

From virtual to reality: The power of augmented reality in triggering impulsive purchases

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ABSTRACT

This study examines the impact of key features of augmented reality (AR) applications on impulsive buying intentions. The study focuses on interactivity, authenticity, and vividness and how they combine with psychological and emotional responses to create an immersive shopping experience. A structured questionnaire was administered to 254 participants via an online survey, and the data were analyzed using the partial least squares (PLS) method. The results demonstrate that all three AR characteristics can stimulate consumers to varying degrees, resulting in impulse purchase intentions. Interactivity provides significant instant gratification stimulation, while vividness creates the strongest form of instant gratification and product presence. Authenticity provides the strongest product presence stimulation but does not significantly stimulate instant gratification. These findings offer valuable insights for AR application developers to optimize AR apps for the best user experience and shed light on the relationship between AR characteristics and consumers' impulse buying intentions.

1. Introduction

Impulse buying, a prevalent and consequential consumer behavior, exerts a significant influence on businesses. Abundant research has firmly established that consumers frequently succumb to impulsive purchases, driven by a myriad of stimuli, including alluring promotional advertisements and captivating product designs (Mihic and Kursan, 2010; Priyanka and Rooble, 2012). Characterized by its spontaneous nature, this behavior is initiated by external cues and typically entails immediate decision-making devoid of prior planning (Amos et al., 2014). The economic impact of impulse buying is far-reaching. A survey targeting American consumers reveals that impulsive purchases account for 40% of total e-commerce expenditures, with women (58%) being more inclined towards impulsive buying than men (48%). Approximately 33% of impulsive buying incidents occur online. Moreover, 64% of impulsive buyers tend to purchase additional items alongside their planned purchases, with 20% using credit cards for these extra acquisitions. Pressure can further exacerbate impulsive buying tendencies, as 67% of individuals acknowledge making such purchases under stress. Due to this surge in impulsivity, promotional messages yield approximately \$4.2 billion in annual revenue for retailers (GITNEX, 2023).

Notably, impulse buying is not confined to the United States; it is a global phenomenon. Significantly, impulse buying transcends the confines of physical retail spaces, extending its reach into the digital domain. A recent social media survey conducted by Statista in 2021 provides compelling insights. Approximately 63% of respondents globally reported engaging in spontaneous buying on social media platforms, exemplified by activities like Live Shopping on Facebook. Furthermore, a noteworthy 23% of respondents candidly admitted to frequently partaking in impulse purchases, while a mere 14% adhered to planned buying practices (Chevalier, 2021). These findings underscore the profound impact of impulse buying on corporate revenue, rendering it a subject of keen interest for business management.

The causes of impulse buying are complex. In some instances, tempted by promotional activities, consumers are unable to restrain themselves, resulting in irrational purchases (Amos et al., 2014). In other instances, an impulse buy may represent the later stages of longer purchase decisions. For example, a consumer may decide to buy a new shirt several months before making the purchase (e.g., needing a new shirt to wear to a friend's wedding), but make the actual purchase "on the spur of the moment" (e.g., seeing a shirt that looks nice and is returnable while browsing social media and then purchasing it on the

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spot). Some consumers see shopping as a social pleasure or even as a means of relieving work pressure or other stress (i.e., “retail therapy”). For such consumers, shopping becomes a hobby, giving them recreational, social, or emotional satisfaction. For these consumers, impulse buying is simply a by-product (Hausman, 2000).

As impulse buying is triggered by the external environment, many online businesses attempt to use technology to create environments that encourage quick purchase decisions. One such technology is augmented reality (AR). When shopping online, consumers do not have the opportunity to physically interact with the product, leading to cognitive inconsistencies. Through AR, products can be made more tangible through presentation in 3D form and combination with real-world environments to highlight the features of the product. Many companies have tried to induce impulse buying using AR, such as IKEA with furniture arrangements, Sephora with virtual makeup, and ZARA with trying on clothes. According to a report by Statista, the AR market is growing; it has been forecast that consumers around the world are projected to spend over USD 25 billion on standalone and embedded AR applications in 2024, and this figure is expected to increase to over USD 36 billion in 2026 (Alsop, 2022). This indicates that AR has immense commercial value and can influence the way consumers shop.

However, despite the potential benefits of AR in design and consumer experience, recent studies suggest that corporate managers often lack understanding of AR technology and hold unrealistic expectations regarding its ability to attract customers and support marketing activities (Fewster, 2019), which means AR marketing is often less effective than expected. In addition, research has indicated that consumers may experience a degree of psychological resistance to such innovative marketing. Thus, to better utilize AR to induce impulse buying, we believe that it is necessary to gain an in-depth understanding of the customer's experience of AR services, explore the links between this experience and impulse buying, and then design marketing activities accordingly. In short, this study aimed to investigate the influence of perceived AR characteristics (i.e., interactivity, vividness, and authenticity) and the inner reactions that consumers have when experiencing AR (i.e., product presence and instant gratification) on their impulse-buying intent.

2. Current studies related to online impulse buying and AR

As more consumers make impulse purchases online, more researchers have been drawn to explore this phenomenon. A systematic review of 68 relevant studies published between 2005 and 2019 found that most of the studies focused on four factors influencing online impulse buying (Abdelsalam et al., 2020): social factors (e.g., number of “likes”, review quality, and source credibility) (Chen et al., 2016; Farivar and Yuan, 2017), marketing factors (e.g., scarcity and product availability) (Handayani et al., 2018; Liu et al., 2013), website factors (e.g., information quality, personalization, and ease of use) (Chen et al., 2016, 2019), and consumer characteristics (e.g., personality, expertise and urgency) (Leong et al., 2017, 2018).

For instance, (Chen et al., 2016) discovered that in Facebook C2C social commerce, product information quality (e.g., ease of understanding, accuracy, and completeness) and the number of likes that netizens give the product exert a significant and positive impact on impulse buying. Other studies (e.g. (Wang and Tsai, 2017; Xiang et al., 2016),) pointed out that website characteristics (e.g., visual appeal and informativeness) and user personality traits (e.g., harmonious passion) also play important roles. Although these studies made valuable contributions to our understanding of online impulse buying, few explored how product displays constructed using emerging technologies (e.g., AR and VR) can induce this purchase behavior.

Augmented reality (AR) combines virtual images with the real world, overlaying them through the device's camera and allowing users to view both at the same time. AR possesses three key features: it amalgamates real and virtual content, facilitates real-time user interaction, and

presents virtual objects in a three-dimensional context within the real world (Caboni and Hagberg, 2019). Delving into the multifaceted realm of AR involves discerning its various applications and approaches. In the context of this study, a nuanced appreciation is extended towards differentiating between distinct AR approaches, such as Web AR and App AR. Web AR is a web technology that allows the presentation of AR functionalities within a web browser. Users are not required to download an application; they can engage in AR interactions seamlessly through their browser. In contrast, App AR necessitates users to download a dedicated application to access immersive AR experiences. Each approach bears its own merits: Web AR provides users with the familiarity of web browsing, ensuring simplicity and convenience. Additionally, the development and deployment of Web AR demand relatively shorter timelines compared to App AR. On the other hand, while App AR entails relatively higher development costs and the requirement for app downloads, it delivers a higher quality AR experience. This encompasses enhanced image fidelity, augmented reality perspective, user fluidity, customizable content, and offline functionality. These attributes collectively contribute to a more stable and superior performance compared to Web AR. The choice between these AR technologies hinges upon an enterprise's target audience and business model. Crucially, AR technology has afforded enterprises the opportunity to enhance customer experiences, particularly within diverse settings and notably within private domains.

AR has revolutionized product presentation in the realm of technology, imbuing it with heightened dynamism, intrigue, and lifelike qualities compared to its two-dimensional counterpart. The accessibility of AR experiences through both browsers and apps further highlights its versatility. Yet, comprehending the precise role and impact of AR in marketing and sales continues to be an exploratory pursuit. This encompasses dimensions such as its influence on consumer decision-making and its potential to trigger impulsive purchases. This exploration delves into aspects like how AR shapes consumer perceptions, stimulates impulse buying behavior, and the key factors shaping these effects.

Our study comprehensively reviews empirical studies published in the last five years (2019–2023) within premier retailing and consumer services journals, shedding light on the current landscape of research on these themes. This analysis culminates in Table 1, offering a synthesized overview of findings. Notably, the discourse on AR's impact reveals its effectiveness in reducing cognitive load and uncertainty for online consumers (Barta et al., 2023; Sun et al., 2022), amplifying purchase intention (Kim et al., 2021; McLean and Wilson, 2019), and enhancing tolerance for premium pricing (Huang and Chung, 2023). Poushneh (2021) underscores AR's role in augmenting buying intention through measurement feedback and proximity, while Huang (2021) explores AR's potential to elevate willingness to pay a premium in the tourism context. However, the specific domain of impulsive buying under AR's influence remains relatively unexplored, with Trivedi et al. (2022) being a notable exception. Trivedi et al. (2022) specifically delve into the motivations of female consumers, exploring the effects of AR application-based value perception on impulsive purchase, elucidating a significant positive relationship.

While existing research is promising, the intricate mechanisms through which AR elicits sensory engagement and affects impulsive buying behavior remain less explored. Addressing this gap head-on, our study probes the influences of AR-induced stimuli on impulsive buying behavior. This cumulative understanding accentuates the evolving impact of AR on consumer decision-making, particularly within the realm of impulsive buying. Specifically, discerning the effects of AR's environmental attributes—interactivity, vividness, and authenticity—holds great promise. For instance, AR applications empower users to interact with products, virtually try them on, and engage in experiences reminiscent of in-store encounters. Investigating whether these simulated engagements genuinely foster impulsive buying behavior warrants focused inquiry.

Table 1

Recent (2019–2023) literature on the impact of AR on consumer behavior.

Auhtor	AR product/application	Independent variables	Moderators/Mediators or Control Variables	Dependent variables	Conclusion
Barta et al. (2023)	AR-based Virtual Try-On (makeup)	Web AR vs No web AR	Perceived similarity Confusion by overchoice Repurchase cognitive dissonance	Purchase intention Willingness to buy more	The application of AR can effectively reduce the cognitive load of online shoppers.
Hilken et al. (2022)	AR/VR based virtual café	AR vs VR vs traditional web	Fluency of product/context-focused mental imagery	Purchase intentions Brand attitudes	Compared to traditional interfaces, AR/VR can lead to increased purchase intent and improved brand attitudes among consumers.
Huang (2021)	Kinect-generated AR environment	AR environment embedding AR simulated physical control	Restorative experience (formative variable) Immersion Tourism involvement in Japan	Actual willingness to pay price premium	The environmental embedding and simulated physical control of AR application will trigger willingness to pay a premium in tourism products
Huang and Chung (2023)	virtual shopping	gesture-based vs mouse-based AR	somatosensory activities kinesthetic experiences	consumer delight consumer stickiness intention	Compared to traditional mouse-click page navigation, the immersive nature of AR can deliver a more enjoyable shopping experience (consumer delight) and enhance consumer stickiness.
Kim et al. (2021)	IKEA VR store	Interactivity Vividness	Perceived Usefulness/Enjoyment Telepresence	Attitude towards VR Behavioral Intention	The vividness of VR applications positively influences consumers' perceived usefulness and enjoyment, subsequently leading to a positive impact on purchase or recommendation intent.
McLean and Wilson (2019)	Variety mobile apps	Interactivity/vividness/Novelty of AR	Perceived ease of use/usefulness Enjoyment Subjective norms	Brand engagement Satisfaction with customer experience Brand usage intention	The characteristics of AR can positively influence perceived usefulness and ease of use, thereby enhancing consumer satisfaction with the brand and willingness to use
Poushneh (2021)	AR-based Virtual Try-On (glasses)	Perceived proximity to virtual product	Perceived measurement feedback Perceived generality Absence of product in consumers' consideration set	Perceived purchase intention in the relatively near future	perceived measurement feedback and proximity brought by AR influence buying intension positively
Sun et al. (2022)	product/user/scenario augmented function on particular EC web site	Product presentation (AR vs Non-AR)	Perceived informativeness Sense of presence Mental Imagery Product quality/fit uncertainty reduction	Product attitude	The application of AR can effectively reduce the uncertainty of online shoppers regarding product quality and suitability for their individual needs.
Trivedi et al. (2022)	AR-based Virtual Try-On (Makeup)	AR tool usage motivation Perceived augmentation quality	Perceived value Online impulse purchase intention	Online impulse purchase intention Product involvement	hedonic and utilitarian factors of AR were the main causes of impulse buying
Zanger et al. (2022)	AR-based Virtual Try-On (makeup)	AR vs Non-AR	Inspiration Enjoyment Product attitude AR familiarity Product knowledge Pre attitude	Purchase intention/WOM	Comparatively, the application of AR, as opposed to Non-AR, can generate more favorable brand attitudes, higher purchase intentions, and improved word-of-mouth (WOM).

Our research diverges significantly from existing studies by centering on how users' psychological experiences, particularly 'product presence' (elaborated in Section 3.2), within AR apps influence their inclination for impulse buying. This relationship carries paramount significance for marketing and sales strategies. Exploring how consumers immerse themselves in the AR context and whether such immersion indeed drives impulsive buying stands as a pivotal concern for marketers. It's worth noting that the current literature remains relatively limited in examining this dimension.

3. Research model and hypotheses

3.1. SOR model

In e-commerce, where consumer purchasing behavior can be significantly influenced by external factors, Augmented Reality (AR) stands out as a powerful tool. As discussed in Section 1, consumers often find themselves susceptible to these external triggers, prompting uncontrollable buying tendencies. To comprehend fully the intrinsic experiential aspects that AR can evoke within consumers and the extent

to which these internal perceptions fulfill user needs while driving impulsive purchases, this study turns to the well-established stimulus-organism-response (SOR) framework, as detailed by Russell and Pratt (1980) in environmental psychology. The SOR model elucidates the intricate interplay between external stimuli (S), individual emotions (O), and observable approach or avoidance responses (R). Previous research, as depicted in Fig. 2–, underscores the significant impact of external stimuli on impulse buying (Chang et al., 2011; Floh and Madlberger, 2013).

This study delves into the dynamic interplay between perceived AR attributes—interactivity, vividness, and authenticity—and consumers' internal responses, particularly concerning product presence and instant gratification, as central factors influencing impulse buying intent. Grounded in consumer behavior theory, the decision-making process entails two pivotal stages: information search and evaluation of alternatives (Blackwell et al., 2006). AR technology, prevalent in both stages, presents products within an augmented reality context, thereby enabling consumers to engage in data collection and evaluation within the simulated AR environment. Augmented Reality products possess the potential to heighten interactivity, immersiveness, and realism (Kim

et al., 2021; McMillan and Hwang, 2002), significantly shaping consumers' perception of product presence (Kim et al., 2021; Poushneh, 2021). Furthermore, the integration of authenticity within the AR environment enhances not only product understanding but also sensory perception (Grayson and Martinec, 2004). Thus, our selection of these AR attributes is rooted in their relevance to consumer perception and experience, aligning seamlessly with the immersive nature of AR technology.

This study integrates these AR stimuli into the SOR model, proposing that they collectively heighten product presence and instant gratification, driving impulsive purchases. We introduce "product presence" as a key psychological mediator linking AR attributes to impulse buying intentions. By immersing users in the virtual environment and enhancing their connection with augmented products, "product presence" significantly influences impulsive buying tendencies. This strengthens our examination of AR's impact within the SOR framework. Visual representation is available in Fig. 1, while comprehensive operational definitions appear in Table 2. In the subsequent section, we elaborate on the role of these stimuli within the organism and introduce corresponding research hypotheses.

3.2. Consumer perception of mobile AR service as stimuli (S)

3.2.1. Interactivity

In this study, interactivity refers to the degree to which users and computer applications can interact (Zhao and Lu, 2012). For example, users can use the computer-mediated environment of AR apps to zoom in on and zoom out from products, browse and look up product information, and interact with online customer service personnel. The interactivity of a computer application involves the subjective perceptions of consumers and is associated with their visual, auditory, and tactile experiences (Downes and McMillan, 2000; McMillan and Hwang, 2002). The interface design, the product display, and the smoothness of AR performance are all factors that influence that affect user experience. Effective interactivity can amplify positive emotions in consumers, and as such, the interactions between users and AR apps can be considered a form of stimulus. While shopping online, consumers cannot directly touch the products. They can only understand the features and functions of the product by looking at pictures, text, and video introductions and by using their imaginations. Interactions with AR apps can effectively reduce the discrepancies between the physical product and the user's imagination. For example, IKEA developed an AR app to project the furniture users are interested in into their own living rooms. During the process, they can zoom in on or out from the furniture and place the

furniture in different places. These interactions exert a positive impact on their purchase decision. Research has shown that people derive satisfaction from their interactions with the media and that more interactions generates greater satisfaction (Liu et al., 2020; Yoo et al., 2010).

3.2.2. Vividness

Vividness refers to the abundance of information that an external environment (e.g., AR app) gives to the human senses, of which perceptual breadth and perceptual depth are the two primary variables (Steuer, 1992). Perceptual breadth refers to the extent to which an individual utilizes multiple sensory modalities to perceive information simultaneously. For instance, an individual uses sight to receive information from a newspaper and uses sight and hearing at the same time when watching a movie. Therefore, the perceptual breadth of a movie is greater than that of a newspaper. Perceptual depth is defined as the measure of both the quantity and quality of information received by the senses. The quality of the media directly impacts perceptual depth, and more advanced technology (e.g., AR) generally has better perceptual depth performance. Bright colors and linear designs are visually stimulating, so vendors often use colorful striking images to attract consumers and enhance their positive emotions. AR apps go beyond static vividness, employing spatial 3D, avatars, multimedia, and haptic feedback to invoke positive emotions in the consumer (Park et al., 2008). Haptic feedback refers to the sounds of impact made by objects in the virtual world colliding with each other. Such feedback can be conveyed by equipment or ultrasonic technology to give users the feeling of "touching" virtual objects (Alakhawand et al., 2020). Research has shown that the virtual experiences constructed using AR are increasingly closer to real-world experiences (Garnham, 2021). Like interactivity, vividness can help consumers imagine themselves using the product (Phillips et al., 1995). It is both convincing and influential (Taylor and Thompson, 1982). In other words, if the media displaying the products can provide more vivid images, it will make consumers want to purchase the products more. Vividness is therefore a type of stimulus.

3.2.3. Authenticity

As e-commerce and digital technology progress, consumers attach more importance to product authenticity. Authenticity was originally used to describe the degree to which objects in the material world (e.g., artwork) are original, genuine, and complete (Trilling, 2009). In e-commerce, individuals generally cannot touch the object physically and require pictures or videos to understand what products look like. Thus, aside from guaranteeing that the products are indeed available for

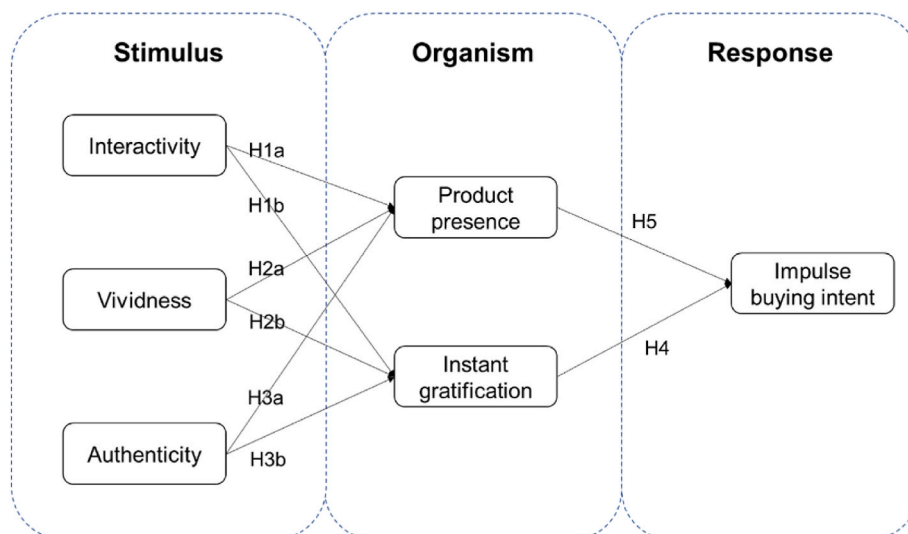


Fig. 1. Research model.



Fig. 2. Wanna Kicks use case example.

Table 2
Operational definitions of Constructs.

Research construct	Operational definition	Reference
Interactivity	Degree to which users can choose, browse, and look up product information and provide feedback through an AR app.	McMillan and Hwang (2002) Steuer (1992)
Vividness	Perceptual depth and breadth that users feel from products in an AR app environment.	Jiang & Benbasat (2007) Vonkeman et al. (2017) Steuer (1992)
Authenticity	Degree to which users understand a product based on their prior consumption experience, knowledge, or time and space in an AR app environment.	Lessiter et al. (2001) Wolfinbarger and Gilly (2003)
Product presence	Psychological feeling generated within an individual when he or she is shopping in an AR app environment.	Vonkeman et al. (2017)
Instant gratification	Emotion evoked by external factors reflecting the degree of satisfaction derived by an individual due to impulse buying.	Liu et al. (2013)
Impulse buying intent	Spontaneous and sudden desire in users to make a purchase due to stimulation while using an AR app.	Do et al. (2020) Rook and Fisher (1995)

purchase, e-commerce companies must convey their products clearly. This is achieved using text, pictures, and videos to display the features of their products (e.g., appearance, specifications, and functions). This information allows customers to perceive and understand product quality and judge product authenticity, which is referred to as iconic authenticity (Grayson and Martinec, 2004; Peirce, 1974) or perceived authenticity. With the rapid development of virtual technology (e.g., AR) and related business models (e.g., metaverse), customers face massive amounts of product information in the virtual world, which

makes understanding what customers perceive as assurance of product quality a crucial issue. Research indicates that individuals link product information to past experiences. If they already have prior knowledge or expectations, these will form a composite image in their minds. They will then compare their impression of the product with this composite image to assess authenticity (e.g., similarity, completeness, accuracy, and reliability) (Grayson and Martinec, 2004).

3.3. Internal psychological response as an organism (O)

3.3.1. Product presence

Sense of presence refers to the psychological feelings (e.g., immersion) that an individual has when active (e.g., shopping or playing games) in a virtual environment. Generally speaking, sense of presence is influenced by the individuals themselves (e.g., previous experience, expectations, and beliefs) and the virtual environment (e.g., physical characteristics and technology) and ultimately determines their psychological feelings and degree of involvement (Cadet and Chainay, 2020; Herbelin et al., 2016). For instance, when a Wii player is playing a new-generation Wii, his or her sense of presence will be influenced by his or her previous experience playing Wii and the hardware and software of the new product. As virtual environments progress, so has research on sense of presence (Skarbez et al., 2017). Studies have indicated that the interactivity and vividness of media are key factors influencing consumers' sense of presence (Fortin and Dholakia, 2005). Rich images, sound effects, and animation can enhance the quantity and quality of information received by an individual's senses. Good interface designs can increase the interactivity between individuals and media, inducing immersive feelings (Fortin and Dholakia, 2005). In AR shopping apps, products are displayed using vivid 3D models. Users can browse, zoom in on or out from, and rotate the product to understand its properties (e.g., appearance and dimensions). This type of stimulus makes consumers feel like the product is right in front of them. The greater the vividness and interactivity that AR shopping provides, the stronger the sense of presence the consumers will perceive. We thus

formulated the following hypotheses:

H1a. In AR e-commerce, greater interactivity between consumers and products causes consumers to perceive a stronger sense of presence.

H2a. In AR e-commerce, greater vividness displayed by the products causes consumers to perceive a stronger sense of presence.

Aside from interactivity and vividness, authenticity is another crucial factor that impacts consumers (Grayson and Martinec, 2004). As described in Section 3.2.3, enabling consumers to perceive product authenticity in an online shopping scenario helps consumers compare the product with their expectations or previous experiences and judge the quality of the product. The virtual products and real-world scenes presented in AR apps make consumers feel as if the product is right in front of them, which gives the product a sense of presence. We therefore put forward the following hypotheses:

H3a. In AR e-commerce, greater authenticity displayed by the products causes consumers to perceive stronger product presence.

3.3.2. Instant gratification

Instant gratification refers to the behavioral tendency of humans to give up a future benefit for the sake of a lesser but more immediate benefit. The concept of instant gratification is drawn from the pleasure principle of psychology, in which humans inherently seek pleasure and avoid pain. To seek good things (e.g., food, entertainment, or a sense of security) and experience them immediately is a natural human impulse (Laplanche, 2018). As technology advances and breaks through the limitations of time and space (e.g., e-commerce), consumers are showing a stronger demand for instant gratification (e.g., wanting to receive messages instantly). A study focusing on a large-scale e-tailing service in online shopping (Yoo et al., 2010) highlighted that higher interactivity in online shopping websites significantly increases perceived value and inner satisfaction among respondents. Interactivity, in this context, encompasses factors such as controllability (e.g., users can freely choose the level of content they wish to view), synchronicity (e.g., websites provide prompt feedback to users), and bi-directionality (e.g., websites offer channels for listening to user feedback). Subsequent research has corroborated these findings. For instance, Chu and Yuan (2013) observed that higher interactivity on shopping websites leads to a more positive user attitude towards the site, significantly boosting trust and loyalty. Conversely, if a website fails to respond quickly to consumers, users may become impatient and prone to abandoning their wait, redirecting their attention elsewhere (Hui and Zhou, 1996; Krishnan and Sitaraman, 2013; Sugarman and Thrift, 2020). In essence, contemporary online shopping websites must possess the ability to promptly engage users to provide instant gratification and deliver benefits (Shanthi and Desti, 2015).

Other important factors that can enhance the feeling of instant gratification are visual effects (e.g., vividness) and interactivity. Yim et al. (2017) discovered that in online shopping scenarios, more vivid product displays can better inspire the imagination of consumers. Users can enter an immersed state due to media vividness and derive pleasure from the process of human-machine interactions, and more interactions during the shopping process will bring greater satisfaction (Liu et al., 2020; Yoo et al., 2010). That is to say, media with good interactivity and vividness can invoke emotions such as pleasure and excitement in consumers. We thus propose the following hypotheses:

H1b. In AR e-commerce, greater interactivity between consumers and products causes consumers to perceive greater instant gratification.

H2b. In AR e-commerce, greater vividness displayed by the products causes consumers to perceive greater instant gratification.

Authenticity and immersion can help create optimal online shopping experiences and help consumers believe in the authenticity of the products and overall shopping experience (Fortin and Dholakia, 2005).

Research has shown that improving the shopping experience of customers can effectively increase customer satisfaction (Nwokah and Gladson-Nwokah, 2016). Thus, stimulation via authenticity can help the online experiences of consumers become more like physical shopping experiences, thereby enhancing their shopping satisfaction. We thus propose the following hypothesis:

H3b. In AR e-commerce, greater authenticity causes consumers to perceive greater instant gratification.

3.4. Impulse buying intent as a response (R)

Impulse buying intent refers to the spontaneous and sudden desire to make a purchase due to stimulation from some internal or external factors (e.g., advertisements, store environment, or peers). Under this impulse, the outcome of the purchase is not as well thought-out, resulting in immediate purchasing without regard to the consequences (Amos et al., 2014). Such behavior is irrational, hedonic, and unplanned and is often accompanied by complex emotions. Beatty and Ferrell (1998) and Rook (1987) pointed out that impulsive intentions can be significantly influenced by both positive and negative emotions. It has been found that high levels of interactivity, vividness, and authenticity while shopping induce a greater sense of instant gratification (Liu et al., 2020; Yoo et al., 2010). Compared to conventional 2D shopping websites, AR offers higher levels of all these factors. The pleasure and excitement they invoke make consumers more likely to make impulsive purchases because the satisfaction gives them mental fulfillment (Youn and Faber, 2000). We thus propose the following hypothesis:

H4. In AR e-commerce, greater instant gratification perceived by the consumers causes them to have stronger impulse buying intent.

Whether consumers are looking to fulfill hedonic or utilitarian objectives, browsing products and collecting information are indispensable parts of the shopping process (Smith and Sivakumar, 2004), during which the visual effects displayed by the products are crucial factors that influence consumer decisions (Madhavaram and Laverie, 2004; Novak et al., 2003; Wolfenbarger and Gilly, 2003). Our study centers on how AR induces product presence and instant gratification, irrespective of the specific motive driving consumers. It is plausible that differing objectives may influence users' experiences of product presence or instant gratification, a facet that warrants exploration by future researchers. As described in Section 3.1-3.3, the greater the sense of presence that consumers perceive, the more likely they will continue browsing and the greater the influence on their purchase decision (Lepkowska-White, 2004). The virtual environments constructed using AR can compensate for the inability to directly interact with products in conventional 2D internet interfaces, increasing the sense of product presence. We thus propose the following hypothesis:

H5. In AR e-commerce, greater product presence perceived by the consumers causes them to have stronger impulse buying intent.

4. Research methodology

4.1. Research design

In this study, the SOR framework was used to explore how the three characteristics of augmented reality (AR) app in mobile commerce - interactivity, authenticity, and vividness - stimulate consumers' instant gratification and product presence and thus influence their impulse buying intent. Six hypotheses were proposed in the previous chapter, and a questionnaire survey was conducted to test them. The questionnaire dimensions, operational definitions, and items mainly used definitions and items provided in the literature listed in Table 2. Specifically, four items were used for vividness, based on Jiang and Benbasat (2007) and Vonkeman et al. (2017); four items were used for interactivity, based on Ko et al. (2005) and McMillan and Hwang (2002); six items

were used for authenticity, based on Lessiter et al. (2001), and Wolf-inbarger and Gilly (2003); five items were used for product presence, based on Vonkeman et al. (2017); three items were used for instant gratification, based on Liu et al. (2013); and seven items were used for impulse buying intent, based on Do et al. (2020) and Rook and Fisher (1995). A 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree) was utilized to rate all measurement items for the aforementioned dimensions. The detailed item contents are presented in Appendix 1.

To ensure the validity of the study and to provide consistent AR experiences for participants, thus avoiding potential cognitive differences resulting from the use of different AR applications, the researchers selected popular AR applications available on the market for participants to download and use (see Appendix 1) before completing the questionnaire designed for this study (see Appendix 2). The selection criteria for the AR app used in this study were: (a) convenience, which meant that it could be easily obtained on major smartphone platforms such as the Apple App Store and Google Play; (b) representativeness, which was determined by the app's download and rating rankings being in the top 20%; and (c) ease of use, which meant that personal information did not need to be provided, the app was easy to set up, and it could be used in Chinese. Based on these criteria, the researchers decided to use Wanna Kicks as the AR app for participants. Developed by WANNA (wanna.fashion), this app uses AR technology to enable consumers to try on sneakers from various well-known brands and see what they look like in real-time. Fig. 2 showcases a screenshot captured by the researchers while utilizing the Wanna Kicks app. We have secured permission from Wanna for the utilization of this image in our paper. If participants like the shoes, they can immediately click a link to purchase them. At the time of the study, Wanna Kicks had over 300K downloads on both the Apple App Store and Google Play, and offered more than 20 well-known brands of sneakers for immediate AR try-ons. Using Wanna Kicks is quite convenient and easy-to-use as it can be used immediately after installation, and offers multi-language options. Overall, by using Wanna Kicks as the AR app for participants, the researchers were able to ensure consistent AR experiences and minimize measurement errors resulting from the use of different AR apps, thereby increasing the validity of the research findings.

4.2. Data collection

This study employed convenience sampling to recruit participants interested in using AR apps. We conducted the survey on two widely used social media platforms in Taiwan, Facebook and Line, where 85.3% and 90.7% of the Taiwanese population were active users, respectively (Kemp, 2023). A pilot test was conducted from May 31 to June 10, 2021, during which 41 valid questionnaires were collected. Based on respondent feedback, the questionnaire underwent revisions for semantic and reliability analyses. Upon confirming the questionnaire's reliability and validity, the formal survey was conducted on the aforementioned platforms from June 1 to July 16, 2021, resulting in 271 complete questionnaires. To encourage participation, we offered eight prizes with a total value of 10,000 New Taiwan Dollars (i.e., Bluetooth speakers, headphones, movie tickets) through a lottery, ensuring that each participant had an opportunity to win. In addition, during the questionnaire survey, to ensure the authenticity of participants' use of Wanna Kicks, each participant was required to upload a screenshot of their actual use of the app as supporting evidence (an example is provided to participants in Fig. 2). Following the exclusion of invalid questionnaires, such as those with incomplete answers or those lacking uploaded screenshots, a total of 254 valid questionnaires were obtained. Table 3 presents an overview of the respondents' characteristics, with an equal distribution between males ($n = 127$) and females ($n = 127$), each accounting for 50% of the sample. The majority of respondents fell into the age group 31 to 35 (23.3%), followed by those aged 36 to 40 (18.1%) and 26 to 30 (16.9%), while the lowest percentage was found among

Table 3
Descriptive statistics of sample.

Item		Samples	Percentage
Sex	Male	127	50.0%
	Female	127	50.0%
Age	Under 20	11	4.3%
	21–25	28	11.0%
	26–30	43	16.9%
	31–35	59	23.2%
	36–40	46	18.1%
	Above 41	67	26.3%
Occupation	Student	14	5.5%
	Medical staff	9	3.5%
	Government	9	3.5%
	Agriculture	8	3.1%
	Financial	10	3.9%
	Service	89	35%
	Electronics	20	7.8%
	Information	12	4.7%
	Manufacturing	64	25.1%
	Others	19	7.3%
Online shopping expenditure per month (USD) ₁	Under 100	27	10.6%
	100–300	77	30.3%
	300–500	81	31.9%
	Above 501	80	31.5%
Average monthly income (USD) ₁	Under 667	43	16.9%
	667–1000	59	23.2%
	1000–1333	72	28.3%
	Above 1333	80	31.4%

Note 1: The original questionnaire survey was conducted using New Taiwan Dollars (NTD) as the unit of calculation. However, for the sake of international readers' ease of understanding, the unit of calculation in Table 3 is presented in US Dollars (USD) here, with an exchange rate of approximately 1 USD: 30 NTD.

respondents aged under 20 (4.3%). The average age of the sample was 34.47 (male = 35.89, female = 33.06), with a standard deviation of 8.08. In summary, the participants in this study primarily consisted of young and middle-aged adults. In terms of occupation, the service industry accounted for the highest proportion (35%), followed by the manufacturing industry (25%). Regarding the monthly average amount spent on online shopping by the respondents, 31% spent more than \$500, followed by 31% who spent between \$500 and \$300, 30% who spent between \$300 and \$100, and only 10% who spent less than \$100. Approximately 60% of the respondents had a monthly average salary exceeding \$1000. According to a prominent Taiwanese market research firm, Money 101, their Consumer Online Shopping Survey (Money101, 2022) ($n = 3,228$ valid samples) revealed that nearly half of Taiwanese respondents heavily relied on online shopping, with the highest participation rates occurring in the 31–35 age group, followed by 20–25 (6.4%), 26–30 (11%), 31–35 (30.4%), 36–40 (22.8%), 41–45 (20.7%), 46–50 (6.2%), and 51 and above (2.31%) age groups. Our study's age distribution similarly showed a peak in the 31–35 age group, followed by a gradual decline. This alignment suggests that our sample exhibits reasonable representativeness concerning the online shopping patterns of the Taiwanese population at the time of the survey.

5. Data analysis and results

Due to the exploratory nature of this study and the relatively small sample size, Partial Least Squares Structural Equation Modeling (PLS-SEM) was utilized as the data analysis method using SmartPLS 3.3.3. To ensure the stability of the estimated parameters for each construct, this study employed the bootstrap resampling method, repeatedly extracting 5,000 samples for parameter estimation and inference. PLS-SEM has been frequently utilized across various disciplines, including marketing, organizational management, information management, and strategic management. Its main advantages include its ability to model multiple dependent and independent variables, handle multicollinearity, deal with data interference and missing data robustly, and build latent

independent variables based on the cross-product matrix of response variables, resulting in more powerful predictions (Hair et al., 2019; Khan et al., 2019).

5.1. Instrument validation

In the initial phase, this study assessed the measurement tool's reliability through two dimensions: indicator reliability and internal consistency reliability, following the approach outlined by Churchill Jr (1979). The outcomes indicated that each question within the scale exhibited a factor loading surpassing 0.7, with the exception of question IB6, thus demonstrating a commendable level of measurement quality for each construct (Hair et al., 2017). Additionally, Cronbach's α coefficients for each construct on the scale ranged from 0.758 to 0.906, all exceeding the recommended threshold of 0.7, thus signifying a strong degree of reliability (Bagozzi and Yi, 1988). Furthermore, the composite reliability (CR) values ranged from 0.847 to 0.925, signifying robust internal consistency for each construct within the scale (Fornell and Larcker, 1981) (see Appendix 2).

Subsequently, this study assessed the scale's validity through two facets: convergent validity and discriminant validity. The outcomes of the convergent validity assessment are presented in Table 4. As indicated, the inter-construct correlation coefficients were all less than 1, and were consistently lower than their corresponding individual Cronbach's α coefficients. Furthermore, the inter-construct correlation coefficients were smaller than the square root of the average variance extracted (AVE), thereby affirming the presence of sound convergent validity (Fornell and Larcker, 1981).

In regard to discriminant validity, the results in Table 4 demonstrate that the root mean square of the average variance extracted (AVE) for each construct within the scale exceeded the correlation coefficients among constructs. This outcome confirms satisfactory discriminant validity. To further enhance rigor, the study employed the heterotrait-monotrait ratio (HTMT) to examine discriminant validity. As demonstrated in Table 5, all HTMT values were below 0.9, which adheres to the criterion indicative of distinct discriminant validity (Henseler et al., 2015).

Given the proximity of certain HTMT values to the threshold of 0.9, a meticulous approach was adopted. Specifically, the SmartPLS software was employed to assess the variance inflation factor (VIF) between different dimensions, addressing the potential issue of multicollinearity. The outcomes, as presented in Table 6, affirm that the VIF values for each dimension in our research model conform to the recommended guideline proposed by Hair et al. (2011), with VIF values well below 5. This substantiates the absence of multicollinearity among the dimensions. To conclude, the scale employed in this study demonstrates robust reliability and validity.

5.2. Hypothesis testing

The present study utilized partial least squares structural equation modeling (PLS-SEM) to empirically test the proposed research model

Table 4
Correlations among latent constructs and Fornell-Larcker criterion.

	Cronbach's α	IN	VI	AU	PP	IG	IB
IN	0.767	0.768					
VI	0.758	0.636	0.762				
AU	0.842	0.720	0.576	0.747			
PP	0.852	0.669	0.597	0.709	0.792		
IG	0.799	0.587	0.684	0.508	0.510	0.845	
IB	0.906	0.537	0.348	0.528	0.510	0.407	0.800

Note: The diagonal matrix value (Italic bold) presents the root mean square of AVE; p all P-value of correlations between constructs are <0.001.

Note: IN=Interactivity, VI=Vividness, AU=Authenticity, PP=Product presence, IG=Instant gratification, IB=Impulse buying intent.

Table 5
HTMT test result.

Construct	IN	VI	AU	PP	IG	IB
IN						
VI	0.833					
AU	0.889	0.717				
PP	0.822	0.745	0.854			
IG	0.745	0.872	0.611	0.619		
IB	0.629	0.396	0.594	0.559	0.457	

Table 6
VIF between constructs.

	PP	IG	IB
IN	2.454	2.454	
VI	1.765	1.765	
AU	2.184	2.184	
PP			1.352
IG			1.352

and hypotheses. The explanatory power of the research model was evaluated using the R^2 (R-squared) measure, as suggested by Pavlou and Fygenon (2006). The results of the hypothesis testing are depicted in Fig. 3 and are elaborated below. Firstly, the study examined the effects of three dimensions of augmented reality (AR) apps, namely interactivity, vividness, and authenticity, on consumers' perception of product presence in a virtual shopping environment. The findings revealed that while interactivity had no significant effect on product presence, vividness and authenticity were positively and significantly associated with this construct. This implies that higher levels of perceived vividness and authenticity in AR apps can enhance consumers' sense of presence in a virtual shopping environment. Therefore, Hypothesis 1a was not supported, but Hypotheses 2a and 3a were supported. Secondly, the study investigated the effects of the same three dimensions of AR apps on consumers' instant gratification. The results showed that interactivity and vividness had significant positive effects on instant gratification, whereas authenticity did not. Hence, when consumers perceive a higher level of interactivity and vividness in AR apps, they experience greater immediate satisfaction. Therefore, Hypotheses 1b and 2b were supported, while Hypothesis 3b was not supported. Lastly, the study examined the impact of product presence and instant gratification on consumers' impulse buying intentions. The results revealed that both product presence and instant gratification significantly and positively affected impulse buying intentions. This suggests that when consumers perceive a higher level of product presence and instant gratification in AR apps, they are more likely to have a stronger urge to make an impulsive purchase. Thus, Hypotheses 4 and 5 were supported. In summary, the three characteristics of AR app (interactivity, vividness, and authenticity) have a moderate to high explanatory power for consumers' internal experiences (product presence and instant gratification). However, the explanatory power of consumers' internal experiences on promoting impulse buying intent is relatively limited ($R^2 = 0.288 > 0.19$).

Furthermore, this study conducted a thorough analysis by computing and observing the f^2 statistic to gain deeper insights into the effect sizes associated with the various constructs in the research model. Cohen (2013) defines f^2 as R^2 divided by $(1 - R^2)$ within a regression framework, where R^2 represents the coefficient of determination, signifying the proportion of variance explained by the model. As per Cohen (2013) guidelines, an f^2 value of 0.02 or higher indicates a low effect size, while values between 0.15 and 0.35 suggest a medium effect size, and values exceeding 0.35 denote a high effect size. The following two points explain the results: First, the impact of the three features of the AR app (Interactivity, Vividness, Authenticity) on consumers' internal sensations (Product presence, Instant gratification) varied significantly in

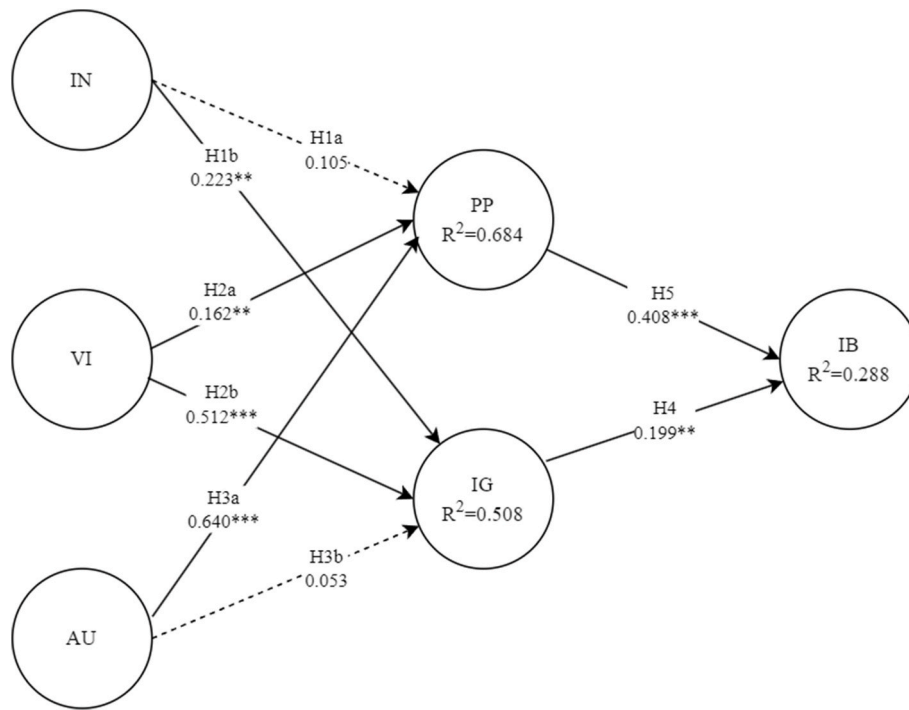


Fig. 3. Model test result

p < 0.01, *p < 0.001, dot line: not significant.

terms of effect size. The f^2 values for Vividness on Product presence and Instant gratification were 0.047 and 0.28, respectively, for Interactivity they were 0.014 and 0.039, and for Authenticity they were 0.596 and 0.000. These results indicate that the three features of the AR app can bring different types of stimuli to consumers' internal sensations: Vividness can provide high levels of instant gratification, but only slight product presence stimulation; Authenticity can provide the most product presence stimulation but does not offer any instant gratification. Interactivity can only provide slight instant gratification. Second, there were significant differences in the effect sizes of consumers' internal sensations (Product presence, Instant gratification) on promoting their impulsive purchase intentions. Specifically, the f^2 analysis found that the impact of Product presence on Impulse buying intent ($f^2 = 0.171$) was higher than that of Instant gratification on Impulse buying intent ($f^2 = 0.041$).

Finally, in addition to examining the direct effects of each construct in the research model, this study also tested the indirect effects between constructs. The results show that Authenticity of the AR app stimulates Product presence in consumers and then affects Impulse buying intent (path coefficient = 0.260, $p < 0.001$), which is the most significant among all indirect effects. Other indirect effects that reached statistical significance but had smaller effects include: Interactivity → Product presence → Impulse buying intent (0.066, $p < 0.01$), Vividness → Instant gratification → Impulse buying intent (0.101, $p < 0.01$), and Interactivity → Instant gratification → Impulse buying intent (0.044, $p < 0.05$). Therefore, it can be concluded that the most important construct of the AR app for consumers' impulse buying intent is its Authenticity, but Vividness and Interactivity also have some degree of influence.

6. Discussion and implications

6.1. Discussion of findings

The promotion of impulse buying has been demonstrated to have a significant effect on increasing business revenue (Chevalier, 2021). With many leading e-commerce companies (e.g., IKEA, Sephora, ZARA)

beginning to offer AR app services, understanding how AR apps can promote impulse buying has become an important research topic (Rauschnabel et al., 2019). However, past literature has mainly focused on the discussion of functional factors such as the system interface design, stability, and anthropomorphic response of AR apps, with little attention given to the analysis of consumers' service experience in using AR apps (Abdelsalam et al., 2020). Therefore, this study constructs a conceptual framework for the AR service experience to discuss how the perceived interactive quality (interactivity, authenticity, vividness) delivered by AR apps affects consumers' psychological cognition (instant satisfaction, product presence) and impulse buying intentions. Drawing on the findings of this study, various discussions are presented below. Specifically, the results suggest that the impact of AR app characteristics on consumers' experience, including product presence and instant gratification, varies across the three dimensions examined (interactivity, vividness, and authenticity):

Firstly, the interactive quality can provide consumers with a certain degree of instant satisfaction, but cannot provide consumers with product presence. This result may be because the sports shoe try-on app used in this study currently only provides visual interactive effects. Although it can satisfy users' desire to immediately know what the new shoes look like, there is still a lack of product presence. If AR apps can provide more sensory experiences such as touch and hearing in the future, the experience of interactivity for product presence should be enhanced. Secondly, the vividness can bring a little product presence and stronger instant satisfaction. This is because AR apps provide consumers with visual, color, and 3D sensory stimuli that traditional apps cannot match. Therefore, it can successfully meet consumers' needs to understand product details carefully. For example, users can clearly know the appearance of new shoes from various angles after wearing them. This effect is closer to the feeling of trying on shoes in a physical store than traditional 2D pictures.

Lastly, the authenticity provides consumers with the strongest sense of product presence, and product presence is the most powerful factor that stimulates consumers' impulse buying intentions. This finding is of great significance. Generally speaking, consumers have psychological

expectations for the products they want to buy, which may come from existing knowledge, past experience, or recommendations from friends. The results of this study show that the vivid product display of AR apps helps consumers compare the gap between their psychological expectations and the reality of the product and evaluate its authenticity (e.g., similar, complete, correct, trustworthy) (Grayson and Martinec, 2004). In other words, the sense of reality helps to strengthen consumers' sense of product presence, which in turn helps consumers understand the gap between their expectations and the reality of the product. If the gap is small, consumers will naturally increase their impulse buying intentions.

As mentioned above, the three characteristics of AR apps can significantly stimulate users' immediate satisfaction and sense of presence, and these two psychological cognitions (immediate satisfaction and sense of presence) have been proven to enhance consumers' impulsive purchase intention. This finding is consistent with previous literature that the sense of presence is a psychological feeling that users experience when shopping in virtual environments. Due to the rich 3D images, sound effects, and animations provided by AR, users can receive a higher quantity and quality of information, and the good interactivity makes consumers feel immersed, as if they are in a physical store. This feeling indeed triggers users' shopping impulse, and similar effects were found in the past literature on online shopping in virtual stores (Chen et al., 2022).

Another psychological feeling, instant gratification, also has a significant effect on impulsive purchase intention. This result shows that AR apps can indeed meet consumers' needs for immediately obtaining key information. In the rapidly changing and competitive e-commerce market, how to attract consumers' attention and press the purchase button in a short period of time is a common challenge (Fitzgerald, 2021). In addition, market research shows that mobile e-commerce is expected to account for 42.9% of e-commerce sales by 2024 (Law, 2022), and 91% of consumers make online purchases using their smartphones (Baluch, 2023). The results of this study indicate that AR apps can meet consumers' needs for virtual try-on and try-out in real-time, triggering their shopping impulse. Therefore, AR technology is clearly a worthwhile option to consider as a mobile marketing strategy for e-commerce.

6.2. Theoretical and practical implications

In the current dynamic landscape, characterized by a growing synergy between the virtual and physical realms, crafting immersive and innovative customer experiences through digital technology has become a paramount concern for retailers. This study offers a designed theoretical model that delineates how businesses can harness the potential of Augmented Reality (AR) to not just engage but enthrall consumers, prompting them towards impulsive buying decisions. From a theoretical vantage point, our research makes two substantial contributions:

- (1) Bridging Theoretical Gaps: While established consumer behavior theories such as the EKB model (Blackwell et al., 2006; Engel et al., 1986), Kotler model (Kotler and Keller, 2006), and Howard-Sheth model (Howard and Sheth, 1969) have furnished robust frameworks for deciphering consumer shopping behavior, they have predominantly overlooked the transformative impact of emerging digital technologies, like AR and VR, on the inner workings of consumer experiences. These models have typically centered on stimuli generated by marketers, such as advertisements and word-of-mouth, often sidelining the disruptive influence of new-age digital innovations. Our study, however, addresses this void by postulating a comprehensive model that probes into the profound influence of AR attributes (Interactivity, Vividness, Authenticity) on consumer impulse buying behavior. By doing so, we bridge an essential gap, granting us deeper

insights into how technology reshapes consumer shopping behaviors.

- (2) Synthesizing AR Research Streams: As outlined in Section 2 and elucidated in Table 1, the realm of AR and VR research is still evolving. While some scholars have ventured into AR, many have primarily explored its broader influence on general purchase intentions. Our study takes a bold step forward, plunging into the intricate dynamics of AR attributes and their nuanced impact on impulsive buying intentions. This distinction is pivotal, as impulsive buying and general purchase intentions encompass diverse conceptual territories. For instance, McLean and Wilson (2019) uncovered that the interactivity, vividness, and innovation of AR applications favorably influence consumers' willingness to purchase, adopting technology acceptance models as a reference. However, our research uncovers a more intricate narrative – AR indeed wields influence over consumers' willingness to buy, but the stimuli triggered by distinct AR attributes manifest differently, thus nurturing distinct mechanisms that mold purchasing intentions. Consider, for instance, Kumar's (2021) exploration, which alluded to varying effects of different AR characteristics on consumption intentions without delving into individual characteristic impacts. Our study extends beyond, meticulously delineating the diverse impact mechanisms of AR characteristics on consumers' impulse buying, thereby illuminating uncharted facets of consumer behavior. The research model we have meticulously crafted can also be readily applied to decode other AR-related services, casting an even wider net to deepen our comprehension of consumers' AR experiences.

From Theory to Practice: Beyond the theoretical contributions mentioned above, our research bears significant practical implications. It furnishes enterprises with a powerful lens to discern how distinct AR attributes can be harnessed to propel consumers towards impulsive buying decisions. Marketers can now harness AR to sculpt consumers' perceptions of their products or brands, convincingly illustrating how a product aligns with a consumer's desires. For instance, our study applied the proposed theoretical framework to scrutinize how the sportswear AR app 'Wanna Kicks' stimulates consumers' senses, satiating their curiosity about how a pair of shoes would look on their feet, and ultimately, igniting their desire to make an immediate purchase. In the context of online shoe shopping, consumers crave the visual experience of trying on new shoes. Herein, attributes like Vividness and Authenticity within the AR app emerge as pivotal, significantly influencing Product presence and Instant gratification. Conversely, in the context of 'Wanna Kicks,' a user-friendly app that simply necessitates selecting the desired shoes to visualize them on their feet, Interactivity has a relatively subdued impact on Product presence and Instant gratification. However, in scenarios where Vividness and Authenticity assume center stage, users unambiguously manifest intentions to make purchases. In this light, the AR app effectively fulfills consumer needs. Building on this, businesses can utilize the proposed theoretical framework to assess the AR scenarios they intend to craft. For instance, in the realm of furniture shopping, heightened Interactivity may significantly bolster consumers' Product presence and Instant gratification. Through a meticulous pre-test phase, companies can confidently steer their AR app design direction and devise astute marketing strategies. To exemplify, AR app service providers now possess the tools to tailor diverse AR apps in alignment with their strategic objectives. Should a company wish to engage customers continuously through its app, it can invest resources in amplifying the vividness and interactivity of the AR app, ensuring customers experience heightened instant gratification and derive relevant information with every interaction. Conversely, if the company seeks to stoke customers' impulse buying intentions, resources may be allocated towards elevating the authenticity of the AR app, engendering a compelling sense of product presence that propels customers to make spontaneous purchases. In conclusion, AR and VR research is still in its

nascent stages, as observed by [Trivedi et al. \(2022\)](#). Our theoretical framework, meticulously constructed and refined in this study, lays a solid foundation for future researchers. It beckons them to build upon this framework, steering AR research into more expansive and comprehensive territories of consumer behavior.

6.3. Limitations and future research directions

Although this study has made every effort to maintain rigor, consistency, and high standards in research design, data collection, analysis, and interpretation, the following limitations still exist due to factors such as time and resources: (1) This study only used popular and highly downloaded sports shoe AR apps as research targets, and the results may not necessarily apply to other significantly different AR services (e.g., furniture, beauty products). In the future, scholars can use the research model proposed in this study on other AR services and compare the differences to further enhance our understanding of the impact of AR apps on impulse buying. (2) This study only analyzed the three interactive qualities (interactivity, authenticity, and vividness) perceived by customers in AR apps, which may not be comprehensive. In the future, scholars can analyze other interactive qualities (e.g., sense of security) to better understand customers' experiences of using AR apps. (3) In this study, we examined the association between product presence and instant gratification. However, our empirical findings did not support our initial hypothesis, indicating a lack of a statistically significant positive correlation. This incongruity can be partially attributed to the unique characteristics of the AR application we employed, which primarily focused on showcasing footwear on the user's feet. Nevertheless, we remain open to the possibility that in alternative AR usage scenarios or with different technological tools, a relationship between product presence and instant gratification may emerge. Therefore, we encourage future researchers to investigate these constructs in various contexts or with different tools. (4) Given our research design, which involved inviting participants to use an AR app and immediately complete a

questionnaire, it is theoretically evident that users' responses would primarily reflect the immediate impact of the AR app. During this moment, their inner perceptions and impulses are vividly expressed in the questionnaire results. However, it's essential to acknowledge that participants may still carry impressions from their prior experiences with other AR apps, potentially introducing bias into the outcomes. Therefore, we recommend that future scholars consider incorporating participants' past AR experiences into their research to gain a more precise understanding of its influence on impulse buying. (5) For the sake of research rigor, we requested participants in this study to provide screenshots as evidence of their actual AR app usage. However, to mitigate possible biases, future researchers may consider requiring participants to concurrently measure their usage time while using the AR app to ensure the accuracy of research findings.

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Declaration of competing interest

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Data availability

The authors do not have permission to share data.

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Appendix 1. AR App Experience Process

Experience Process:

1. Please download the "Wanna Kicks" app.
2. Once you enter the app, please click on the "Discover" and "Search" buttons at the bottom of the screen to find and select the products you like.
3. After browsing the product information, click on the "Try on" button to enter the AR interactive interface.
4. In the AR screen, please interact and observe the product as much as possible. Please try on at least 3 pairs of shoes.
5. After experiencing the AR, please reflect on the difference between the process and your usual shopping experience, whether it has made you feel pleased and eager to purchase the product immediately.

Thank you for your cooperation.

Appendix 2. Questionnaire

Construct	Item	Question	Factor loading	CR	AVE
Interactivity Cronbach's α : 0.767	IN1	This app allows me to communicate in both directions.	0.820	0.851	0.589
	IN2	I can express my opinions using this app.	0.745		
	IN3	It's easy for me to find the products and information I need using this app.	0.704		
	IN6	Overall, I find this app very interactive.	0.797		
Vividness Cronbach's α : 0.758	VI1	The products shown in this app look very realistic.	0.775	0.847	0.580
	VI2	The products shown in this app have bright and vibrant colors.	0.741		
	VI3	This app provides product information that stimulates different senses.	0.712		
	VI4	The product information shown in this app is likely to make people feel excited (happy and pleased).	0.816		
Authenticity Cronbach's α : 0.842	AU07	The display on this app makes me feel like I'm looking in a mirror, it's so realistic.	0.728	0.883	0.558
	AU08	The visuals on this app give me a sense of being in the physical space and environment.	0.739		
	AU09	This app provides me with a sense of integrating the virtual and physical worlds in real time.	0.753		

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(continued)

Construct	Item	Question	Factor loading	CR	AVE
Product presence Crobach's α : 0.852	AU10	When using this app to try on or place products, I believe the products are truly on my body or in front of me.	0.767	0.894	0.628
	AU11	Using this app makes me feel like I can actually touch the various products.	0.727		
	AU12	This app helps me to believe in the effectiveness of the products I'm trying on or placing.	0.767		
	PP1	Using this app feels like I'm experiencing the product in a physical store.	0.817		
	PP2	The experience of using this app feels consistent with my memories of experiencing products in real life.	0.800		
	PP3	The products on this app look very realistic.	0.766		
	PP4	I feel like the products presented in this app are just as real as physical items, not just virtual objects.	0.774		
	PP5	When using this app, the products feel like they are being presented to me as if I were actually there in person.	0.805		
Instant gratification Crobach's α : 0.799	IG1	Using this AR app to browse products gives me an immediate sense of joy.	0.850	0.882	0.714
	IG2	I feel very happy when I use this AR app to browse products.	0.850		
	IG3	I feel very excited when I use this AR app to browse products.	0.834		
Impulse buying intent Crobach's α : 0.906	IB1	Using this AR app often gives me the impulse to buy products.	0.819	0.925	0.639
	IB2	"Just do it" describes the feeling I have when using this AR app.	0.848		
	IB3	When using this AR app, I feel like I can make purchases without much consideration.	0.854		
	IB4	"See it, buy it" is my approach to shopping using this AR app.	0.851		
	IB5	When using this AR app, I often have the thought of "buy now, think later."	0.768		
	IB6	I tend to make impulsive purchases when using this AR app.	0.661		
	IB8	When using this AR app, I often feel like my purchases are impulsive.	0.777		

Note: CR: Composite Reliability, AVE: average variance extracted.

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