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Shopping in augmented reality: The effects of spatial presence, personalization and intrusiveness on app and brand responses

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ABSTRACT

Augmented reality (AR) applications add a new dimension to the consumer experience by overlaying the consumer's face or surroundings with virtual products. The aim of this study was to examine three underlying processes (spatial presence, perceived personalization, and perceived intrusiveness) that could explain the persuasiveness of AR apps. In two experiments, we compared an AR app to a non-AR app. Study 1 used an app that augmented the user's face with virtual products (make-up), while Study 2 used an app that showed virtual products within one's surroundings (furniture). The results showed that spatial presence and perceived personalization can explain positive persuasive responses towards AR apps. For the app that augmented the user's face with virtual products, perceived personalization enhanced purchase intentions, while perceived intrusiveness had negative persuasive consequences. For the app that showed virtual products in one's surroundings, spatial presence enhanced purchase intentions, and no negative persuasive consequences were found.

1. Introduction

Augmented reality (AR) is considered a promising technology in retailing and e-commerce, because it enables consumers to virtually overlay products on their own face or surroundings, 'as if' they are part of their real world (Verhagen, Vonkeman, Feldberg, & Verhagen, 2014). For example, AR apps show consumers through their smartphone's camera how make-up will look on their own faces or how furniture will look in their own living rooms (Hilken, de Ruyter, Chylinski, Mahr, & Keeling, 2017). As such, AR apps enable a 'try before you buy' experience and could bridge the gap between an online and an offline shopping experience (Baek, Yoo, & Yoon, 2018; Scholz & Smith, 2015). While marketers and retailers have begun to explore the possibilities of AR, a lack of knowledge on whether and how AR can add value for the consumer and brand, provides a barrier for many to invest in AR (BCG, 2018).

Along with a need for knowledge in the industry, academic research has recently started to examine potential benefits of AR shopping apps (e.g., Hilken et al., 2017; Javornik, 2016; Rauschnabel, Felix, & Hinsch, 2019). While previous research has provided relevant insights into the effectiveness of AR shopping apps, few studies have focused on both app- and brand-related responses or found mixed results, it has not been examined whether AR could potentially have negative effects, and

studies mostly focused on apps that augment products on one's face (self-augmentation). More research is needed to further disentangle when and how AR can provide value for consumers. This study contributes to the existing literature in three ways.

First of all, besides its potential positive consequences, previous research has largely neglected potential negative consequences of AR apps and have called for more theoretical explanations underlying effects of AR apps (Baek et al., 2018; Javornik, 2016; Rauschnabel et al., 2019; Verhagen et al., 2014). Therefore, we tested two conflicting underlying processes which could add to theoretical explanations underlying positive and negative consequences of AR apps. Perceived personalization is hypothesized as an underlying process because AR enables consumers to visualize products in a personally relevant context (Hilken et al., 2017), which can induce positive responses. At the same time, this real-time view could also increase the perceived intrusiveness of the experience, and lead to negative responses.

Second, building on previous studies, the current study further explores the role of spatial presence, which is considered an important underlying process to explain how virtual experiences can be perceived as real experiences (Schubert, 2009). Although previous AR studies have focused on presence, these studies showed mixed effects as to whether and which types of brand responses were affected (Javornik, 2016; Rauschnabel et al., 2019; Verhagen et al., 2014). Therefore, we

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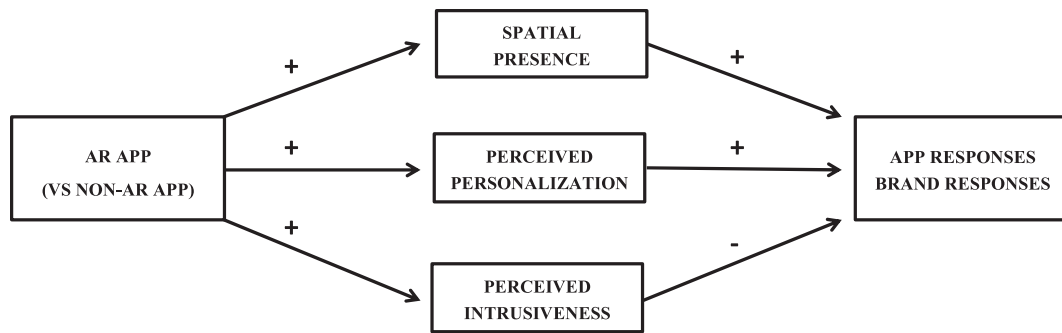


Fig. 1. Conceptual model. [two column fitting figure].

distinguished between affective and behavioral responses to the app and brand to shed more light on which processes (spatial presence, personalization, and intrusiveness) positively or negatively affect these responses.

Third, while research has mostly focused on the effects of AR apps that enable consumers to try on products using self-augmentation (e.g., make-up, sunglasses), few studies have focused on AR apps that augment products within the users' surroundings (e.g., furniture; Javornik, 2016). This begs the question whether the positive and negative consequences of AR apps are related to the self-view, or whether these effects can be extended to AR apps that augment the users' surroundings. Therefore, we first examined the effects of an AR app that depicted virtual make-up on the users' own faces (Study 1). Then, we complemented the findings of Study 1 by using an AR app that showed virtual furniture within the users' surroundings (Study 2).

In sum, this study advances AR literature by explaining in more detail when and how AR apps lead to positive or negative persuasive consequences by considering three underlying processes, for two different apps (see Fig. 1). In doing so, this study provides retailers and marketers insights on which processes are relevant to consider when investing in (different types of) AR apps and to help induce positive consumer experiences while diminishing potential negative experiences.

2. Theoretical framework

2.1. Shopping in augmented reality

AR adds a new dimension to the product experience, because it has three distinct features: (1) it overlays virtual content onto the physical world, (2) the virtual objects are interactive and shown in real time, and (3) the virtual objects are registered on a fixed position in 3D (Azuma, 1997). As such, AR enables consumers to try out products as if they are really there by interacting with the virtual products in real time and inspecting it from different angles (e.g., being able to walk around a virtual couch). These features simulate a more direct product experience, as opposed to other online product experiences, such as static pictures or video, which provide a more indirect product experience (Verhagen et al., 2014). This is what differentiates product experiences with AR from other virtual product experiences and could therefore induce different persuasive responses.

2.2. Previous research on augmented reality shopping apps

We summarized previous studies focusing on AR shopping apps in Table 1, which can be distinguished based on the underlying processes, outcome variables, moderating variables, and type of apps examined. As can be seen, previous AR studies (e.g., Hilken et al., 2017; Huang & Liao, 2015; Rauschnabel et al., 2019; Rese, Baier, Geyer-Schulz, & Schreiber, 2017) have mostly focused on hedonic (e.g., enjoyment, hedonic value/benefits) and utilitarian processes (e.g., informativeness,

usefulness, ease of use, utilitarian value/benefits). These processes are related to how AR apps are experienced. Other than that, studies have examined underlying processes which more closely relate to characteristics of the technology. For example, research has focused on processes related to the realism and vividness induced by AR (e.g., presence, perceived augmentation, augmentation quality; Hilken et al., 2017; Javornik, 2016; Rauschnabel et al., 2019; Verhagen et al., 2014), interactivity (Yim, Chu, & Sauer, 2017) and flow (Huang & Liao, 2017; Javornik, 2016).

Overall, previous research showed positive effects on app responses (e.g., app attitude, use intention) through these processes (e.g., Javornik, 2016; Rese et al., 2017; Yim et al., 2017). Regarding brand responses, mixed results were found. While generally positive effects were found on purchase intention (Hilken et al., 2017; Poushneh & Vasquez-Parraga, 2017; Verhagen et al., 2014), results regarding brand attitude were mixed. For example, Javornik (2016) found positive effects on app responses, but not on brand responses, when comparing an AR app to a non-AR app. At the same time, Rauschnabel et al. (2019) found positive effects when comparing brand attitude before and after using an AR app. Both studies considered similar underlying processes (perceived augmentation/augmentation quality).

In addition, few studies have also considered moderating effects of user characteristics (e.g., body image, cognitive innovativeness, privacy-related concerns; Hilken et al., 2017; Huang & Liao, 2015; Yim & Park, 2018) or previous AR experience (e.g., novelty; Yim et al., 2017). These variables can affect the strength of effects of AR apps, such that they become either stronger or weaker.

Lastly, different types of AR shopping apps were examined. Most studies focused on apps that enable users to visualize products on their own face (self-augmentation) for products such as make-up, clothing and sunglasses (Poushneh & Vasquez-Parraga, 2017; Verhagen et al., 2014; Yim et al., 2017). Few studies focused on apps that visualize products within one's surroundings, such as furniture (except for Javornik, 2016, and Rauschnabel et al., 2019).

2.3. Spatial presence

Spatial presence is a subjectively perceived construct, which explains how virtual objects or environments can be experienced as real, physical objects or environments (Lee, 2004; Schubert, 2009). Presence has been linked to traditional mediated communication (e.g., books, TV), as well as advanced human-computer interfaces (e.g., websites, Virtual Reality; see Lee, 2004, for an overview). With respect to AR, the virtual objects become part of the user's physical world. By allowing users to control and interact with these virtual objects in the physical world, it can feel as if they exist in the real world, and induce spatial presence (Hilken et al., 2017; Huang & Liao, 2015; Verhagen et al., 2014). While similar concepts have been defined in relation to AR, such as *augmentation quality* (Rauschnabel et al., 2019), *perceived augmentation* (Javornik, 2016), and *local presence* (Verhagen et al., 2014), they are all defined as the degree to which virtual objects are experienced as

Table 1
Literature overview of empirical studies on AR shopping applications.

Study	AR application (type), product	Method	Conditions ¹	Underlying process(es) ²	Moderators	Outcome variables	Main findings
Baek et al. (2018)	Ray Ban Virtual Mirror (web application), sunglasses	Online experiment	Self-viewing (AR) vs. other-viewing (non-AR)	Self-brand connections (SBC)	Narcissism (NAR)	Purchase intention (PI)	Positive effect of AR on PI via SBC, only found for people scoring high on NAR
Hilken et al. (2017)	Mister Spex (web application), sunglasses L'Oreal's AR virtual mirror (web application), make-up	Lab experiment	Simulated physical control (SPC, high/low) Environmental embedding (EE, high/low) AR virtual mirror vs. photo-based try-on vs. 360 rotation vs. picture	Spatial presence (SP)	Style-of-processing (SOP) Awareness of privacy practices (APP)	Utilitarian value (UV) Hedonic value (HV) Decision comfort (DC) Purchase intention (PI) Word-of-mouth (WOM)	Positive effect of AR (high SPC+high EE) on outcome variables via SP Negative effect of SP on DC for people scoring high on APP
Huang and Hsu Liu (2014)	Virtual fitting room (web application), clothing	Survey	-	Perception presence (PP), Perception narrative (PN), Media richness (MR)	-	Aesthetics (AE) Playfulness (PL) Consumer ROI (ROI) Service excellence (SE)	PP and MR positively affected AE and SE PN positively affected all outcome variables and had the strongest effects (compared to PP and MR) Positive effect of PR on all other variables
Huang and Liao (2015)	Virtual fitting room (web application), clothing	Survey	-	Presence (PR) Perceived ease of use (PEOU) Perceived usefulness (PU) Perceived aesthetics (PA) Service excellence (SE) Perceived playfulness (PP) Self-location (SL) Haptic imagery (HI) Psychological states (PS) Flow (FL)	Cognitive innovativeness (CI): high/low	Sustainable relationship behavior (SRB)	Positive effect of PU, PA and SE on SRB for people with high CI Positive effect of PEOU, PU and PP on SRB for people with low CI Positive effect of SL and HI on TI and SA, via PS and FL
Huang and Liao (2017)	Virtual fitting room (web application), clothing	Survey	-	Perceived playfulness (PP) Self-location (SL) Haptic imagery (HI) Psychological states (PS) Flow (FL)	-	Time spend with AR app (TI) Satisfaction (SA)	Positive effect of AR on PA No effect of AR on IN Positive effect of PA on AA and RI2, via FL Negative effect of PA on AT, via FL
Javornik (2016)	Furniture app (mobile application), furniture Virtual try-on app (web application), sunglasses	Lab experiment	AR vs. non-AR (pictures)	Perceived augmentation (PA) Interactivity (IN) Flow (FL)	-	App attitude (AA) Brand attitude (BA) Recommendation intention (RI) Reuse intention (RI2) Purchase intention (PI) App-related thoughts (AT) Brand-related thoughts (BT) User satisfaction (US)	Positive effect of AR on PA No effect of AR on IN Positive effect of PA on AA and RI2, via FL Negative effect of PA on AT, via FL No effects of PA on brand-related responses Positive effect of AR on AQ and UC-API Positive effect of AQ and UC-API on US
Poushneh (2018)	Ray Ban Virtual Mirror (web application), sunglasses Star Chart (mobile application) ³ Virtual Hyundai application (mobile application) ³	Lab experiment	AR vs. non-AR (pictures)	Augmentation quality (AQ) User's control of access to personal information (UC-API)	-	Augmentation quality (AQ) User's control of access to personal information (UC-API)	Positive effect of AR on AQ and UC-API Positive effect of AQ and UC-API on US
Poushneh and Vasquez-Parraga (2017)	Ray Ban Virtual Mirror (web application), sunglasses	Lab experiment	AR vs. non-AR	User experience (UX): Hedonic quality Aesthetic quality Pragmatic quality Utilitarian benefits (UB) Hedonic benefits (HB) Augmentation quality (AQ) App attitude (AA) Inspiration (IN)	Trade-off between price and value (TOPV) User information privacy control (UIPC)	User willingness to buy (UWB) User satisfaction (US) Brand attitude (BA)	Positive effect of AR on UX Positive effect of UX on UWB and US No moderation effects Positive effect of UB and HB on AA Positive effect of HB and AQ on IN IN mediated the effect of HB and AQ on BA (AA did not)
Rauschnabel et al. (2019)	IKEA Planner (mobile application), furniture Tunnel (mobile application) ³	Survey	-	Augmentation quality (AQ) App attitude (AA) Inspiration (IN)	-	Augmentation quality (AQ) App attitude (AA) Inspiration (IN)	Positive effect of AR on UX Positive effect of UX on UWB and US No moderation effects Positive effect of UB and HB on AA Positive effect of HB and AQ on IN IN mediated the effect of HB and AQ on BA (AA did not)

(continued on next page)

Table 1 (continued)

Study	AR application (type), product	Method	Conditions ¹	Underlying process(es) ²	Moderators	Outcome variables	Main findings
Rese et al. (2017)	IKEA catalogue (mobile application), furniture AUTO BILD (mobile application) ³ Mister Spex/Ray Ban (web application), sunglasses IKEA catalogue (mobile application)	Lab experiment	Marker-based AR app vs. markerless AR app	Perceived informativeness (PI) Perceived enjoyment (PE) Perceived usefulness (PU) Perceived ease-of-use (PEOU)	-	Attitude towards using (AT) Behavioral intention to use (BI)	Positive effect of PI and PE on PU (not of PEOU) Positive effect of PU on AT and BI Stronger effects for markerless AR apps
Rese, Schreiber, and Baier (2014)	IKEA catalogue (mobile application)	Survey	-	Perceived informativeness (PI) Perceived enjoyment (PE) Perceived usefulness (PU) Perceived ease-of-use (PEOU)	-	Attitude towards using (AT) Behavioral intention to use (BI)	Positive effect of PI and PE on PU (not of PEOU) Positive effect of PU on AT and BI
Smink, Frowijn, van Reijmersdal, van Noord, and Neijens (2019)	Sephora virtual artist (web application), make-up	Online experiment	AR vs non-AR (picture of own face/model)	Perceived informativeness (INF) Perceived enjoyment (ENJ) Perceived intrusiveness (INT)	-	Brand attitude (BA) Purchase intention (PI) Willingness to disclose personal information (WDPI)	Positive effect of AR on BA via ENJ Positive effect of AR on PI and WDPI via INF Positive effect of AR on INT, but no negative effects on outcome variables
Verhagen et al. (2014)	Ray Ban Virtual Mirror (web application), sunglasses	Lab experiment	AR vs. non-AR (360 pin & picture)	Local presence (LP) Product tangibility (PT) Product likeability (PL) Media usefulness (MU) Media enjoyment (ME) Interactivity (IN) Media irritation (MI)	-	Purchase intention (PI)	Positive effect of AR on LP Positive effect of LP on PI, via PT and PL
Yim and Park (2018)	Ray Ban Virtual Mirror (web application), sunglasses	Online experiment	AR vs. non-AR (pictures)	Media usefulness (MU) Media enjoyment (ME) Interactivity (IN) Media irritation (MI)	Body image (BI): unfavorable/favorable	Attitude toward technology (ATT) Adoption intention (AI)	Positive effect of AR on ATT and AI via MU and ME, only for people with unfavorable BI Positive effect of IN on AI stronger for people with favorable BI Negative effect of MI on AI stronger for people with favorable BI
Yim et al. (2017)	Ray Ban Virtual Mirror (web application), sunglasses Tissot (web application), watches	Online experiment	AR vs. non-AR (pictures)	Interactivity (IN) Vividness (VI) Immersion (IM) Media usefulness (MU) Enjoyment (EN)	Media novelty (MN) Previous media experience (PME)	Attitude toward medium (ATM) Purchase intention (PI)	Positive effect of IN and VI on IM, consequently IM on MU and EN, consequently, ATM and PI Positive effect of MN on IM Relations stronger for AR (vs. non-AR)

Note. Studies that involve an AR shopping app, with a focus on underlying processes. Some studies also involved other AR apps. ¹Only for experimental studies. ²In surveys the underlying processes often function as the independent variables in the conceptual model, but are here indicated as underlying processes. ³This does not concern an AR shopping app.

actual objects in one's own physical environment.

The amount of presence a consumer experiences is influenced by the number of senses that are engaged by the experience and the amount of control the user has over the experience (Ahn et al., 2016; Hilken et al., 2017; Steuer, 1992). When using an AR app, one can add, modify, and interact with virtual products within one's own physical space as if they are part of the real world (Scholz & Smith, 2015). Thus, AR enables a more direct product experience that provides a sensory-rich (by simulating the touch-and-feel of physical products) and vivid experience, and gives users control over their experience (Hilken et al., 2017; Verhagen et al., 2014). In contrast, a non-AR app represents a more indirect product experience (e.g., a picture or video of the product) that offers less opportunity for user control and sensory engagement. Previous research also showed that AR led to a higher level of spatial presence (or related concepts), compared to other product presentation formats (pictures or 360-degree rotation; Hilken et al., 2017; Javornik, 2016; Verhagen et al., 2014). Given these assumptions, an AR app is expected to induce a stronger spatial presence than a non-AR app.

The more presence a consumer experiences, the lower the discrepancy between the virtual and actual product experience (Suh & Chang, 2006) and the more one would respond to the experience as if it is a real, unmediated, direct experience (Ahn et al., 2016; Klein, 2003). Direct experiences have been linked to increased persuasion, and have stronger and longer lasting effects than indirect experiences (Ahn et al., 2016; Kim & Biocca, 1997). Moreover, because spatial presence is characterized by increased sensory and cognitive engagement, it is likely to also induce positive affect (Kim & Biocca, 1997; Lombard & Ditton, 1997; Mollen & Wilson, 2010; Schubert, 2009). Consequently, this positive affect can be transferred to the app and brand responses.

Research shows that spatial presence intensifies media effects. For example, previous studies showed that presence can positively influence attitude towards the AR app and intention to reuse or recommend the app (Huang & Hsu Liu, 2014; Javornik, 2016). Moreover, presence can strengthen beliefs about product attributes and thereby help consumers reduce the perceived risk of buying a product (Hilken et al., 2017; Lee, Li, & Edwards, 2012; Suh & Chang, 2006), which can enhance purchase intentions. AR studies indeed showed that spatial presence enhanced product likeability and purchase intention (Hilken et al., 2017; Verhagen et al., 2014). With regard to brand attitude, previous studies have shown that presence enables a more accessible and confident brand attitude (Kim & Biocca, 1997; Klein, 2003; Lee et al., 2012). However, in AR studies, mixed results have been found. Rauschnabel et al. (2019) found that spatial presence enhanced brand attitude, via spatial presence and *inspiration* (the extent to which consumers can imagine and visualize possibilities and new ideas). In contrast, Javornik (2016) found that AR did not enhance brand-related responses through presence. However, following the predominantly positive effects of presence on brand-related responses found in other studies (Hilken et al., 2017; Klein, 2003; Li, Daugherty, & Biocca, 2002; Rauschnabel et al., 2019; Suh & Chang, 2006; Yim, Cicchirillo, & Drumwright, 2012), we hypothesize:

H1: The AR app elicits more spatial presence than the non-AR app (H1a), which consequently leads to more positive app (H1b) and brand responses (H1c).

2.4. Perceived personalization

Perceived personalization is defined as the consumer's recognition that information is personalized and tailored for that specific consumer (Vesonen, 2007). Personalization is linked to increased persuasive power, as it appeals to the needs and interests of the individual consumer (Keyzer, Dens, & Pelsmacker, 2000; Kim, Lin, & Sung, 2013; Tam & Ho, 2006). Technologies can induce a personalized experience when consumer information is used to tailor an experience to a specific consumer (Vesonen, 2007). For example, personalization strategies can

vary from personalizing communication or messages, such as addressing the receiver by their name, to giving personalized recommendations based on web-data (Tam & Ho, 2006), or using personalized virtual models to fit clothes on (Merle, Senecal, & St-Onge, 2012). When these personalization cues are used and recognized, the information is encoded in relation to the self and the experience is perceived as more personalized (Ahn & Bailenson, 2011; Baek & Morimoto, 2012; Maslowska, Smit, & van den Putte, 2016).

With regard to AR, the technology enables consumers to visualize products in a personally relevant context (Hilken et al., 2017), this is also referred to as *context-driven personalization* (Tam & Ho, 2006). For example, allowing users to visualize products on their own face or body (e.g., make-up, sunglasses, clothing), or within their personal surroundings (e.g., furniture, a TV), tailors the experience to that specific consumer.

Moreover, the interface enables users to customize their experience by picking different (virtual) products which directly appear in the real-time view of the self or one's physical world. In comparison, a non-AR experience (e.g., a picture of the product), does not allow users to see the product in a personally relevant context and does not offer such personalization cues. Because AR shows an actual representation of the self or the user's environment, we argue that these personalization cues are more salient (compared to a non-AR experience) and therefore will be perceived as more personalized.

Perceived personalization elicited by AR is consequently expected to induce positive persuasive consequences. Research has shown that personalized communication attracts more attention, thereby increasing the processing and elaboration of the content, and is perceived as more relevant (Keyzer et al., 2000; Maslowska et al., 2016; Tam & Ho, 2006). Moreover, consumers tend to prefer and show more positive affect towards self-relevant information (Kalyanaraman & Sundar, 2006). Research showed that personalized communication (e.g., personalized social media ads or newsletters), enhanced attitude towards the source and behavioral intention (Keyzer et al., 2000; Maslowska et al., 2016). Moreover, the positive affect triggered by personalization cues can be transferred to the brand. Because consumers relate and encode personalized information in relation to the self, a positive associative link between the self and the brand emerges (Ahn & Bailenson, 2011; Baek et al., 2018). For example, research has shown that personalized newsletters or recommendations resulted in positive responses to the brand and enhanced behavioral intentions (Maslowska et al., 2016; Tam & Ho, 2006). In line with these studies, we expect the following:

H2: An AR app elicits a higher perceived personalization compared to a non-AR app (H2a) which consequently leads to more positive app responses (H2b) and more positive brand responses (H2c).

2.5. Perceived intrusiveness

An AR app could also induce a negative consumer experience by increasing its perceived intrusiveness. Perceived intrusiveness is a cognitive reaction towards media or advertising that evokes feelings of annoyance, or irritation (Li, Edwards, & Lee, 2002). An advertisement can be perceived as intrusive because it interrupts the goals of the consumer. For example, when someone is watching a TV program and gets interrupted by a commercial block, this can cause annoyance (Li, Edwards, et al., 2002). Intrusiveness is also linked to personalized advertising, as advertisements that become too personal (e.g., by using very private information) can cause an uncomfortable feeling and raise feelings of intrusiveness (van Doorn & Hoekstra, 2013).

Similarly, AR can evoke feelings of intrusiveness in several ways. First of all, when opening an AR app, users need to provide camera access to enable the AR function. This can make users feel as if they are not in control over their personal information, which can be perceived as disturbing and raise intrusiveness (Poushneh, 2018). Second, since

AR technology is relatively new to consumers, they can feel inexperienced and unfamiliar with the technology when experiencing it for the first time, which may induce an unpleasant feeling and raise intrusiveness (Hopp & Gangadharbatla, 2016; Tokunaga, 2013). Moreover, the AR app will project virtual products onto the consumers' own face or surroundings, they may perceive this practice as coming too close to their own physical world, increasing the perceived intrusiveness.

Intrusiveness can induce negative emotions, such as irritation and annoyance, which can negatively affect consumer reactions (Li, Edwards, et al., 2002). Several studies have shown that intrusiveness can cause reactance and avoidance (e.g., Baek & Morimoto, 2012; Li, Edwards, et al., 2002). Reactance theory states that consumers try to resist persuasive messages when they experience a lack of control or freedom (Brehm, 1966), which may happen when AR apps ask for camera access. When people experience reactance, they are motivated to resist persuasion and respond negatively (Baek & Morimoto, 2012; Li, Edwards, et al., 2002). For example, advertising research has shown that increased intrusiveness can cause reactance, resulting in negative evaluations and behavioral intentions regarding the source that triggers the reactance (Baek & Morimoto, 2012; McCoy, Everard, Polak, & Galletta, 2008; Ozcelik & Varnali, 2019). Additionally, when advertising is perceived as intrusive, this can lead to negative brand responses (Ozcelik & Varnali, 2019; van Doorn & Hoekstra, 2013). Similarly, we hypothesize:

H3: An AR app elicits a higher perceived intrusiveness compared to a non-AR app (H3a) which consequently leads to more negative app responses (H3b) and more negative brand responses (H3c).

3. Study 1

3.1. Method

3.1.1. Participants and design

An experiment was conducted at the university lab. Participants ($N = 113$) were recruited using an online student subject pool. The experiment was employed using a single-factor between-subjects design and participants were randomly assigned to one of the three conditions (one AR condition vs. two non-AR conditions). Because the stimuli concerned an app from a make-up brand, only women could participate in the experiment ($M_{\text{age}} = 21.45$, $SD = 2.27$). Women are an important target group of AR apps, since they experience higher levels of perceived risk when shopping online than men, and actually have a higher preference for direct product experiences (Garbarino & Strahilevitz, 2004; Hasan, 2010). Since AR is argued to reduce the perceived risk of buying online by enabling users to visualize products and have more direct product experiences, AR may be especially beneficial to women. Therefore, women's reactions to AR shopping apps can provide valuable insights to practice and a relevant study sample.

3.1.2. Stimulus material

The existing app 'Makeup Genius' from make-up brand L'Oréal Paris was used to represent the AR condition ($N = 37$). The app uses AR technology with face recognition to virtually overlay make-up on the participant's face through the tablet's camera. After their faces were scanned, the participants could choose between 32 make-up looks and try them on their own faces in real time.

Two versions of the make-up app were created by a programmer to represent the non-AR conditions. Both versions had the same content as in the original app. However, in these conditions, participants saw the make-up looks on a professional model. In the first version of the non-AR app ($N = 36$), participants could choose between twelve models with different hair colors, eye colors, and ethnicities. This version most closely resembled the AR condition, as the participants could select someone who looked like them. A second version of the non-AR app

was created without choice ($N = 40$), where participants could see the make-up looks on one model, which is the most common practice of online web stores.

3.1.3. Procedure

Upon arrival at the university laboratory, participants had to read an information sheet about the study and gave informed consent. Then, they were seated behind a desk with a computer and a tablet. On the computer screen, the experimental task was explained; participants were instructed to imagine going to a party for which they had to choose a make-up look¹. They were instructed to try several looks with the app and to choose the one they preferred. Participants had to follow step-by-step instructions on how to use the app, adjusted for each condition. They had ten minutes to perform the task, after which they filled in the questionnaire, measuring the mediating variables, followed by all dependent and control variables. Participants could choose between an incentive or research credits in exchange for their participation.

3.1.4. Measures

The scales regarding the underlying processes and dependent variables were measured using existing, validated scales which were adjusted to fit the context of this study. All variables were measured on 7-point scales and mean scores were calculated from the items to create the scales. An overview of the items, descriptive statistics, and reliability of the scales can be found in Table 2.

Additionally, several control variables were included. Participants were asked if they were familiar with the brand (98% yes) and had previously used the app (5% yes). Frequency of use was measured regarding the product (85% uses make-up daily/sometimes), and the tablet (66% uses a tablet daily/weekly/monthly). Furthermore, technology innovativeness ('the tendency of a person to be a technology pioneer'; Parasuraman, 2000) and product involvement were measured as these variables could possibly influence adoption and evaluation of the app. Lastly, age and educational level were measured as background variables.

3.2. Results

3.2.1. Control variables

First, it was checked whether the experimental groups differed on the control variables. Product use, $\chi^2(3) = 3.38$, $p = .337$, tablet use, $\chi^2(3) = 2.59$, $p = .459$, brand familiarity, $\chi^2(1) = 0.991$, $p = .319$, previous app use, $\chi^2(1) = 0.857$, $p = .355$, education, $\chi^2(2) = 3.30$, $p = .192$, technology innovativeness, $F(1, 111) = 1.44$, $p = .233$, and age, $F(1, 111) = 0.00$, $p = .951$, did not differ between the experimental groups.

3.2.2. Analyses

Since preliminary analyses showed that the two non-AR apps did not differ on any of the underlying processes or dependent variables, the two versions were combined to form the non-AR condition ($N = 76$) and were compared to the AR condition ($N = 37$)².

PROCESS (Model 4; Hayes, 2013) was used to calculate the direct and indirect effects on the dependent variables. Bootstrapping with 10,000 samples was used to calculate bias-corrected bootstrap confidence intervals (BCBCI) for the indirect effects (Hayes, 2013). Four

¹ This experimental context was chosen as it concerned a situation in which it was more likely that women would wear make-up than in a daily situation, and therefore it would provide a relevant situation to use the make-up app.

² By taking the two non-AR conditions together, sample size differed between the AR and non-AR conditions. However, additional analyses correcting for differences in sample size (e.g., Welch's test) resulted in similar results as those reported.

Table 2
Reliability, descriptives and measurement items of variables.

Variable	Study 1		Study 2		Measurement items
	Cronbach's Alpha	Mean (SD)	Cronbach's Alpha	Mean (SD)	
Spatial presence ^a (Hilken et al., 2017; Verhagen et al., 2014)	0.88	2.84 (1.41)	0.94	3.19 (1.49)	Trying <i>make-up/furniture</i> in the app... - Was similar to experiencing the products in reality - Felt like it was in reality - Seemed real rather than virtual - Was as realistic to me as in the real world
Perceived personalization ^a (Baek & Morimoto, 2012; Srinivasan, Anderson, & Ponnnavolu, 2002)	0.88	3.45 (1.47)	0.90	4.06 (1.36)	Trying <i>make-up/furniture</i> in the app... - Was tailored to my situation - Felt like a personal experience - Matched my needs - Was personally relevant to me
Perceived intrusiveness ^a (Li, Edwards, et al., 2002)	0.90	1.73 (0.97)	0.92	2.20 (1.07)	Trying <i>make-up/furniture</i> in the app was... - Disturbing - Interfering - Intrusive - Unpleasant - Invasive
Attitude towards the app ^b (Li, Daugherty, et al., 2002)	0.86	4.62 (1.28)	0.88	5.45 (1.09)	In my opinion, the app is... - (un) appealing - (un) likeable - bad/good
Behavioral intention regarding the app ^a (van Noort, Voorveld, & van Reijmersdal, 2012)	0.86	2.33 (1.26)	0.72	4.05 (1.17)	I would like to: - Talk about this app with friends, family, or colleagues - Recommend this app to friends, family, or colleagues - Share content (i.e., pictures) from the app via social media - Share content (i.e., pictures) from the app with a friend
Brand attitude ^b (Li, Daugherty, et al., 2002)	0.91	5.50 (0.99)	0.83	6.07 (0.84)	In my opinion, <i>Brand X</i> is... - (un) appealing - (un) likeable - bad/good
Purchase intention ^b (Bearden, Lichtenstein, & Teel, 1984)	0.97	3.59 (1.46)	0.95	4.06 (1.61)	After using the app, the chance that I will buy <i>product</i> from <i>Brand X</i> is:* - (un)likely - (un)certain - small/big
Technology innovativeness ^a (Parasuraman, 2000)	0.74	3.88 (1.19)	0.77	4.73 (1.14)	- I enjoy the challenge of figuring out new technologies - I have fewer problems than other people in making technology work for me - I am among the first in my circle of friends to acquire a new technology - I keep up with the latest technological developments
Product involvement (Zaichkowsky, 1985)	0.93	4.55 (1.31)	n.a.	n.a.	To me, make-up is: - (ir)relevant - (un)necessary - (in)essential - (un)important - meaningless/meaningful

^a 7-point Likert scale.

^b semantic differential.

* In Study 2, 'after using the app' was removed from this measurement item.

parallel multiple mediation models were analyzed, one for each dependent variable, with the AR app (versus the non-AR app) as independent variable, and with spatial presence, perceived personalization, and perceived intrusiveness included as mediators. Additionally, one-way analyses of variance were conducted to compare the AR condition to the non-AR condition on the main variables from the conceptual model. The mean scores per condition can be found in Table 3, all indirect effects from the mediation models can be found in Table 4, all direct effects are presented in Table 5.

3.2.3. Spatial presence

It was expected that the AR app would elicit more spatial presence

than the non-AR app (H1a), which would lead to more positive app (H1b) and brand responses (H1c). The data showed a significant difference between the two conditions, $F(1, 111) = 37.08, p = .000, \eta_p^2 = 0.25$. Using the AR app ($M = 3.84, SD = 1.49$) resulted in more spatial presence than using the non-AR app ($M = 2.35, SD = 1.08$). Thus, H1a was confirmed.

Furthermore, the mediation model showed significant indirect effects on attitude and behavioral intention regarding the app, via spatial presence (see Table 4). The AR app elicited more spatial presence, which consequently led to positive effects on app attitude and behavioral intention regarding the app (see Table 5). Hence, H1b was confirmed. However, there were no indirect effects of the AR app on brand

Table 3
Means and standard deviations of the underlying processes and dependent variables.

Dependent variable	Study 1		Study 2	
	Non-AR app	AR app	Non-AR app	AR app
Underlying processes				
Spatial presence	2.35(1.08)	3.84***(1.49)	2.64(1.32)	3.69***(1.47)
Perceived personalization	3.07(1.35)	4.23***(1.41)	3.60(1.35)	4.50**(1.23)
Perceived intrusiveness	1.57(0.81)	2.04*(1.19)	2.47(1.19)	1.96*(0.90)
App responses				
Attitude towards the app	4.27(1.22)	5.34***(1.07)	5.20(1.16)	5.69*(0.97)
Behavioral intention	2.08(1.08)	3.18***(1.31)	3.55(1.22)	4.52***(0.92)
Brand responses				
Brand attitude	5.51(0.99)	5.49(1.00)	6.00(0.88)	6.14(0.81)
Purchase intention	3.63(1.40)	3.50(1.60)	3.93(1.79)	4.18(1.43)

Note. Means (with SD between parentheses); Significant means the AR app is significantly higher/lower than the non-AR app in that study. N = 113 for Study 1; N = 81 for Study 2.

† p < .10. * p < .05. ** p < .01. *** p < .001.

Table 4
Indirect effects of Study 1 and 2.

Dependent variable	Spatial presence		Perceived personalization		Perceived intrusiveness	
	Study 1	Study 2	Study 1	Study 2	Study 1	Study 2
App responses						
Attitude towards the app	0.59 (0.17) [0.305, 0.971]	0.20 (0.11) [0.047, 0.470]	0.29 (0.12) [0.107, 0.570]	0.15 (0.10) [0.008, 0.414]	-0.05 (0.05) [-0.203, 0.020]	0.24 (0.12) [0.040, 0.516]
Behavioral intention	0.36 (0.16) [0.096, 0.730]	0.18 (0.11) [0.024, 0.449]	0.34 (0.11) [0.162, 0.626]	0.15 (0.11) [-0.002, 0.462]	-0.10 (0.08) [-0.321, -0.006]	0.13 (0.09) [0.008, 0.379]
Brand responses						
Brand attitude	-0.25 (0.17) [-0.681, 0.015]	0.05 (0.08) [-0.087, 0.221]	0.13 (0.08) [-0.009, 0.325]	0.02 (0.10) [-0.133, 0.246]	-0.13 (0.08) [-0.351, -0.017]	0.12 (0.08) [0.018, 0.343]
Purchase intention	-0.13 (0.20) [-0.511, 0.260]	0.49 (0.19) [0.192, 0.934]	0.44 (0.17) [0.168, 0.857]	0.04 (0.16) [-0.246, 0.401]	-0.15 (0.11) [-0.445, -0.009]	0.22 (0.13) [0.025, 0.572]

Note. Unstandardized b-coefficients (with boot SE between parentheses); [95% Bias corrected bootstrap confidence interval using 10,000 bootstrap samples between brackets]; significant indirect effects are bold; N = 113 for Study 1; N = 81 for Study 2.

Table 5
Direct and total effects of Study 1.

Dependent variables	Predictors				R ²	AR (total effect)
	AR (direct effect)	SP	PP	PI		
Underlying processes						
Spatial presence	1.50*** (0.25)	...	...	...	0.25	...
Perceived personalization	1.16*** (0.27)	...	...	...	0.14	...
Perceived intrusiveness	0.46* (0.19)	...	...	...	0.05	...
App responses						
App attitude	0.24 (0.23)	0.39*** (0.08)	0.25** (0.07)	-0.11 (0.10)	0.49	1.07*** (0.24)
Behavioral intention	0.49* (0.23)	0.24** (0.08)	0.30*** (0.08)	-0.22* (0.10)	0.45	1.10*** (0.23)
Brand responses						
Brand attitude	0.23 (0.23)	-0.17* (0.08)	0.11 (0.08)	-0.28** (0.10)	0.12	-0.02 (0.20)
Purchase intention	-0.29 (0.32)	-0.09 (0.12)	0.38*** (0.11)	-0.32* (0.14)	0.19	-0.13 (0.29)

Note. Unstandardized b-coefficients (with boot SE between parentheses); SP = Spatial Presence, PP = Perceived Personalization, PI = Perceived Intrusiveness; N = 113.

* p < .05. ** p < .01. *** p < .001.

attitude and purchase intention, via spatial presence. H1c was rejected.

3.2.4. Perceived personalization

The AR app was expected to increase perceived personalization (H2a), which would in turn positively affect app responses (H2b) and brand responses (H2c). The results showed that perceived personalization was significantly higher for the AR app (M = 4.23, SD = 1.41) than the non-AR app (M = 3.07, SD = 1.35), F(1, 111) = 17.83, p = .000, η_p² = 0.14. Thus, H2a was accepted. Furthermore, we found significant indirect effects of the AR app on attitude and behavioral intention regarding the app, via perceived personalization (see

Table 4). As expected, the perceived personalization (induced by the AR app), enhanced app attitude and behavioral intention (see Table 5). H2b was accepted.

With regard to brand responses, we found a significant indirect effect on purchase intention. Thus, the AR app induced a higher level of perceived personalization, which consequently enhanced purchase intention. However, the data revealed no indirect effect, via perceived personalization, on brand attitude. Therefore, H2c was partly confirmed.

3.2.5. Perceived intrusiveness

The hypothesis that the AR app would elicit a higher level of perceived intrusiveness was confirmed by the data, $F(1, 111) = 5.91$, $p = .017$, $\eta_p^2 = 0.05$. Perceived intrusiveness was higher for the AR app ($M = 2.04$, $SD = 1.19$), than the non-AR app ($M = 1.57$, $SD = 0.81$), confirming H3a.

Consequently, the greater perceived intrusiveness of the AR app was expected to negatively affect app (H3b) and brand responses (H3c). A significant indirect effect on behavioral intention regarding the app was found (see Table 4). The higher perceived intrusiveness for the AR app, consequently negatively affected behavioral intention regarding the app (see Table 5). However, no indirect effect was found on app attitude. Therefore, H3b was partly confirmed.

The AR app also negatively affected brand responses, as shown by the significant indirect effects on brand attitude and purchase intention, via perceived intrusiveness. The AR app induced a higher perceived intrusiveness, which negatively affected attitude and purchase intention. H3c was accepted.

4. Study 2

The purpose of Study 2 was to examine whether we could replicate the findings from Study 1 with an AR app that projects virtual objects onto the user’s surroundings. As stated previously, there are numerous AR apps that do not use the self-view but rather use the view of consumers’ surroundings (e.g., placing virtual furniture within the living room). By conducting an additional study, we could examine whether the positive and negative consequences of AR apps are related to the self-view or whether these effects can be extended to AR apps that augment users’ surroundings. As such we added to the external validity of this study by testing the same hypotheses as in Study 1 for another AR app. We pose the following research question:

RQ1: Do the effects (and its underlying processes) found for an AR app that enables self-augmentation also hold for an AR app that augments the users’ surroundings?

4.1. Method

4.1.1. Participants and design

An experiment was conducted at the university lab, where participants were randomly assigned to either the AR or non-AR condition. Eighty-four students were recruited by using an online student subject pool, who received research credits for their participation. All participants performed a task with a branded app on a tablet. Three participants had to be removed because of problems with the app, leading to a final sample of eighty-one participants (77% female, $M_{age} = 21.32$,

$SD = 2.26$).

4.1.2. Stimulus material

The AR app ‘IKEA Place’ was used to represent the AR condition ($N = 42$). The app enables users to scan their room and place virtual IKEA products in their room. Users can walk around the virtual furniture and inspect the furniture from up close and from different angles. For the non-AR condition ($N = 39$), we used a web-based application that had the same icon and content and showed the same IKEA collection as in the AR app. However, instead of showing the furniture in AR, participants could see pictures of the furniture from different angles, similar to how consumers would normally shop for furniture in an online webstore.

4.1.3. Procedure

After reading and signing an informed consent form, participants received a tablet with instructions for the experimental task. Participants were instructed to imagine they had just moved to a new apartment, and had to buy a new sofa for their living room using the IKEA app. In the university laboratory, we created a living room that was decorated with real furniture (e.g., a desk with chair, a cabinet with TV). The real furniture was in neutral tones so participants could choose a sofa to with it according to their own personal taste. They could try several sofas and pick the one they liked best. This setting was used to provide high internal validity, yet aiming to induce a natural setting by recreating a situation in which participants could imagine buying a new couch (e.g., students often move into new student homes for which they need to buy furniture).

After reading the instructions, the experimenter opened the IKEA app for the participant with the sofa collection already displayed. Then, the participant was left alone in the living room to select the sofa using either the AR or non-AR app. Participants took approximately five minutes to perform the task. Afterwards, they filled in the questionnaire that measured the underlying processes, dependent, and control variables. The same measures as in Study 1 were used (see Table 2).

4.2. Results

4.2.1. Analyses

The hypotheses were tested with the same procedures as in Study 1 (see method section Study 1). The mean scores per condition can be found in Table 3, all indirect effects are shown in Table 4, and all direct effects are shown in Table 6.

4.2.2. Control variables

Gender, $\chi^2(1) = 0.006$, $p = .319$, product use, $\chi^2(1) = 0.003$, $p = .958$, technology innovativeness, $F(1, 79) = 0.02$, $p = .889$, and

Table 6
Direct and total effects of Study 2.

Dependent variables	Predictors				R ²	AR (total effect)
	AR (direct effect)	SP	PP	PI		
Underlying processes						
Spatial presence	1.05*** (0.31)	...	...	...	0.13	...
Perceived Personalization	0.90** (0.29)	...	...	...	0.11	...
Perceived Intrusiveness	-0.50* (0.23)	...	...	...	0.06	...
App Responses						
App Attitude	-0.09 (0.21)	0.19* (0.07)	0.16* (0.08)	-0.48*** (0.09)	0.42	0.49* (0.24)
Behavioral Intention	0.50* (0.24)	0.17* (0.09)	0.17† (0.09)	-0.26* (0.11)	0.35	0.97*** (0.24)
Brand responses						
Brand Attitude	-0.04 (0.20)	0.04 (0.07)	0.02 (0.08)	-0.23** (0.09)	0.10	0.14 (0.19)
Purchase Intention	-0.50 (0.35)	0.47*** (0.12)	0.04 (0.13)	-0.44** (0.15)	0.28	0.25 (0.36)

Note. Unstandardized b-coefficients (with boot SE between parentheses); SP = Spatial Presence, PP = Perceived Personalization, PI = Perceived Intrusiveness; N = 81.

* $p < .05$. ** $p < .01$. *** $p < .001$.

age, $F(1, 111) = 0.405, p = .527$, did not differ between the experimental groups. Therefore, none of these variables were included in the further analyses. However, previous app use differed between the experimental groups, $\chi^2(1) = 4.340, p = .037$, with 31% that had previously used an IKEA app in the non-AR condition versus 12% in the AR condition. Since previous app use did not show any correlations with the underlying processes or dependent variables, it was not included in the main analyses.

4.2.3. Spatial presence

The AR app ($M = 3.69, SD = 1.47$) induced more spatial presence than the non-AR app ($M = 2.64, SD = 1.32$), confirming H1a, $F(1, 79) = 11.31, p = .001, \eta_p^2 = 0.13$. The AR app had significant indirect effects, via spatial presence, on app attitude and behavioral intention (see Table 4). The higher level of spatial presence induced by the AR app, consequently enhanced app attitude and behavioral intention (see Table 6). H1b was also confirmed. Furthermore, we found a significant indirect effect on purchase intention, via spatial presence. The higher level of spatial presence elicited by the AR app increased purchase intention. The indirect effect on brand attitude was not significant. Hence, H1c was partly confirmed.

4.2.4. Perceived personalization

The AR app was perceived as more personalized ($M = 4.50, SD = 1.23$) than the non-AR app ($M = 3.60, SD = 1.35$), $F(1, 79) = 9.95, p = .002, \eta_p^2 = 0.11$. H2a was accepted. With regard to the app responses, we found an indirect effect only on app attitude, but not on behavioral intention (see Table 4). The AR app enhanced the perceived personalization, which consequently enhanced attitude towards the app (see Table 6). Hence, H2b was partly confirmed. Furthermore, none of the indirect effects of the AR app on brand responses, via perceived personalization, were significant. Therefore, H2c was rejected.

4.2.5. Perceived intrusiveness

Contrary to our hypotheses, the AR app ($M = 1.96, SD = 0.90$) was perceived as less intrusive than the non-AR app ($M = 2.47, SD = 1.19$), $F(1, 79) = 4.67, p = .034, \eta_p^2 = 0.06$. Hence, H3a was rejected. Perceived intrusiveness had direct, negative effects on attitude and behavioral intention regarding the app, brand attitude, and purchase intention (see Table 6). Because the effect of the AR app on perceived intrusiveness was reversed, the indirect effects were also in the opposite direction (see Table 4). Therefore, H3b and H3c were rejected. An overview of all accepted and rejected hypotheses can be found in Table 7.

Table 7
Overview of accepted and rejected hypotheses per study.

Hypotheses	Study 1	Study 2
AR → Spatial presence (H1a)	✓	✓
→ Attitude towards the app (H1b)	✓	✓
→ Behavioral intention (H1b)	✓	✓
→ Brand attitude (H1c)	✗	✗
→ Purchase intention (H1c)	✗	✓
AR → Perceived personalization (H2a)	✓	✓
→ Attitude towards the app (H2b)	✓	✓
→ Behavioral intention (H2b)	✓	✗
→ Brand attitude (H2c)	✗	✗
→ Purchase intention (H2c)	✓	✗
AR → Perceived intrusiveness (H3a)	✓	✗
→ Attitude towards the app (H3b)	✗	✗
→ Behavioral intention (H3b)	✓	✗
→ Brand attitude (H3c)	✓	✗
→ Purchase intention (H3c)	✓	✗

Note. ✓ means the hypothesis is accepted for that variable; ✗ means the hypothesis is rejected for that variable.

5. Discussion

5.1. Theoretical implications

This study examined three underlying processes that explained how an AR app positively or negatively affects persuasive responses to the app and the brand, for two different apps: an AR app that used the self-view to project virtual make-up onto the face and an AR app that projects virtual furniture in the view of the surroundings. We can draw four main conclusions from the findings across the two studies.

First of all, both studies showed that spatial presence and perceived personalization were underlying processes that positively affected attitude and behavioral intention regarding the AR app. In line with previous studies (Javornik, 2016; Verhagen et al., 2014), the AR app elicited more spatial presence than the non-AR app. Because AR enables users to overlay virtual products into their physical space in real-time, it allows users to experience virtual objects as if they are really there, thereby inducing stronger spatial presence than a non-AR app. Moreover, because the AR app enables consumers to visualize products in a personally relevant context, the experience was also perceived as more personalized than a non-AR app. Consequently, these processes led to positive responses towards the AR apps, in line with previous studies (Javornik, 2016). Only for the furniture app, there was no indirect effect on behavioral intention, via perceived personalization. The results suggest that perceived personalization plays a less significant role for the furniture app, as was also indicated by its less prominent effects on brand responses (as explicated below).

Second, the underlying processes that positively affected brand responses, differed depending on the type of augmentation. For the AR app that used self-augmentation, personalization was the underlying process that led to positive effects on brand responses, while spatial presence was the underlying process that led to positive brand responses (purchase intention) for apps augmenting the surroundings. As these personalization cues are more salient for seeing one's own face than for seeing one's own environment, it could explain the stronger effect of perceived personalization on brand responses for the make-up app, while this effect was absent for the furniture app.

At the same time, presence induced stronger purchase intentions regarding the furniture app, while this effect was absent for the make-up app. With regard to furniture, spatial attributes could be a more important decision aid when judging the product, because AR enables users to inspect specific attributes of the product (e.g., design, shape and size of the product), while for make-up, these spatial attributes are less important.

Third, in our study, the AR apps did not yield any effects on brand attitude, via spatial presence and perceived personalization, in accordance with Javornik (2016) findings. In contrast, Rauschnabel et al. (2019) showed a difference in brand attitude before and after using an AR app, via augmentation quality and inspiration, using a similar app. However, our results showed that the use of AR specifically (as opposed to non-AR), did not enhance brand attitude. As the use of AR within the app is mainly focused on enabling users to better visualize products and is less focused on the brand, this could explain why there was an effect of the AR app on purchase intentions, but not on brand attitude. Moreover, one-time app use might be insufficient to enhance attitudes towards well-established brands, because consumers already have strong existing associations (Campbell & Keller, 2003).

Fourth, this study adds to the literature by showing that AR apps can have negative persuasive consequences by inducing a more intrusive experience. However, these negative effects via intrusiveness were only found for the make-up app. This suggests that intrusiveness is especially activated by the self-view. Not all consumers might want to use the self-view function, which can cause reactance. Consequently, this induced a more negative behavioral intention regarding the app (e.g., sharing the result on social media), and contributed to a more negative brand attitude and purchase intention.

For the furniture app, the effect was reversed, with the non-AR app being perceived as more intrusive than the AR app. A possible explanation is that the AR experience was more enjoyable and immersive than the non-AR experience (e.g., Yim et al., 2017). This aspect could distract from the actual purpose of the app (selling products) such that reactance is higher for the non-AR version, which is more clearly aimed at selling products, thus increasing the intrusiveness of the non-AR app.

5.2. Managerial implications

The findings of these studies provide relevant practical insights to retailers and marketers. An AR app can add a new dimension to the shopping experience by creating a more realistic and personalized experience. Moreover, AR apps can be a powerful tool to enhance purchase intentions, but seem to be less effective in enhancing brand attitude. As such, the app delivers a 'try before you buy' experience that could bridge the gap between online and offline shopping. However, retailers and marketers should be cautious in ensuring that the experience does not become too intrusive for products that concern the self, as greater intrusiveness could negate the positive persuasive outcomes. Therefore, it is advisable to give consumers the option to choose for the AR function themselves, but also providing an alternative, non-AR mode.

5.3. Limitations and future research

When interpreting the results, some limitations should be taken into account. First of all, our study focused on a young, tech savvy student sample. Therefore, some of our results may be specific to this group, which are generally known to be the early adopters of new technologies (Rice & Pearce, 2015). Furthermore, in Study 1, only women could participate in the experiment (since it involved an AR make-up app), which may limit the generalization of our results. While previous AR studies have not focused on gender differences, one study considered both female-only and mixed gender samples found similar effects of AR apps across both samples (Hilken et al., 2017), and one study controlled for gender and reported no differences in how men and women responded to AR apps (Hinsch, Felix, & Rauschnabel, 2020). Therefore, we expect that in general, the findings of our study generalize to men as well. However, previous research on online shopping has shown that women perceive a higher risk when shopping online than men (Garbarino & Strahilevitz, 2004). Therefore, they may respond more positively towards AR than men, as it enables users to better visualize products (inducing spatial presence). Future research is needed to better account for potential differences due to gender or age, and examine whether the effects found in this study hold when considering a more general population, including older people and men.

Moreover, future studies could also account for the influence of individual characteristics and previous AR experience on the effects of AR. For example, novelty, narcissism, body image, and privacy concerns can influence whether consumers adopt or respond positively to AR (e.g., Baek et al., 2018; Rauschnabel, 2018; Yim & Park, 2018). These characteristics should also be explored in relation to the underlying processes examined in this study to shed more light on when and for what types of consumers AR apps have positive as well as negative persuasive consequences. Since AR is also being employed into AR smart glasses (Rauschnabel, He, & Ro, 2018), enabling users to directly see virtual objects within their own viewing field, these devices could lead to even stronger and richer experiences and should be taken into account in future research.

In addition, our studies were carried out in a lab setting, which increased the internal validity of this study, but different effects may be found when considering a more natural setting. For example, in Study 2, participants had to choose a couch (using an AR or a non-AR app) for their 'new living room', simulated in the lab room. While we aimed to create a natural setting by recreating an actual living room, it could be

that the effects found on perceived personalization and perceived intrusiveness would become stronger when users would try the app within their actual living room. Therefore, future studies should consider field experiments to examine these effects in a more natural setting.

Lastly, our findings did not show any effects on brand attitude. While there may be several explanations for this finding, one may be measuring brand attitude for brands that already had strong, existing associations. To measure changes in brand attitude after using an AR app, future studies should consider AR apps from unfamiliar brands, use control groups, or control for pre-existing brand attitude (following the approach from Rauschnabel et al., 2019).

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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