-consumer relationship.

1 Introduction

Simultaneously with the increasing percentage of e-commerce sales resulting from mobile retail commerce (m-commerce), it is estimated that in the U.S., by 2020, 49.2% of online sales will be made using mobile apps (Statista, 2019b). Also, in 2018, approximately 57% of internet users purchased fashion-related products online (Statista, 2019a).

Several factors have contributed to the rise of m-commerce, such as the increased computing capacity of mobile devices, the fact it saves time and money, and the inclusion of technological innovations that create new ways to present products (Beck & Crié, 2018; Pantano & Priporas, 2016). Thus, the incorporation of technology like Augmented Reality (AR) leads to a whole new retail experience, primarily through the development of m-commerce AR apps (Dacko, 2017).

AR is a point on the Virtual Continuum where 3D computer-generated artefacts are overlaid on the real environment to enable blending of the real and virtual worlds (Azuma, 1997; Milgram, Takemura, Utsumi, & Kishino, 1994; Schmalstieg & Hollerer, 2016). Thus, AR can enhance our perception of reality by augmenting both the product (within a marketing context) and the environment (Preece, Sharp, & Rogers, 2015). This enhancement of reality can be achieved through different devices, such as handheld displays (e.g. smartphones, tablets), head-mounted displays (HMD, e.g. smartglasses) or special displays (Carmigniani et al., 2011).

In order to comprehend the increasing incorporation of Mobile Augmented Reality (MAR) into company marketing strategies, we need to understand which factors influence consumers the most while using this technology. Additionally, studies regarding the use of m-commerce AR apps within the context of a social event are scarce.

Therefore, drawing on the theories related to the media characteristics inherent in AR, namely those focusing on augmentation and presence (Javornik, 2016b, 2016a; Verhagen, Vonkeman, Feldberg, & Verhagen, 2014), as well as on theories related to social influence (Borges, Chebat, & Babin, 2010; Lee, Shi, Cheung, Lim, & Sia, 2011), we explore how these factors affect consumer attitudes towards m-commerce AR apps. Specifically, we aim to address the following questions:
RQ1: Do AR media characteristics affect consumer attitudes towards the medium in a mobile shopping context?
RQ2: Do the opinion and physical presence of people influence attitudes towards an m-commerce AR app?
To answer these questions, we structured this study as follows: we review the literature on AR and its augmentation affordance; the usability of new technologies, and the social factors that influence the use of an m-commerce AR app. We then present our experimental design, followed by the results of the logistic regression and a discussion of the results.

2 Literature Review

2.1 Acknowledging Augmented Reality

Past research on the acceptance of AR technology focused on three main themes: a) Acceptance of smart glasses (i.e. wearable computer glasses); b) MAR; c) AR marketing effectiveness.

Acceptance of smart glasses
Smart glasses are a type of portable AR solutions. Due to their inherent characteristics, several authors studied their emergence from different perspectives. For instance, to explain the adoption and use of smart glasses, we can focus on the Big Five Model of Human Personality (Rauschnabel, Brem, & Ivens, 2015), the Technology Acceptance Model (Rauschnabel & Ro, 2016), or the Uses and Gratifications Theory (Rauschnabel, 2018). People who displayed extraversion and openness traits were more likely to adopt smart glasses, whereas those who score higher on neuroticism were less prone to adopt such devices (Rauschnabel et al., 2015). Moreover, the degree of technology innovativeness was found to be a predictor of the use of smart glasses, whereas social norms were relevant for the consumer's intention to adopt these devices, despite not being related to consumer attitudes towards the use of smart glasses (Rauschnabel & Ro, 2016). Regarding the Uses and Gratifications Theory, Rauschnabel expanded the current literature by developing a framework that considers six gratifications derived from the use of smart glasses, with a particular emphasis on the need to enhance reality, as well as the segmentation of the context of private vs public use (Rauschnabel, 2018).

MAR
The sophistication of the computational power and sensors of mobile devices, the ubiquity they offer, and the 24/7 Internet access they provide, made them the perfect target for developing mobile AR apps (MAR). MAR differs from the Azuma's 'traditional' definition of AR because the MAR system runs and/or displays the 'new reality' on mobile devices, such as smartphones or tablets (Chatzopoulos, Bermejo, Huang, & Hui, 2017). Further research focused on the User Experience (UX) found that a good UX of an AR mobile app leads to more positive experiences, thus

increasing emotional engagement, and that this UX is affected by characteristics intrinsic to the technology itself (Dirin & Laine, 2018; Olsson, Lagerstam, Kärkkäinen, & Väänänen-Vainio-Mattila, 2013).
Additionally, Dacko focused his research on the use of MAR as part of a smart retail environment. He found that MAR apps offer extrinsic benefits, which are highly valued by app users (Dacko, 2017). Moreover, MAR apps offer more benefits than those offered during a shopping experience, and they leverage retail setting evaluations, which add experiential value to the retail setting (Dacko, 2017).

AR marketing effectiveness
Past research focused on understanding whether AR was a useful tool for marketing purposes. Therefore, there are studies analysing the impact of the incorporation of AR technology on e-commerce websites. These found that the perceived ease of use, perceived usefulness and perceived enjoyment of the system promotes an attitude that leads to the adoption of AR technology, which consequently affects the behavioural intention of AR usage (Pantano, Rese, & Baier, 2017). Moreover, when comparing a technical aspect of AR, namely the tracking techniques, Brito and Stoyanova found that the use of a markerless AR system outperforms the marker-based one (those that need a fiducial and tangible marker to create the AR experience) when comparing brand recommendation intentions (Brito & Stoyanova, 2018).

2.2 Perception of Augmented Product
The definition of AR relates to the ability of this technology to expand the real environment interactively and in realtime with 3D computer-generated data (Azuma, 1997). This 'data' that can be overlaid to the real-world can come from a variety of sources, namely, images, videos, texts, and haptics (Craig, 2013; Roxo & Brito, 2018). With the advent of MAR, companies started to develop mobile apps that superimpose commercial products, such as make-up (e.g. L'Oréal), sunglasses (e.g. Ray-Ban), or even furniture (e.g. IKEA), on the real environment.
Drawing on the study conducted by Laroche and colleagues (2005) on the link between intangibility and difficulty of evaluation and perceived risk in an online shopping context (which lacks physical tangibility), we adapt their concept of intangibility to the AR context. Therefore, we define 'projection' as a concept that grasps the ability to augment the presence of a product (making it more tangible) using an AR visualisation. Thus,
H1: *AR Projection will positively influence consumer attitudes towards the use of m-commerce AR apps.*
Traditionally, imagery is "a mental event involving visualisation of a concept or relationship" (Lutz & Lutz, 1978, p. 611), which can be elicited by a pictorial or verbal stimulus, or by inducements (Lutz & Lutz, 1978).
In this study, we follow the definition offered by Bone and Ellen, who consider imagery as "the clarity with which the individual experiences an image" (Bone & Ellen, 1992, p. 96). This is similar to the conceptualisation of vividness used by Yim, Chu, & Sauer (2017). In their study, Yim and colleagues found that vividness generates positive consumer evaluations that will impact media immersion. Therefore, as AR can enrich the environment with pictorial stimuli, it creates a sense of presence/mimics the real experience of the product (Rodríguez-Ardura & Martínez-López, 2014; Roggeveen, Grewal, Townsend, & Krishnan, 2015). Therefore, the way

users perceive the quality of the augmented product (in this case sunglasses) will affect their attitudes towards the AR app.
H2: *Imagery will positively affect consumer attitudes towards MAR Apps.*

2.3 Perception of Environmental Augmentation

Augmentation can be defined as the ability of AR to add additional virtual and dynamic capabilities/content to real systems (Billinghurst, Clark, & Lee, 2014). Despite this inherent characteristic of AR, which enriches the real environment by blending both the virtual and the real, few studies have focused on this feature. Javornik devoted her attention to understanding whether the use of AR generated perceived augmentation, i.e., the way the self psychologically processes the environment enhancement. She found that its effects on subjects' affective and cognitive responses were mediated by flow (Javornik, 2016b). However, a link between perceived augmentation and the subjects' attitude towards AR is a topic that has yet to be studied. Therefore,
H3: *Perceived Augmentation positively influences consumer attitudes towards the use of m-commerce AR apps.*
When in a Mixed Reality (MR) context, the subject experiences object presence or the sense of being somewhere else through a computer-mediated environment (Steuer, 1992). Drawing on the notion of Klein's telepresence and Verhagen and colleagues' local presence definition, we conceptualise perceived presence as the way that the self positions itself within an MR context, i.e. whether the person feels (s)he is closer to the real or the virtual environment (Klein, 2003; Verhagen et al., 2014). Verhagen and colleagues found that new ways of presenting products reinforce the likability and tangibility of products, which leads to purchase intention (Verhagen et al., 2014). However, they did not find any link between presence and behavioural intentions.
H4: *Perceived Presence positively impacts consumer attitudes towards the use of m-commerce AR apps.*

2.4 Technology Usability

The Technology Acceptance Model proposed by Davis explains users' acceptance of technology according to two dimensions: ease of use (EoU) and usefulness (Davis, 1989). Ease of Use expresses the degree to which a user feels (s)he can use a system/technology effortlessly, and this can be due to a good user interface, whether the system is intuitive or not, and so on (Davis, 1989).
Past research did not find a direct link between EoU and attitude (Kim & Forsythe, 2008). However, a comparison between German and Italian samples found a positive association between EoU and users' attitudes towards the adoption of AR systems for the German sample (Pantano et al., 2017).
H5: *Perceived Ease of Use of the app will positively influence users' attitudes towards the use of m-commerce AR apps.*

2.5 Social Influence

Shopping is perceived as a social experience (Falk & Campbell, 1997; Tauber, 1972), influenced by friends, family and reference groups – social influence. Conversely, in the paradigm of Web 2.0 and social media, the influence that others might exert over consumption decisions is even more relevant (Bilgihan, Kandampully, & Zhang, 2016). However, manifestations of this phenomenon are not evident within the context of mobile shopping. Past research highlights the fact that shopping with

friends is positively associated with the companion effect and hedonic shopping values, as compared to shopping alone or with relatives (Borges et al., 2010). In addition, it was found that the link between attitudes towards online shopping and the intention to purchase online is reinforced by the role of strangers as sources of social influence (Lee et al., 2011). Moreover, younger adults place a higher value on the opinions of others, such as reviews posted by ordinary people (as in Amazon), influencers and bloggers (Pantano & Gandini, 2018). Therefore, we anticipate that consumers rely on others' opinions when shopping in mobile platforms, whether they are companions (family, friends, peers) or strangers (such as influencers), and that consumers are willing to voice their opinions.

H6: *The opinion of others will positively affect consumer attitudes towards AR apps.*

H7: *The presence of acquaintances when using the AR app will influence attitudes towards AR.*

H8: *The presence of strangers when using the AR app will influence attitudes towards AR.*

H9: *My willingness to express an opinion when my acquaintances try the app will positively influence attitudes towards the use of m-commerce AR apps.*

H10: *My willingness to express an opinion when strangers try the app will positively influence attitudes towards the use of m-commerce AR apps.*

3 Method

3.1 Participants

A total of 218 university students in the North of Portugal participated in the experimental design. Once in the lab, they were asked to interact with an AR app installed on tablets. The average age of the participants was 19.62 (*SD*=2.285), 68.0% were female, and 60.7% were Portuguese (the remaining 39.3% were Portuguese speakers). College students are an age group and educationally homogenous group which is more prone to try new technologies like AR, and more experienced in purchasing fashion items online than older people (Owyang, 2010; Priporas, Stylos, & Fotiadis, 2017; Zhitomirsky-Geffet & Blau, 2016).

3.2 Stimuli

We selected sunglasses as the product for the experiment because they are products students perceive as relevant, and they are likely to buy them (product involvement: M= 4.03, SD= 1.891; Zaichkowsky, 1985).

3.3 Procedure

Firstly, the students agreed to take part in the study. Then, they were randomly assigned to the experimental condition (Malhotra, Nunan, & Birks, 2017): 1) using the mobile app alone, with no external interference (n=54); 2) using the app alone, with external interference (n=24); 3) using the app accompanied, with no external interference (n=58); 4) using the app accompanied, with external interference (n=82).

We used the EVO Sunglasses AR mobile app (downloaded from Play Store) and installed it on the tablets. The participants were asked to browse the app and to try one to three sunglasses models for 5 minutes. This time frame was set after several pre-tests and in line with similar designs (Brito & Stoyanova, 2018).

3.4 Measures

This study was a pretest-posttest experimental design (Malhotra et al. 2017). As pre-test measurements, we asked the participants questions about their demographic data and product involvement (Zaichkowsky, 1985). After interacting with the app, we asked the participants about the media characteristics of *perceived* augmentation (adapted from Javornik, 2016a), *perceived* presence (Klein, 2003; Verhagen et al., 2014); *projection* (adapted from Laroche, Yang, McDougall, & Bergeron, 2005), *ease of use* (Davis, 1989). We asked participants about the *imagery* (adapted from Bone & Ellen, 1992), and their attitude towards the AR app (Yim et al., 2017). We further questioned them on the importance they attribute to the opinions of others when using a mobile AR app, the influence they are able to exert on others, and vice-versa. All the measurements were built on 7-point Likert scales, except Attitude towards the AR app, which was a 5-point Likert scale.
The reliability test values (Cronbach alpha) for the variables were acceptable ($0.711 \leq \alpha \leq 0.828$) (Hair Jr., Black, Babin, & Anderson, 2014; Nunnally & Bernstein, 1994).

Logistic Regression
Logistic Regression is a data analysis technique used to fit a logistic model relating a binary/dichotomous outcome variable to explanatory/independent variables (Cox & Snell, 1989; Hosmer Jr., Lemeshow, & Sturdivant, 2013). This model is often used to study the likelihood of an observation that belongs to a particular group (Malhotra et al., 2017).
In this model, the response of the individual took one of two possible values: 0= negative; 1= positive attitude towards m-commerce AR apps. All the model variables are listed in Table 1.

Table 1. Summary of the variables and respective hypothesis

Model	Variable Name	Hyp.
Dependent Variable (DV): attitude towards AR*	ATT	
Projection Imagery	Proj_AR IMG	H1 H2
Perceived Augmentation Perceived Presence	PAug PercPres	H3 H4
Ease of Use	EoU	H5
Importance of others' opinion about the app	ImpOut	H6
Influence I can exert on others while using the app	Influenc1 Influenc2	H7 H8
Influence others can exert on me while using the app	Influenc4 Influenc5	H9 H10

*The DV was coded as 1= positive; 0= negative attitude
We considered gender and the experimental condition as independent variables, they were set as contrasts indicators.

4 Results

Table 2 shows the results of our model.

Table 2. Results of the binary logistic regression

Parameter	Estimate	S.E.	Wald χ^2	Sig.	Odds-ratio
Experimental Condition (M3PInter)			4.117	0.249	
M3PInter1	0.002	0.508	0.000	0.998	1.002
M3PInter2	**-1.204**	**0.635**	**3.590**	**0.058#**	**0.300**
M3PInter3	-0.288	0.496	0.337	0.562	0.750
Gender (Gen)	0.112	0.409	0.075	0.785	1.118
Projection (Proj AR)	**0.922**	**0.221**	**17.486**	**0.000***	**2.515**
Imagery (IMG)	**0.573**	**0.276**	**4.296**	**0.038***	**1.774**
Perceived Augmentation (PAug)	0.041	0.308	0.018	0.894	1.042
Perceived Presence (PercPres)	0.200	0.254	0.620	0.431	1.221
Ease of Use (EoU)	0.088	0.194	0.207	0.649	1.092
Importance of others' opinion about the app (ImpOut)	-0.142	0.186	0.585	0.444	0.867
Influenc1	0.148	0.163	0.826	0.363	1.160
Influenc2	-0.125	0.181	0.479	0.489	0.882
Influenc4	0.013	0.180	0.005	0.943	1.013
Influenc5	0.230	0.183	1.574	0.210	1.258
Constant	-9.135	2.204	17.183	0.000	0.000
Model Fit Statistics					
-2LL	179.259				
Cox & Snell R^2	0.403				
Nagelkerke R^2	0.546				
% Correct predict/obs.	81.7				

Notes: #Significant at 10% level; *Significant at 5% level; $\chi 2$=112.297; 14 df

As a measure of the model fit, we use the Pseudo R^2 variation introduced by Nagelkerke, where the higher the value, i.e., the closer to 1, the greater the model fit (Hair Jr. et al., 2014). Nagelkerke R^2 was preferred over the Cox & Snell R^2 because it gets round the fact that the latter cannot equal 1.0, even when the model fit is perfect (Malhotra et al., 2017). Therefore, our model explained 54.6% (0.546) of the variance in the attitude towards AR (based on Nagelkerke R^2). Despite the fact that the measures of model fit fell somewhat short of the levels of predictive accuracy achieved by this estimation method, the overall per cent of cases that it correctly predicted was 81.7%.

The variables that contributed most to a positive attitude toward m-commerce AR apps were Projection and Imagery, therefore supporting H1 and H2. Moreover, Projection and Imagery showed odds-ratio greater that one, meaning that the attitude towards an m-commerce AR app exerts a stronger influence on the perception of the augmented product.

5 Discussion and Conclusion

In this study, we investigate the impact of several factors related to AR, as well as those associated with a social shopping experience. The former refers to the ability to augment a product in order to enrich reality, and the effortlessness of using the technology. The latter involves the importance of others, the impact of their presence, and a willingness to express their opinion within a purchasing context.

Our findings support H1 and H2 and do not support H3-10 (see Table 3). Moreover, we found a positive relationship between experimental condition 3 (using the app accompanied, with no external interference) and the attitude towards use the of an MAR app.

The empirical results support the fact that product augmentation (in this case sunglasses) to a certain extent reduces the sense of intangibility, and therefore promotes a positive attitude towards the use of these kinds of m-commerce apps. The same rationale can be established for the perception subjects have of a pictorial stimulus such as an AR-based image. This means that the superimposition of 3D computer-generated artefacts enabled by AR, and the perception of the quality of such augmentation, favour the adoption of AR technology in e&m-commerce, especially when increased interactivity and vividness are considered (Yim et al., 2017).

Regarding the influence of the ability of AR to enrich reality, and the induction of this enhanced reality on the self, we did not find any empirical evidence to support its impact on consumer attitudes towards the use of m-commerce AR apps. Our results might reflect the fact that the effect of perceived augmentation is mediated by flow, a variable that we did not take into consideration in our own model (Javornik, 2016b). Also, the lack of support for H4 might be because we investigated the impact of perceived presence on attitudes towards m-commerce AR apps, rather than purchase intention. These findings somehow contradict the study by Klein (2003), who found that higher levels of telepresence lead to more intense attitudes towards the advertised product. The difference in our results might be explained by the fact that we studied an m-commerce app, rather than an advertisement.

Concerning the link between ease of use and attitudes, our results are in line with those of Pantano and colleagues for the Italian sample of their study, (Pantano et al., 2017), which might be due to some cultural influence.

Regarding the lack of support found for the hypothesis relating to social influence (H7-10), this might be related to the fact that young consumers prefer shopping to be an individual activity, rely on friends when needed, and regard intervention by the salesperson with caution (Pantano & Gandini, 2017).

Table 3. Summary of the results of the hypothesis

Hypothesis		**Result**
H1	Projection -> attitude towards use MAR App	Supported
H2	Imagery -> attitude towards use MAR App	Supported
H3	Perceived Augmentation -> attitude towards use MAR App	Not Supported
H4	Perceived Presence -> attitude towards use MAR App	Not Supported
H5	Ease of Use -> attitude towards use MAR App	Not Supported
H6	Others' Opinion -> attitude towards use MAR App	Not Supported

H7	Physical Presence acquaintances -> attitude towards use MAR App	Not Supported
H8	Physical Presence strangers -> attitude towards use MAR App	Not Supported
H9	Willingness to give an opinion to acquaintances -> attitude towards use MAR App	Not Supported
H10	Willingness to give an opinion to strangers -> attitude towards use MAR App	Not Supported

6 Conclusions and future research

In this study, we tried to understand if the attitude towards m-commerce AR apps is influenced by AR characteristics, and by the physical presence of other people. Regarding the media characteristics, we found that both Projection and Imagery had a positive influence on the attitude towards m-commerce AR apps. We found that Perceived Augmentation, Perceived Presence, and Ease of Use did not prove to be significant among our sample, which might be because they could be mediators between Projection or Imagery and the Attitude towards the medium. In a future study, other variables could be added as mediators and/or moderators, such as flow or interactivity.

Another finding of our research was that, contrary to what we expected, social influence did not play a significant role within the context of m-commerce. This finding could be due to the sample used, undergraduate students aged between 17 and 22 years. Thus, further research is needed to reframe the concepts of social influence studied, and well as extend this research to other age groups, both younger (Thaichon, 2017), and older (Drolet, Jiang, Pour Mohammad, & Davis, 2019).

An aspect that deserves further investigation is the link between the attitude towards m-commerce AR apps, and a self-reported measure of purchase intention, as well as to attempt to establish a link between variables such as augmentation and presence and the physiological state of the subjects.

Besides these theoretical contributions, this research provides managers with useful insights into which aspects of MAR interaction could be better designed to meet consumers' needs and expectations.

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