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Abstract

For e-retailers, optimizing their online presence is becoming crucial to stay competitive. Thanks to continuous technological development, particularly in terms of mobile networks and augmented reality (AR)–based apps, retailers are today able to commercialize their products anytime and anywhere. The aim of this study was to identify factors explaining people's use and adoption of AR-based apps. Drawing upon the S-O-R framework, we propose a model that explains the intention to reuse AR-based apps. The results of a study involving 224 participants suggest that the relationship between perceived augmentation and consumers' behavioural intention is fostered by a mediation pattern combining three interrelated cognitive factors, namely, sense of immersion, product presence and perceived realism. The results reveal the importance of perceived realism to encourage adoption of this means of shopping by creating a favourable attitude towards mobile shopping, which, in turn, convinces consumers to reuse such shopping apps.

Keywords: Augmented reality, sense of immersion, product presence, perceived realism, attitude, intention to reuse AR-based apps.

1. Introduction

Advances in immersive technologies and the widespread use of smart devices make online shopping easier than ever. Recent estimates (eMarketer, Jan 2018) show that mobile retail commerce sales worldwide reached 58.9% of overall e-commerce spending in 2017, and by 2021 m-commerce is expected to account for 72.9% of the e-commerce market. Widely used in video gaming, immersive technologies including virtual reality (VR) and augmented reality (AR) have now been massively adopted in the online retail environment, thereby transforming the way people shop. In recent years, many retailers have introduced immersive technology features in their ecommerce websites and have developed mobile apps that enable consumers to try products on virtually (e.g. glasses and clothes) or visualize them in their own spaces (e.g. house furniture) (Scholz and Duffy, 2018). This '*try before you buy*' experience (Smink et al., 2019) could help consumers manipulate virtually and evaluate the product attributes as if they were in a conventional store (Hilken el al., 2017; Peukert et al., 2019), thereby mitigating the lack of real contact with the product (Suh and Chang, 2006). In this way, AR provides consumers with a more realistic and compelling experience, compared to other forms of online product presentation (solely showing the product in 2D and/or manipulating it in a 3D format, showing the product on a model, or on the consumer's own photograph).

The proliferation of smart devices and immersive technologies coupled with the recent and rapid advances in gesture recognition and motion capture techniques offers great opportunities for both retailers and consumers. Effectively, the AR-based experience is more persuasive than other forms of presenting products online (Javornik, 2016a; Smink et al., 2019). These kinds of technologies offer opportunities enabling retailers to provide customers with innovative solutions which enrich their experience with the product (Peukert et al., 2019), thus reducing their reticence towards online shopping. In other words, the AR-based experience is able to reduce consumer decision-making uncertainty (Dacko, 2016; Hilken et al., 2017; Pantano et al., 2017). Accordingly, these innovative technological solutions grant retailers a competitive edge (Cuny et al., 2015).

Flavian et al. (2019) claimed that immersive technologies enhance the consumers' online shopping experience. Effectively, AR is thought to influence the consumers' affective and cognitive responses, and behavioural intentions (Javornik, 2016a). Research has shown that AR increases both the utilitarian (cognitive effects) and hedonic (affective effects) values of the shopping experience (Hilken et al., 2017; Smink et al., 2019), maximizes consumer engagement (Scholz and Smith, 2016), delivers an informative and enjoyable product

experience (Smink et al., 2019), improves the consumers' understanding of products (Yim et al., 2017), and positively affects consumers' attitude and behavioural intentions (Pantano et al., 2017; Javornik, 2016a). However, to our knowledge, no study has addressed the cognitive processes related to AR-based app adoption.

The present study aimed to extend our understanding of the AR-based experience by examining the cognitive factors that drive the adoption of AR-based apps. To do so, we followed the Stimulus-Organism-Response (S-O-R) framework to provide the structure and foundation of our study. Accordingly, this study puts forth a mediation pattern (organism) which acts as a cognitive explanatory process in the relationship between perceived augmentation (stimulus) and the consumers' attitudinal and behavioural responses towards AR-based apps (response).

The remainder of this research article is organized as follows: the following section presents a conceptual framework that defines immersive technologies and their related concepts (Section 2). In Section 3, the S-O-R paradigm is used to create a framework of understanding of the consumer's intention to reuse AR-based apps. We then describe the method adopted to empirically test our research hypotheses (section 4). Finally, we conclude with a discussion of the implications of our results and some pointers for further research.

2. Conceptual framework

2.1. Immersive technologies

To improve the understanding of the trends and focus of immersive technology, we have drawn on the reality-virtuality continuum proposed by Milgram and Kishino (1994) and refined by Flavian et al. (2019). This typology serves to classify the different immersive technologies, ranging from totally real to totally virtual.

Immersive technology is a multi-sensory (mainly visual and auditory) digital environment that extends or totally replaces the user's real surroundings with digital content. This technology has blurred the boundary between the physical world and the simulated world, thereby creating a sense of immersion (Lee et al., 2013; Suh and Prophet, 2018). Immersive technology includes diverse types, such as AR and VR[1]. These two realities differ in their level of proximity with the real world (Javornik, 2016a). AR overlaps with the real world

[1] According to Suh and Prophet (2018), Virtual Reality is also called Augmented Virtuality.

through digital content, whereas VR creates a virtual world that might simulate the real world (Flavian et al., 2019; Suh & Prophet, 2018).

VR is a media format that creates an interactive virtual environment able to simulate a real-life experience (Lee et al., 2013; Suh and Prophet, 2018). This interactivity is mainly based on avatars, 3D simulation of products and the creation of virtual space (Javornik 2016a). According to Flavian et al. (2019), VR involves real content superimposed on the user's virtual environment.

AR technologies display digital content within the user's real surroundings. These technologies enable users to engage with digital content superimposed on their physical world (Suh & Prophet, 2018), interactively and in real-time (Azuma et al. 2001). AR enriches the real physical environment with digital content. Thus, an AR-based environment looks like a "virtual mirror" that captures the real-world in real-time (e.g. the user's body and the environment around it) onto which 3D object/product representations (e.g. virtual clothes, make-up products) are fused (Yim and Park, 2019). These added virtual objects respond to the user's movements as they would in the real environment (Javornik & Pizzetti, 2017).

In light of the previous discussion, VR technology is suitable for situations in which user body-representation does not matter (e.g. video gaming or flight simulators), whereas AR is more appropriate for situations in which self-representation is imperative to simulate direct experiences (try-on body-involving products such as clothes and accessories). As argued by Yim et al. (2017) and Verhagen et al. (2014), AR is more beneficial than VR to both retailers and consumers. Given the scope of the current study (trying on virtual products), we focussed on AR as immersive technology that merges objects/products from the virtual word with the consumer's real world. AR enables consumers to interact in real-time with the product thus stimulating a sense of product presence which may determine their behaviour.

2.2. The recipe for a more compelling AR-based experience

In this section, we introduce three constructs deemed useful for assessing the consumer's perception of an augmented environment.

2.2.1. Sense of immersion

The concept of immersion has been conceptualized and operationalized in two different ways: system-focussed (i.e. sensory immersion, based on media features) and user-focussed (i.e. sense of immersion, based on user experience). As noted by Kim (2013), sensory immersion

emphasizes the technology itself that delivers the immersion to users, whereas psychological immersion deals with the users' feelings when immersed in the augmented environment.

The system-focussed approach considers immersion as an objective description of the augmented environment, which reflects the immersive quality of the technology (i.e. sensory immersion). Slater and Wilbur (1997) proposed to assess objectively the degree of immersion through five environment-related features (inclusiveness, extensiveness, surroundingness, vividness and proprioceptive matching). In this sense, immersion refers to the technology's ability to generate a convincing and immersive environment with which the user can interact (Schultz, 2010).

For the user-focussed approach, immersion is based on individual interactions with the mediated environment (i.e. sense of immersion). Through this approach Witmer and Singer (1998) define immersion as "*a psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences*" (p. 227). In this way, immersion is viewed as the person's psychological response to the mediated environment. This psychological state of immersion is "*the degree to which a virtual environment submerges the perceptual system of the user*" (Biocca & Delaney, 1995, p. 57).

These two conceptualizations would not be opposing but rather complementary and very closely interrelated. As argued by Hudson et al. (2019, p. 461), "the notion of immersion can occur as an objective description of the immersive properties of the system, with the assumption that subjective immersion follows". Accordingly, consumers' sense of immersion relies on the immersive quality of the environment with which they interact (Cuny et al., 2015). Effectively, the system through which consumers interact with the product have to include sufficient immersive features (objective: sensory immersion assessed through manipulating features) to deliver a surrounding environment that stimulates the consumers' immersive response (subjective: the sense of immersion assessed through self-report measures). Since the technological aspect of immersion is covered by the augmentation abilities offered by the AR-based apps, this study adopts the user-focussed approach, considering immersion as a psychological state called sense of immersion.

2.2.2. Product presence

Over recent decades, the concept of presence[2] has generated numerous studies, resulting in a multitude of definitions and terminologies (Lee, 2004). As noted by Lombard and Jones (2015), scholars have developed divergent and overlapping definitions of the concept.

The concept of presence reflects the sense of being present in a mediated environment ('being there'), experienced while interacting with virtual objects/products (Heeter, 1992; Steuer, 1992; Kim and Biocca, 1997; Slater and Wilbur, 1997). To study this phenomenon, authors have used various terms such as '*subjective experience*' (Heeter, 1992; Witmer and Singer, 1998), '*state of consciousness*' (Slater and Wilbur, 1997), '*perceptual illusion'* of non-mediation (Lombard and Ditton, 1997), '*psychological state*' (Lee, 2004; Mollen and Wilson, 2010) or '*the perceptual illusion of being there*' (Slater, 2018), to qualify the concept of presence as a subjective perception or experience (Lombard and Jones, 2015). In that sense, the concept of presence should be operationalized in a psychological way rather than an objective way (Lee, 2004).

Minsky (1980) introduced the concept of telepresence in the context of teleoperations while questioning whether it could replace "the real thing". According to Minsky (1980), "The biggest challenge to developing telepresence is achieving that sense of 'being there'" (p. 45). The majority of the most cited definitions (Sheridan, 1992; Witmer and Singer, 1998; Biocca et al., 2003, to mention few) refer to the illusion of 'being there' as a common foundation.

The common denominator of all these definitions is that they highlight the notions of location and the sense of transportation. *Location* refers to places and environments (Witmer and Singer, 1998; Biocca et al., 2003). *Transportation*, however, refers to the feeling of 'you [user] are there', 'we [users] are together' or 'it [object] is here' (Lombard and Ditton, 1997). Transportation includes, the feeling of being part of the visually simulated environment (transported to another place: 'you are there'), the feeling of being transported and sharing a common place with other users (shared space: 'we are together') and the feeling of 'it is here' which occurs when the user perceives the imaginary object moving into his/her actual environment.

Given that AR-based apps function as "virtual mirrors" (Javornik and Pizzetti, 2017; Rauschnabel et al., 2019; Yim and Park, 2019), we focussed on the type of presence that

[2] Presence (also referred to as spatial presence) is a shortened version of the term "telepresence" (see Lombard and Jones, 2015). These three terms are often used synonymously and interchangeably.

brings virtual products to the consumer's real surroundings. Accordingly, the concept of spatial presence is particularly relevant. More precisely, the 'it [product] is here' form of spatial presence is consistent with virtual product try-on, creating an intense illusion that the product moves into the consumer's immediate physical environment. This 'it [product] is here' form of spatial presence is similar to what Barfield and Hendrix (1995) called "object presence" which occurs when a virtual object/product is projected into the consumer's real world. In the current study, we qualify this form of spatial presence as product presence.

2.2.3. Perceived experience realism

Realism refers to the perceived correspondence between a technology-mediated experience and a similar experience not mediated by technology (Lombard and Jones, 2015). The concept of realism is often considered as one of different forms of presence (i.e. presence as realism; Lombard and Ditton, 1997; Lee, 2004; Lombard and Jones, 2015). From this viewpoint, realism has been categorized into perceptual and social sub-dimensions. Social realism is a "realistic or plausible portrayal of the real world in that it reflects events that do or could occur in the real world". However, perceptual realism is a "life-like creation of the physical world by providing rich sensory stimuli" (Lee, 2004, p. 31).

To our knowledge, the concept of realism was first investigated by communication scholars while studying the persuasive impact of narratives. In this context, perceived realism is described as "the audience's judgment of the degree to which the narrative world is reflective of the real world" (Gerbner and Gross 1976, cited in Cho et al., 2014, p.3). Similarly, Hall (2003) wrote, realism is "the way in which a media representation is seen to relate to real-world experience" (p.624).

In the typology provided by Hall (2003), perceived realism mainly deals with aspects of plausibility, typicality, factuality, emotional realism, consistency and perceptual quality. This typology proposes an integrative perspective on perceived realism based on previous conceptualizations and results of focus-group interviews. The Table below depicts the different aspects of perceived realism, adapted by analogy to our study context (i.e. AR-based experience).

Table 1

Multidimensional conceptualization of perceived realism (adapted from Hall (2003) and Cho et al. (2014)).

Dimensions	Description
Plausibility	A realistic experience is one that represents events or behaviours that have the potential to occur in the real world.
Typicality	A realistic experience is one that portrays attributes that are representative to a large proportion of a real-world population.
Factuality	A realistic experience is one that accurately represents a specific real-world event or person.
Emotional realism	A realistic experience is one that affects emotions.
Consistency	A realistic experience is one that is judged to be congruent and coherent, and without contradictions.
Perceptual persuasiveness	A realistic experience is one that creates a convincing and compelling portrayal of the reality, independent of the degree to which it is related to real-world experience.

As argued by Cho et al. (2014), only dimensions of plausibility, typicality, and factuality reflect the closeness of the experience to one's own reality. Effectively, the dimensions of consistency and perceptual persuasiveness focus on the quality of the experience rather than its realism. Furthermore, Cho et al. (2014) have modelled emotional realism (also called emotional involvement) as a result of perceived realism rather than one of its components.

Although communication scholars have focussed on reality programs and the realism of media texts, their results can be transferred to our study context, namely, an AR-based shopping experience. Perceived realism refers to whether the AR-based experience is perceived as realistic with regard to the environment augmented by the virtual products and the activities performed by the consumer. Perceived realism involves the capacity of the augmented world to closely mimic real-world sensations. The realism of the augmented environment indicates how natural and authentic the experience is for the consumer. In other

words, realism reflects the degree to which the augmented environment creates rich consumer experiences, thereby faithfully reproducing the "real" shopping context.

Building on the theoretical and conceptual framework discussed in detail above, we present a model investigating the combined role of the sense of immersion, product presence and perceived realism in encouraging AR-based app adoption.

3. Model and hypotheses development

Studies investigating the use of technologies and their related effects on users' responses have often employed the Stimulus-Organism-Response (S-O-R) framework. Historically, the S-O-R paradigm finds its origins in the behaviourists' Stimulus-Response framework. The S-R paradigm was later adopted and extended by cognitive psychologists to include mediating "organismic" variables that intervened between stimulus and response (Moore, 1996). According to Mehrabian and Russell (1974), this framework describes human reactions to their environments. Lee et al. (2011) argue that S-O-R constitutes a robust and parsimonious framework for predicting consumer responses to variations in media formats among others. In other words, the S-O-R framework is a sequence of events starting with exposure to environmental cues (Stimuli) that cause changes to the user's internal state (Organism), which, in turn, leads to behavioural reactions (Response) (Vieira, 2013).

Stimuli are environment-related cues that cause changes to peoples' organismic experiences (Animesh et al., 2011). According to Suh and prophet (2018), stimuli may manifest either in terms of sensory information (sensory stimuli: e.g. visual display, auditory modality, etc.), perception (perceptual stimuli: e.g. interactivity and media richness), or in terms of content topics (content stimuli: e.g. learning and training, and gaming). Organism is a set of intermediate reactions (cognitive and/or affective processes) that precede and determine the user's behavioural responses. Response refers to the final outcomes, the behavioural responses of approach or avoidance (Lee et al., 2011).

According to Suh and Prophet (2018), the S-O-R framework is appropriate to investigate the interaction between factors including system features, user experience and the outcomes of immersive technology use. Furthermore, this framework could help retailers to identify which technological stimuli should be manipulated in order to provide consumers with engaging experiences (Vieira, 2013).

This study is based on the S-O-R framework (Fig. 1) to propose a model that explains consumers' reuse intention of AR-based apps. Applying the S-O-R framework to the use

setting of AR-based apps, we posit that augmentation (perceptual stimulus) elicits consumers' behavioural intentions (response) through their cognitive state, namely, sense of immersion, the sense of product presence, and perceived realism (Organism).

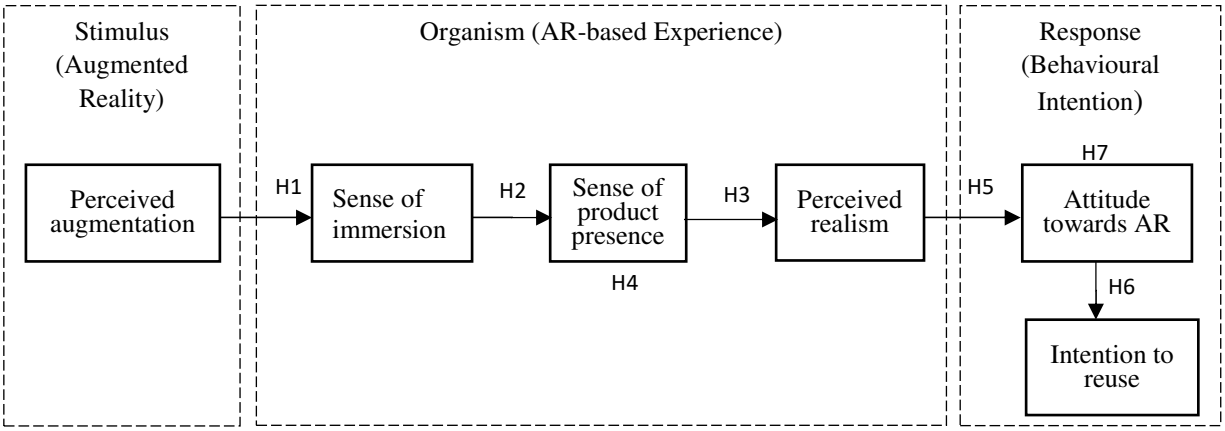

Fig. 1. Research Model.

3.1. Stimulus: Perceived augmentation

In the context of traditional online shopping, stimuli pertain to the media features with which consumers interact (Eroglu et al. 2003). Moreover, media features are recognized as one of the most important conceptual and measurement tools to assess the potential impact of technology on consumers (Hoffman and Novak, 1996; Javornik, 2016a). In that shopping setting, interactivity and richness of the mediated environment represent the most significant media characteristics that lead to an engaging experience (Biocca et al., 2001; Klein, 2003; Li et al., 2002; Steuer, 1992; Debbabi et al., 2010; Yim et al., 2017). According to Cuny et al. (2015), the sense of immersion results from people's interaction with a specific environment and thus relies on the features of that environment.

According to Slater and Wilbur (1997), a system is considered as immersive if it enables users to forget their physical reality, provides them sufficient sensory information and offers them a vivid illusion of reality. The augmented environment with which consumers interact covers all those immersive features. Effectively, AR interactively aligns computer-generated objects with physical reality (Azuma et al., 2001; Javornik, 2016b). By embedding digital content in reality, AR-based apps provide richer sensory information about the product and enable interactions with it in real time, thereby offering a "para-authentic" direct experience. Therefore, AR helps consumers see how products fit their environments or them personally (Hilken et al., 2017).

In the context of using AR-based apps, Javornik (2016a) introduced the concept of augmentation as a salient media characteristic that creates an immersive experience for consumers. The concept of augmentation is getting closer to what Hilken and colleagues (2017) called service augmentation, operationalized through simulated physical control (i.e. the ability to perform natural movements with the product) and environmental embedding (i.e. the visual integration of digital content into a person's real-world environment). Such augmentation has a power to provide an immersive experience by enabling consumers to virtually try-on a product. Thus, we hypothesize:

H1: Perceived augmentation is positively related to the sense of immersion.

3.2. Organism: The I-P-R mediation pattern

The consumer's evaluation process (Organism) is here operationalized according to three interrelated cognitive factors, namely, sense of immersion, sense of product presence and perceived realism.

There is a consensus that the technological level of immersion generated by mediated environment facilitates the level of psychological presence (Cummings and Bailenson, 2016; Peukert el al., 2019; Slater, 2018; Slater & Wilbur, 1997). Accordingly, environments with multiple sensory features, such as those afforded by AR-based apps, allow consumers to explore and control the mediated environment (Hudson et al., 2019) and consequently to become psychologically engaged in the AR-based experience (Cummings and Bailenson, 2016). Such experience is likely to create an increased sense of product presence.

Given that the focus of the current study is on consumers' reactions in an augmented environment, we adopted the user-focussed approach, namely, sense of immersion. In accordance with Witmer and Singer (1998), the sense of immersion is conceptualized as the cognitive state of being enveloped by the augmented environment. As claimed by these authors, the mediated environment that generates a greater sense of immersion will elicit higher levels of presence. Effectively, AR-based apps have the power to immerse consumers by allowing them to virtually try on products (Yim et al., 2017), therefore creating the illusion of the product being present in their real physical environment (Verhagen et al., 2014). Concretely, when a consumer feels his or herself absorbed by the augmented environment, he/she may feel and act as if the augmented product is being transported to the place where he/she is. This psychological immersion state creates an illusory experience in which the consumer feels that the imaginary product is present in his/her actual surroundings, thereby

emphasizing the relationship between the sense of immersion and the generated sensation of product presence. In light of this assumption, we hypothesize the following:

H2: The sense of immersion is positively related to the sense of product presence.

The sense of presence has been considered as an intermediate variable between technological properties and consumers' attitudinal and behavioural responses (Animesh et al., 2001; Fiore et al., 2005; Suh and Chang, 2006). Nonetheless, past studies have not unanimously established a direct relationship between the sense of presence and consumer attitudes and behaviours (Mollen and Wilson, 2010). To fill this gap, we believe that the perceived realism of the experience might contribute to reinforcing the relationship between the sense of product presence and consumers' behavioural intentions.

Recent studies have offered signals about the potential of perceived realism to explain consumers' behavioural responses towards AR-based apps. For example, Hilken et al. (2017) wrote "when a customer senses spatial presence, the online service experience becomes 'real'" (p. 885). Although the relationship between perceived realism and the sense of presence seems theoretically supported, to our knowledge this association has never been explored or empirically tested. Similarly, a few studies have considered perceived realism as an antecedent of the sense of presence (e.g. Bae et al., 2012). Our study does not share this foundation.

To clarify this point, we draw upon the field of psychology to understand the difference between sensation and perception and the relationship between the two. According to Kasschau (2003), "*a sensation occurs anytime a stimulus activates one of your receptors……any aspect of or change in the environment to which an organism responds is called a stimulus…… A perception is the organization and interpretation of sensory information into meaningful experiences*" (p. 208). Building on this, it is clear that sensation precedes perception. Concretely, perception is the way we select, organize and interpret our sensations, and therefore we construct our representations of the external world. Perception may also be affected by other subjective factors such as previous experience, expectations, emotions and cognitive processing (Baron, 2001, cited in Lee 2004). Moreover, presence is a sensation that occurs during the AR-based experience (i.e. during the interaction with the product through the augmented environment), while realism is perceived after one has felt the product presence.

Subsequently, product presence is a sensation, which gives the impression that the product is physically present in the consumer's immediate reality. This sensation enables naturalistic interactions with the product, leading to higher perceived realism. With AR-based apps, the imaginary product is embedded seamlessly in the consumer's surroundings and consequently appears as a realistic part of his/her physical environment (Javornik and Pizzetti, 2017). Thus, the more the consumer feels the presence of the product in his/her real-time surrounding, the more the AR-based experience will be perceived as 'real'. Therefore, we propose the following hypothesis:

H3: The sense of product presence is positively related to perceived realism.

We also expect that the sense of product presence, generated by the augmented environment, will mediate the relationship between the sense of immersion and perceived realism of the experience. Hence, we hypothesize the following:

H4: The sense of product presence mediates the relationship between the sense of immersion and perceived realism.

3.3. Response: Attitude and intention to reuse

The general attitude towards a behaviour has been described as "an individual's positive or negative feelings" about performing a particular behaviour (Fishbein and Ajzen, 1975, p. 216). Similarly, in this present work, attitude towards AR-based apps refers to the feeling associated with the use of such apps. As discussed above, the concept of presence alone often fails to stimulate favourable consumer attitudes. According to Mollen and Wilson (2010), the concept of presence might contribute to another experiential construct which, in turn, might elicit consumer attitudes. We expect that perceived realism might play an intermediate role in triggering consumer attitudes. To our knowledge, no study has attempted to investigate the relationship between the perceived realism of the AR-based experience, and the consumers' attitudinal and behavioural responses towards AR-based apps.

As mentioned previously, the level of realism generated by the augmented environment allows customers to try on the product and evaluate how it fits them as in a conventional store. By reproducing the simulated perception of direct experience as close as possible to what is 'real', such realism brings an experiential value which enables consumers to be engaged in the experience. Consequently, consumers who believe that AR-based apps simulate the shopping experience to a similar extent to in-store shopping are more likely to feel more positively about AR-based apps. Thus, we suggest that perceived realism of the

experience may predict shoppers' attitudes towards using AR-based apps. Therefore, we posit:

H5: Perceived realism is positively related to attitude towards AR-based apps.

Evidence from Ajzen's (1991) theory of planned behaviour and Davis's (1989) technology acceptance model supports the idea that attitudes towards technology contribute to the user's intention to use it. In line with this, Park and Yoo (2020) showed that consumers' attitudes generated after shopping cosmetic products using AR-based apps influence their behavioural intentions. The same results were found by Pantano and colleagues' (2017) in their study exploring the effects of augmented environments on consumers' behavioural intention after trying on sunglasses via the website. Thus, the more positive an individual's attitude towards AR-based apps, the more likely his/her intention to reuse such apps will be. Consequently, it seems coherent that consumer attitude towards AR-based apps serves as an intermediate variable between perceived realism and intention to reuse such apps. Namely:

H6: Attitude towards AR-based apps is positively related to intention to reuse such apps.

H7: Attitude towards AR-based apps mediates the relationship between perceived realism and the intention to reuse such apps.

4. Method and findings

4.1. Method

4.1.1. Participants

This five-month study involved 224 volunteer French women. Participants were students recruited from courses at our University. Those who volunteered to participate in our study were mainly female. We also observed that this target group of younger French women regularly consume beauty products. For these two reasons, we selected a mobile application for makeup for the study. We used the "YouCam Makeup" application which proposes in-app purchase of a wide variety of cosmetic products such as lipstick and eyelashes. We recruited only participants who had never used the "YouCam Makeup" app to avoid possible effects of previous exposure (Park and Yoo, 2020). Furthermore, only those women interested in cosmetic products and who regularly wore makeup were allowed to participate.

4.1.2. Procedure

Participants received an email describing the focus and instructions about the study procedure. We asked volunteers to enrol in one of the planned survey sessions, which were organized at

lunchtime. Each of these sessions which took place in a classroom at the University involved about 15 participants. As in Park and Yoo (2020), participants began by downloading YouCam Makeup on their smartphones. They were then asked to visit the app and try on the cosmetic products they were interested in. Thanks to the smartphone camera, and gesture recognition and motion capture techniques, the app detects the participant's face and once the participant has chosen a cosmetic product it is immediately superimposed on her face (see Appendix 1). After a 20-min session, participants completed a questionnaire containing the different items from the measurement scales chosen for this study.

4.1.3. Measures

The questionnaire for data collection in the present study consisted of measurement scales adapted from prior studies (see Appendix 2). Perceived augmentation was measured using Javornik et al's (2016) scale. Originally composed of five items measured on a seven-point Likert scale, the following item "The way the make-up was placed on my face seemed real" was dropped before analysis to avoid confounding effects with the concept of perceived realism. The sense of immersion was assessed using the scale from Cuny et al. (2015), which has six items measured on a seven-point Likert scale. To measure the sense of product presence, we chose Hartmann and colleagues' (2016) scale, consisting of eight items measured on a 7-point Likert scale. This scale has recently been adapted and validated by Hilken et al (2017) in a similar research context. The original items were reworded to fit the "product is here" form of presence (Hilken et al., 2017).

To measure perceived realism, we adapted one item from Witmer and Singer (1998), one item from Schubert et al. (2001), and developed two other items based on prior research. The four items were scored using a 7-point Likert scale and tapped how closely the augmented environment approximated the in-store shopping experience. Furthermore, perceived realism was hereby conceptualized as a unidimensional construct. Wang et al's (2009) scale consisting of three 7-point semantic differential items was used to capture the consumer's attitude towards AR-based apps. Lastly, intention to reuse was assessed using three items adapted from Jiang and Benbasat (2007), measured on a 7-point Likert scale.

With the help of two bilingual (French/English) faculty members, all the items were translated from English to French then back-translated into English. This procedure is used to avoid misunderstanding and therefore guarantees linguistic equivalence of the measures (Brislin, 1986).

4.2. Findings

4.2.1. Preliminary data analysis

Before testing our hypotheses, we first performed an exploratory factor analysis (EFA) to check for the dimensionality and reliability of the measures. The EFA was conducted using IBM SPSS Statistics 20. An SPSS-based principal components analysis was performed on each measurement scale without specifying the number of factors to be extracted. The KMO test of sampling adequacy as well as Bartlett's test of sphericity allowed us to verify the appropriateness of using factor analysis. The latter was deemed appropriate for all measurement scales in our data set. The preliminary results showed that all six latent variables were found to be unidimensional.

The internal consistency of each construct was then assessed using Cronbach's alpha coefficient and composite reliability (CR) score, based on the internal consistency of the items. For all of the constructs alpha coefficients and CR estimates exceeded the recommended cut-off value of 0.70, establishing high construct reliability (Fornell & Larcker, 1981).

Following this, a confirmatory factorial analysis (CFA) was conducted using STATISTICA 7.0 (StatSoft, Tulsa, OK). Based on the common guidelines, our data had acceptable model fit. Effectively, all values exceeded the universally accepted thresholds, as shown in Table 2.

Table 2
Assessment of measurement model.

Constructs	Cronbach's α	CR	AVE
Perceived Augmentation (P-Aug)	0.91	0.91	0.72
Sense of immersion (S-Imm)	0.93	0.93	0.70
Product Presence (Prod-Pre)	0.95	0.95	0.74
Perceived Realism (P-Real)	0.83	0.82	0.55
Attitude towards AR-based apps (Att)	0.85	0.85	0.66
Intention to reuse AR-based apps (Int)	0.83	0.83	0.62
Fit Indices			
χ^2 (df = 335)	702.22		
Normed Chi-square: χ^2/df.	2.09		
Comparative Fit Index (CFI)	0.933		
Incremental Fit Index (IFI)	0.934		
Root Mean Squared Error of Approximation (RMSEA)	0.080		

The study also assessed convergent and discriminant validity tests. Convergent validity assumes that indicators load on the appropriate construct. The computed average variance

extracted (AVE) for each construct was over 0.50, indicating appropriate convergent validity. Discriminant validity determined whether the measures of the six constructs were distinct from one another. For adequate discriminant validity, the AVE of each construct must be higher than the square of its correlation with the other constructs (Fornell & Larcker, 1981). As shown in Table 3, the results confirmed acceptable levels of convergent and discriminant validities.

Table 3
Convergent and Discriminant validities.

			Correlation of constructs[1]					
	Mean	SD	P-Aug	S-Imm	Prod-Pre	P-Real	Att	Int
P-Aug	4.8	0.98	**0.85**					
S-Imm	3.26	1.60	0.70***	**0.84**				
Prod-Pre	3.77	1.56	0.59***	0.83***	**0.86**			
P-Real	4.43	1.00	0.48***	0.59***	0.66***	**0.74**		
Att	4.94	1.29	0.74***	0.64***	0.54***	0.46***	**0.81**	
Int	4.01	1.28	0.56***	0.51***	0.45***	0.53***	0.58***	**0.79**

Note: *** correlations are significant at the 0.001 level
[1]Diagonal elements in bold are the square root of average variance extracted.
Perceived augmentation (P-Aug); Sense of immersion (S-Imm); Product presence (Prod-Pre)
Perceived realism (P-Real); Attitude (Att); Intention to reuse (Int)

It should be noted that the correlation between product presence and the sense of immersion exceeds substantially the recommended cut-off value of 0.71 (MacKenzie et al., 2011). Therefore, the square-root of the AVE for these two constructs is only slightly higher than their correlation value. However, this is not enough for discriminant validity to be questioned, but it is probably a sign of multicollinearity (Kock and Lynn, 2012). Consequently, we checked the variance inflation factor (VIF), and all of the values were lower than the common threshold of 10 (Petter et al., 2007) ranging from 1.844 to 4.222, thus suggesting that multicollinearity is not a substantial issue in this study.

4.2.2. Structural model analysis

After checking for measurement model appropriateness, the next step was to test the research model. The hypothesized structural model was estimated using STATISTICA 7.0 (StatSoft, Tulsa, OK). As illustrated in Fig. 2, all direct paths in the research model were supported at a significance level of 0.001. Furthermore, the explained variances (R^2) of all endogenous variables showed acceptable levels of predictive accuracy (Hair et al., 2014). Overall, the model explained 54% of the variance in intention to reuse AR-based apps.

As shown in Figure 2, perceived augmentation was positively and significantly associated with the consumer's sense of immersion ($\beta = 0.749$; $p < 0.001$), providing empirical support

for H1. As expected, the results also indicate that the sense of immersion was positively related to the sense of product presence ($\beta = 0.886$; $p < 0.001$), which, in turn, was positively associated with perceived realism ($\beta = 0.790$; $p < 0.001$). Therefore, H2 and H3 were both supported statistically. Perceived realism was positively related to the consumer's attitude towards AR ($\beta = 0.659$; $p < 0.001$), thus supporting H5. Finally, the relationship between consumers' attitudes towards AR-based apps and their intention to reuse such apps was found to be significant and positive ($\beta = 0.729$; $p < 0.001$), which confirms H6.

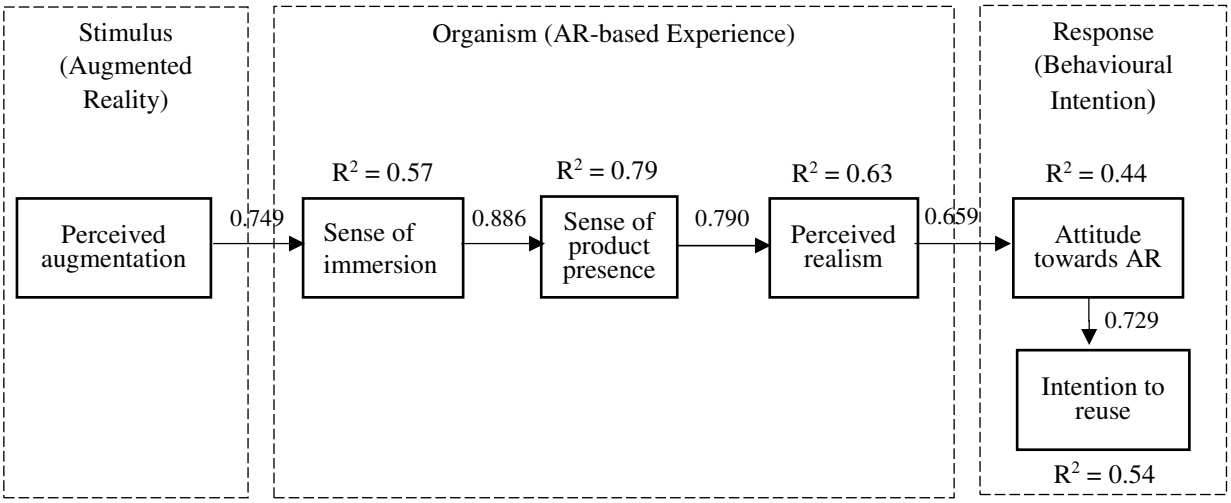

Fig. 2. Structural model path coefficients.

4.2.3. Mediation analysis

The two mediator tests (H4 and H7) were carried out following Baron and Kenny's (1986) procedure, based on three regression models:

- First regression: The independent variable must be related to the dependent variable (path c).
- Second regression: The independent variable must be related to the mediator (path a).
- In the third regression, the dependent variable is predicted by the independent variable and the mediator simultaneously. As a result, the mediator must be related to the dependent variable (path b), and the independent variable (path c') must not relate to the dependent variable (full mediation) or should become lower in magnitude ($c' < c$; partial mediation). Additionally, a Sobel[3] test (z-value) was computed to support the mediation effect further (Sobel, 1990).

[3] http://quantpsy.org/sobel/sobel.htm

As shown in Table 4, a full mediating role for product presence was observed between the sense of immersion and perceived realism. Effectively, the path from sense of immersion to perceived realism was found to be positively significant ($c = 0.688$; $p < 0.001$). The sense of product presence was then regressed on the sense of immersion and their relationship was also positive and significant ($a = 0.887$; $p < 0.001$). Finally, when perceived realism was regressed on the sense of product presence and the sense of immersion simultaneously, the relationship between product presence and perceived realism was significant ($b = 0.644$; $p < 0.001$), and the sense of immersion no longer related to perceived realism ($c' = 0.122$, *ns*). The Sobel test was also significant ($z = 4.78$; $p < 0.001$). Consequently, H4 is supported, confirming that the sense of product presence fully mediated the relationship between the sense of immersion and perceived realism.

Table 4
Regression analyses related to the mediating role of the sense of product presence.

Regressions	Paths	Beta	Standard error	Sobel test
Regression 1	c Sense of immersion → Perceived realism	0.688***	0.045	
Regression 2	a Sense of immersion → Product presence	0.887***	0.018	
Regression 3	b Product presence → Perceived realism	0.644***	0.134	
	c' Sense of immersion → Perceived realism	0.122(*ns*)	0.140	4.78***

Note: *** $p < 0.001$, *ns* = not significant

Hypothesis 7 predicted that consumers' attitudes towards AR-based apps would mediate the relationship between perceived realism and the intention to reuse such apps. The results (see Table 5) indicate a significant relationship between perceived realism and the consumer's intention to reuse AR-based apps ($c = 0.645$; $p < 0.001$). The path from perceived realism to attitude towards AR-based apps was significant ($a = 0.548$; $p < 0.001$). Finally, intention to reuse AR-based apps was simultaneously regressed on attitude towards such apps and perceived realism. The results indicate that the relationship between attitude and intention to reuse the AR-based app was significant ($b = 0.483$; $p < 0.001$), and the relationship between perceived realism and intention to reuse AR-based apps was attenuated but remained

significant (c' = 0.383 < c = 0.645; p < 0.001). Additionally, the results of a subsequent Sobel test confirmed the mediation effect (z = 5.50; p < 0.001). Consequently, we conclude that consumers' attitudes partially mediated the relationship between perceived realism and their intentions to reuse AR-based apps.

Table 5
Regression analyses related to the mediating role of attitude.

Regressions	Paths	Beta	Standard error	Sobel test
Regression 1	c Perceived realism → Intention to reuse	0.645***	0.053	
Regression 2	a Perceived realism → Attitude	0.548***	0.060	
Regression 3	b Attitude → Intention to reuse	0.483***	0.070	
	c' Perceived realism → Intention to reuse	0.383***	0.073	5.50***

Note: *** p < 0.001

5. General discussion and contributions

The purpose of the current study was to understand how consumers experience AR and which cognitive factors determine their willingness to reuse AR-based apps. The findings show that perceived augmentation acts as a perceptual stimulus that creates an immersive experience for the consumer. Such sense of immersion leads to a greater sensation of product presence. Therefore, consumers who feel the presence of the product evaluate the experience as being closer to what can happen naturally in a real shopping setting. Hence, thanks to the sensation of product presence, consumers perceive the inspection of the product as 'real'. This experienced realism, powered by the sensation of product presence, translates into a more favourable attitude towards AR-based apps, which, in turn, drives consumer intention to reuse such apps. Below we discuss the theoretical and practical contributions of this study.

5.1. Theoretical contributions

To our knowledge the current study is the first that has explored the relationships between the sense of immersion, the sense of product presence and perceived realism in AR-based environments. The S-O-R framework served here to structure the cognitive factors that mediate the relationship between perceived augmentation and consumers' behavioural intentions.

Although scholars continue to evaluate technological stimuli through their interactivity and vividness (e.g. Yim et al., 2017), the current study focussed on perceived augmentation as a perception-related factor (i.e. perceptual stimulus) to operationalize the effectiveness of augmentation as a main feature of AR-based apps. Our results are consistent with most recent studies (Javornik, 2016a; Hilken et al., 2017) and affirm the relevance of perceived augmentation as an alternative construct to capture the consumer's perception of the technology featured. In fact, augmentation generates richer sensory information, and reacts to and interacts with the surrounding physical environment in real time (Javornik, 2016a).

Furthermore, our results are in line with those of Fiore et al (2005) and demonstrate that technology-related stimuli do not have a direct relationship with consumers' responses towards AR-based apps. One recent study found that the quality of augmentation did not have a direct impact on consumer attitude towards AR-based apps (Rauschnabel et al., 2019). Similarly, Javornik (2016a) demonstrated that the effect of perceived augmentation on consumer responses towards AR-based apps was mediated by flow. Indeed, it is the consumer's evaluation process aroused within the organism that has the power to engage the consumer in the experience, which subsequently leads to the consumer expressing positive behavioural responses towards the augmented environment.

This study contributes to theory by establishing a sequential I-P-R mediation pattern as the first cognitive reactions to technological stimuli that precede behavioural intentions. Specifically, the proposed I-P-R mediation pattern not only clarifies the differences between these three experience-related concepts but also establishes their different relationships. First, the I-P stage supports the idea that the sense of immersion is associated with high product presence sensations. Likewise, as in Cuny et al. (2015), this study adopted a user-centred rather than a technology-centred approach. In fact, most previous research was mainly exploratory and attempted to identify what features would make a good mediated environment. As noted by Cummings and Bailenson (2016), the common assumption that immersive technology improves the sensation of presence has been explored by simply manipulating the system features, considered as highly or lowly immersive. Given the current technological advances, a user-centred approach was found to be more suitable to evaluate consumers' reactions in an augmented environment.

It should be noted that our findings showed a strong correlation between the sense of immersion and the sense of product presence, indicating that these two constructs were not perfectly orthogonal (i.e. correlated constructs with cross-loading items). This finding is

probably linked to our sample size which was not large enough, with regard to the widely accepted subject-to-item ratio, which should be at least 10:1 (i.e. ten times as many subjects as items) (Castello and Osborne, 2005). Effectively, EFA statistical estimates are sensitive to sample size (Thompson, 2004) and can often lead to misclassified items (Castello and Osborne, 2005) and potentially produce unstable correlation estimates when applied to small samples (Finch et al., 2016).

Second, previous studies (Animesh et al., 2011; Mollen and Wilson, 2010; Fiore et al. 2005) have argued that [tele]presence is a mediating enhancer of the effect of media format on consumer behaviour. Specifically, media characteristics stimulate a sense of telepresence, which has a positive impact on consumer responses towards the mediated environment (Klein, 2003; Fiore et al. 2005; Suh and Chang, 2006; Debbabi et al., 2010; Nah et al., 2011). However, telepresence alone often fails to elicit optimal consumer attitudes and behaviours (Suh and Chang, 2006; Mollen and Wilson, 2010). To address this gap, the current study introduced the concept of perceived realism. Through the P-R stage of the mediation pattern, our results successfully showed that the sensation of product presence was related to higher levels of perceived realism, which, in turn, created positive behavioural intentions towards AR-based apps.

5.2. Practical contributions

From the consumer's perspective, the quality of augmentation plays an important role by generating positive and engaging experiences. By enhancing the experience of mobile application use, the augmentation allows consumers to inspect the product attributes as in physical stores. Consequently, developers should innovate further the design of AR-based apps to reinforce their ability to simulate environments able to persuade consumers that they are 'actually' trying the product on. Furthermore, as has been demonstrated by this study, perceived realism offers consumers more compelling experiences and should be seen as a key success factor to ensure effective attractiveness of AR-based apps. Designers seeking to foster the adoption of AR-based apps should provide consumers with the most realistic augmented environments possible to fully simulating the consumer's real-world interaction with products.

From a managerial viewpoint, AR-based apps create new market opportunities and allow companies to maintain and/or improve their business competitiveness. As people are continually connected, marketers can attract potential consumers anywhere and at any time. Furthermore, by engaging a mobile commerce strategy, companies create value for their

potential consumers by allowing them to reduce their decision-making uncertainty (Dacko, 2016). Commercially-speaking, creating an authentic and realistic representation of a shopping context induces the continual use of AR-based apps, which could potentially encourage purchases via mobile apps.

5.3. Limitations and Future directions

The findings of this study should be interpreted with caution. Effectively, this study presents some inherent limitations, which open up new lines for further research. First, the representativeness of the sample is a limitation to external validity and needs to be improved. Given the category of products used in this study (make-up products), we targeted female consumers only. However, previous studies have shown that men are more likely to accept AR technologies than women (Suh and Prophet, 2018). Additional research could investigate the moderating role of gender. Moreover, prior studies have shown that younger generations are the most interested in immersive technology (Flavian et al. 2019). Effectively, young people are constantly connected and tend to have less technology anxiety than older people (Smink et al., 2019; Suh and Prophet, 2018). As participants in this study were mainly young students, future research is needed to examine the effect of user age by empirically assessing the moderating role of generational cohorts.

Second, the scope of the current study is limited to one product category only (i.e. experiential products) using a specific AR-based application. As argued by Rosa and Malter (2003), experiential products such as cosmetics involve both mind and body. These products are evaluated mainly on the basis of fit and feel characteristics (Hilken et al., 2017). Future research could also investigate the relevance of the I-P-R mediation pattern across product types with different levels of body involvement. Moreover, further research is needed to determine whether our results are applicable to other categories of AR-based applications or other contexts of use, such as home furniture planners (e.g. IKEA Place) or AR-based games (e.g. 'Pokémon Go').

Third, the major limitation of this study is the scale used to measure the perceived realism of AR-based environments. Although the concept of perceived realism is fundamental and of great theoretical and practical relevance in explaining why AR-based apps are adopted, little research has addressed this issue. Consequently, there is a lack of standardized self-report measures of perceived realism adapted to the context of "virtual mirrors" and mobile shopping. Additional research is required in order to fully understand consumer perception of AR-based app realism. Particularly, we call for qualitative studies to explore further the

different facets of augmented environment realism. Such studies could help in the development of scales suitable for the mobile commerce setting.

Fourth, this study focussed on cognitive processes to understand consumers' behavioural intentions in the context of AR use. However, other factors than cognitive reactions can explain consumers' behavioural intentions. Thus, our research model could be extended by integrating consumers' affective reactions (e.g. perceived enjoyment) likely to increase the effectiveness of AR-based environments. Other factors could also be integrated, such as involvement, individual's innovativeness and privacy concerns.

Finally, our study was correlational and consequently does not provide evidence for causal conclusions. Future studies could use an experimental methodology to offer further support to the I-P-R mediation pattern by providing insights into the causal effects between the sense of immersion, the sense of product presence and perceived realism, and also their combined impact on the adoption of AR-based apps. Nonetheless, the proposed model has advanced our understanding of the relationships between these three cognitive factors, and their combined role in encouraging AR-based app adoption.

6. Conclusion

AR has become a prominent technology for successful business and at the same time it tends to be indispensable for people's daily life in terms of shopping practices. In such a context, this study attempted to understand how the quality of augmentation of a mobile application determines the consumers' intention to reuse it. Grounded in the stimulus-organism-response paradigm, this study extends our understanding of the adoption of AR-based apps, by offering a structured view of the cognitive factors driving consumers' behavioural intentions towards AR-based apps. Despite the limits discussed above, the current study is one more step towards a better understanding of the cognitive factors that reinforce consumers' behaviour towards AR-based apps.

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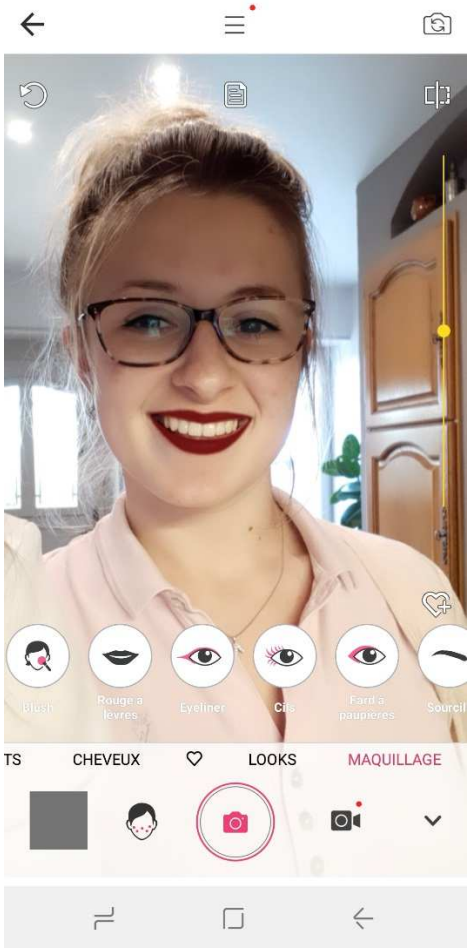
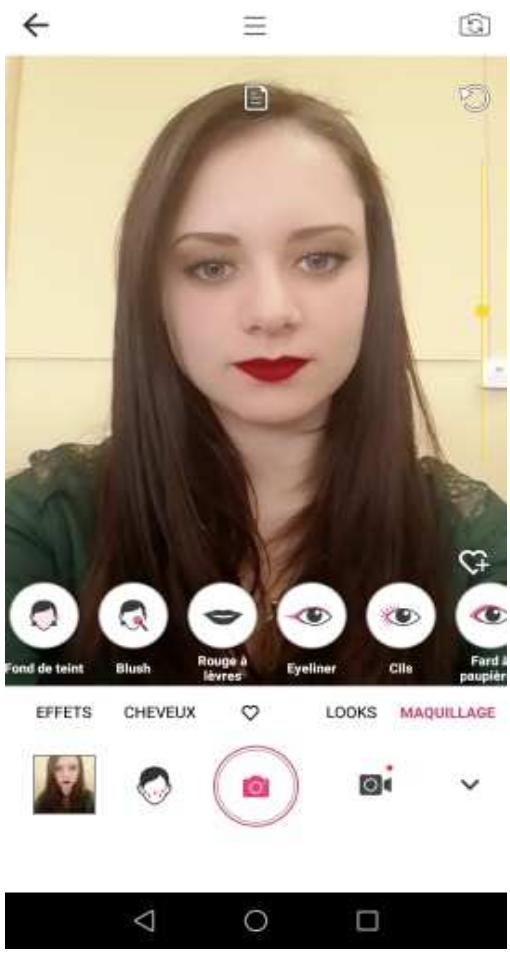
Appendix 1. Stimulus: Overview of YouCam Makeup





Appendix 2. Items for Measuring Constructs

Perceived augmentation (Javornik et al., 2016)	Seven-point Likert scale: Strongly Disagree (1) to Strongly Agree (7) The application added virtual make-up to my face.

	The way the make-up was placed on my face seemed real (dropped before analysis). The make-up seemed to be part of my face. The make-up moved together with my face when I turned my head. The make-up seemed to exist in real time.
Sense of immersion (Cuny et al., 2015)	Seven-point Likert scale: Strongly Disagree (1) to Strongly Agree (7) The app created a new environment that suddenly disappeared at the end of the show. At times, I was unaware of my surroundings. During the virtual experience, my body was in the room, but my mind was in the world created by the show. The app made me forget the reality of the outside world. During the virtual experience, I forgot about things that had happened before the show or that would occur after the show. The virtual experience made me forget my immediate surroundings.
Sense of product presence (Hilken et al., 2017 adapted from Hartmann et al., 2016)	Seven-point Likert scale: Strongly Disagree (1) to Strongly Agree (7) I felt like the [product] was actually there in the real world. It was as though the true location of the [product] has shifted into the real world environment. I felt like the [product] meshed with the real world surroundings. It seemed as if the [product] actually took part in the action in the real world. I had the impression that I could be active with the [product] in the real world. I felt like I could move the [product] around in the real world. The [product] gave me the feeling I could do things with it. It seemed to me that I could do whatever I wanted with the [product].
Perceived realism (Schubert et al. (2001), Witmer and Singer, 1998)	Seven-point Likert scale: Strongly Disagree (1) to Strongly Agree (7) In comparison with the real world, the augmented environment seemed real. My experience in the augmented environment seems consistent with my real-world experience. The things that happen in the augmented environment look like the things that happen in real life. This augmented reality–based experience was similar to in-store shopping experience.
Intention to reuse AR-based apps (Jiang and Benbasat, 2007)	Seven-point Likert scale: Strongly Disagree (1) to Strongly Agree (7) Next time I need to shop for cosmetics, I would like to use this app. Next time I need to shop for cosmetics as a gift for a friend, I would like to use apps with characteristics similar to those of this app. I would use apps with similar characteristics to those of this app in the future.
Attitude toward AR-based apps (Wang et al., 2009)	Seven-point Semantic Differential Scale : How do you feel about your overall experience with this Application: Unfavourable…….Favourable Bad……..Good Negative…….....Positive