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From screen to reality: How AR drives consumer engagement and purchase intention

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ABSTRACT

This study examines the critical role of telepresence in augmented reality (AR) retail, focusing on the key attributes of interactivity and vividness, and their impact on online marketing effectiveness. Through an online survey, the research reveals that a highly interactive and vivid AR shopping platform enhances media usefulness and media enjoyment. Furthermore, AR technology creates a realistic product experience that closely mimics physical shopping, thereby increasing consumer engagement. The results indicate that media usefulness and media enjoyment significantly enhance consumer engagement, subsequently leading to stronger purchase intentions. The study further demonstrates the sequential relationships between AR attributes, media usefulness, media enjoyment, consumer engagement, and purchase intention. This research provides valuable insights into the theoretical foundations of AR's influence on consumer behavior, shedding light on how this technology can be effectively leveraged to enhance online shopping experiences for consumers.

1. Introduction

The rise of online shopping has revolutionized the retail landscape, offering businesses unprecedented opportunities to reach global audiences. However, this shift to digital commerce has also brought challenges, particularly regarding consumers' lack of physical interaction with products inherent in traditional brick-and-mortar stores (Li et al., 2001; Steinmann et al., 2014; Zeng et al., 2020), which might affect consumer purchase, and consequently, harm online retailers' profitability. In response to these challenges, Augmented Reality (AR) technology has emerged as a promising solution, offering interactive and immersive experiences that bridge the gap between the online and physical worlds. The AR market, which was valued at $31.97 billion in 2019, is projected to expand from $42.04 billion in 2023 to $375.90 billion by 2031, indicating a compound annual growth rate of 31.5% (Skyquest, 2024). Over the past decade, brands and social media platforms have increasingly invested in AR-based marketing tools, anticipating significant growth in this sector (Rauschnabel et al., 2019).

AR enriches users' virtually immersive experience. However, compared with VR, which constructs a complete virtual environment (Zeng et al., 20202), AR augments viewers' images in the virtual setting (Milgram et al., 1995). By combining reality and an electronically generated setting, AR is believed to benefit consumers more than VR by creating a more immersive but realistic environment (Yim et al., 2017). For instance, AR apps, such as TYRO and Wanna Kick, allow consumers to view virtually whether the product fits them well. However, creating engaging content with AR technology remains challenging for brands, as the lack of appealing experiences might hinder mass adoption. Therefore, understanding the consumer experience of AR technologies is essential for fostering consumer

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engagement and purchases.

Previous studies have examined the role of AR in consumer purchase decisions (Hilken et al., 2017; Kumar and Srivastava, 2022), as well as the role of flow experience in influencing AR usage (Barhorst et al., 2021; Lin and Huang, 2024). Despite the growing body of research on AR in online shopping, there remain inconsistencies and gaps in understanding the underlying mechanisms through which AR influences consumer perceptions and behavioral intentions. While some studies have focused on the effects of spatial presence (Kumar and Srivastava, 2022; Lavoye et al., 2023), others have emphasized the importance of media perceptions, such as perceived usefulness and enjoyment (McLean and Wilson, 2019; Yim et al., 2017). Additionally, the role of consumer engagement in AR retail and marketing has not been thoroughly investigated.

To address these gaps, this study adopts the telepresence theory (Steuer et al., 1995) as a theoretical lens to investigate the effectiveness of AR in shaping consumer perceptions and behavioral intentions. Specifically, we aim to: a) investigate the impact of interactivity and vividness on consumer perceptions and purchase intentions in AR-based marketing; and b) to examine the mediating roles of media usefulness, media enjoyment, and consumer engagement in the relationship between AR attributes and purchase intentions. We propose that the interactivity and vividness of AR positively influence purchase intention through the mediating effects of media usefulness and media enjoyment. Furthermore, we hypothesize that consumer engagement acts as a mediator between media perceptions and purchase intention in the application of AR in online retailing. The study hypotheses were tested through an online survey with 308 consumer participants with AR shopping experience,

The present study makes several contributions to the literature on AR in online shopping. First, it extends the application of telepresence theory to the application of AR in online retailing, providing a theoretical foundation for understanding the impact of interactivity and vividness on consumer perceptions and behavioral intentions. Second, it identifies the mediating roles of media usefulness, media enjoyment, and consumer engagement, offering a more granular understanding of the underlying mechanisms through which AR influences consumer behavior. Finally, it provides practical insights for marketers to design online shopping experiences that optimize interactivity and vividness to drive consumer engagement and purchase intentions.

2. Literature review

2.1. AR in marketing and retail

AR is a technology that seamlessly blends the real world with virtual objects, creating an interactive and immersive user experience (Craig, 2013). This technology superimposes computer-generated elements onto the physical environment, and acts as a bridge between the two, generating a “mixed reality environment” (Cho and Schwarz, 2010). In the online shopping platform, AR technology enables customers to visualize products fairly accurately by displaying them based on their physical characteristics (Ma and Choi, 2007). AR's ability to overlay virtual content on the physical world creates engaging experiences that influence consumer perceptions, attitudes, and behaviors (Yim et al., 2017).

AR offers new ways for consumers to interact with products online (Javornik, 2016). Media characteristics, such as interactivity, vividness, and augmentation, play a crucial role in shaping customer experiences, with interactivity being a unique feature of AR that incites psychological and behavioral actions (McLean and Wilson, 2019; Nikhashemi et al., 2021). AR creates immersive experiences through flow, spatial presence, and mental imagery, which influence hedonic and utilitarian values, satisfaction, decision-making processes, and attitudes towards brands (Javornik, 2016; Hilken et al., 2017; Yim et al., 2017). Flow experience, in particular, has been identified as a crucial mediator between AR characteristics and consumer engagement (Arghashi and Yuksel, 2022; Barhorst et al., 2021). Numerous studies have identified flow experience as the primary underlying mechanism that leads to positive consumer perceptions of the application of AR in online shopping (e.g., Arghashi and Yuksel, 2022; Huang and Liao, 2017; Javornik, 2016; Lin and Huang, 2024; Yuan et al., 2021).

AR can significantly influence consumers’ purchasing decisions by offering both practical and enjoyable benefits (Hilken et al., 2017; Kumar and Srivastava, 2022). Moreover, it enhances satisfaction and shopping intent by forstering consumer engagement (Moriuchi et al., 2021; Nikhashemi et al., 2021; Scholz and Smith, 2016). Through the integration of AR features, brands can enhance engagement by leveraging increased acceptance of technology attributes, thereby elevating the intention to use the brand (McLean and Wilson, 2019). Recent research by Lin and Huang (2024) illustrates that AR technology fosters engagement by creating a seamless flow experience for users and augmenting satisfaction with AR services.

The integration of AR technology within retail settings yields several noteworthy outcomes, including heightened consumer engagement, strengthened brand connections, and heightened purchase inclinations (Davis and Aslam, 2024; Lin and Huang, 2024; Arghashi and Yuksel, 2022; Heller et al., 2019; Hilken et al., 2017). Recent research delves into the significance of customization within AR experiences, revealing its capacity to elevate consumer engagement and bolster purchase intentions (Xu et al., 2023). Additionally, investigations into the influence of time efficiency and emotional factors on the adoption of AR mobile applications shed light on their pivotal role in consumer behavior (Chekembayeva et al., 2023).

Despite the significance of existing research, there remains a need for further investigation to enhance our understanding of how AR influences consumer perceptions. This study aims to explore the effectiveness of AR-based marketing by identifying telepresence as a key determinant of consumer perception, with consumer engagement and media perceptions as central mediators. Additionally, the study demonstrates how media perceptions act as mechanisms through which consumer engagement via AR contributes to positive consumer behavioral intentions, specifically purchase intention.

2.2. Telepresence theory

Telepresence theory refers to the feeling of being present in a communication medium (Steuer et al., 1995). Unlike presence, which describes the natural sense of being in an environment, telepresence refers to the mediated perception of an environment (Steuer et al., 1995). According to Kim and Biocca (1997), two factors contribute to the sense of presence in a virtual environment: arrival, which is the feeling of actually being there, and departure, which is the feeling of not being in the physical environment. AR generates a high level of immersion for users, leading to significant effects on consumer behavior during AR experiences (Yim et al., 2017). Previous research has confirmed both the direct and mediating effects of telepresence on consumer perception (Han et al., 2020; Kim et al., 2021) and AR-based behavioral intention (Kim and Hyun, 2016; Ma et al., 2021). However, more detailed research is needed to understand the underlying mechanisms that influence these effects, as well as how they can be leveraged to optimize consumer engagement and decision-making in AR environments.

Interactivity and vividness as two key components of telepresence (Steuer et al., 1995). Researchers have examined these components as antecedents of telepresence in virtual contexts (Lim and Ayyagari, 2018; Kim et al., 2021). Interactivity refers to the ability to enable mutual communication between two parties (Kang et al., 2021) and is a part of almost every human activity (Heeter, 2000). Researchers have emphasized the importance to build interaction between a company and its customers to enhance its performance (Lettner et al., 2022). In the context of media, “everything a human does to or with a computer is a human-computer interaction” (Heeter, 2000). In AR content, interactivity allows users to control the visualization that combines the virtual and real worlds (McLean and Willson, 2019). AR technology is known for having a higher level of interactivity compared to other media (McLean and Wilson, 2019; Nikhashemi et al., 2021; Yim et al., 2017).

Vividness is defined as the representational richness of a mediated environment that can induce a sense of presence (Steuer et al., 1995). In online shopping, vividness relates to the quality of product presentation and is associated with consumers' cognitive elaboration processes (Jiang and Bengasat, 2007; Yim et al., 2017; Kim et al., 2021). A vivid online environment should include rich sensory content to stimulate consumers' senses (Steinmann et al., 2014).

Interactivity and vividness have garnered significant attention from researchers exploring immersive AR technologies. These components play a crucial role in creating immersive experiences in virtual contexts by generating flow experiences (Barhorst et al., 2021; Lin and Huang, 2024) and leading to higher perceived information utility (Yim et al., 2017; McLean and Wilson, 2019; Barhorst et al., 2021). Interactivity, as a fundamental feature of AR, has been studied more extensively than vividness, showing that it contributes to both hedonic and utilitarian value through flow experiences (Arghashi and Yukse, 2022; Gatter et al., 2022; Kumar and Srivastava, 2022). However, as antecedents of flow experience, the impact of interactivity and vividness on consumers' media perceptions and subsequent behavioral intentions remains underexplored.

2.3. Hypothesis development

2.3.1. Underlying mechanism between telepresence and AR performance

In the online shopping context, AR is believed to increase perceived hedonic and utilitarian value (Barhorst et al., 2021; Kumar and Srivastava, 2022) by allowing consumers to visually examine virtually displayed products (Ariely, 2000). The AR shopping experience enables consumers to enjoy the combination of reality and virtual elements while processing product information. This experience is expected to increase both perceived media usefulness and media enjoyment of shopping with AR. The capability of AR features, interactivity and vividness, to enhance purchase intention has been widely examined (Baytar et al., 2020; Kumar and Srivastava, 2022; Yim et al., 2017). This study aims to reveal the underlying mechanism of media perception (i.e., media usefulness and media enjoyment) in the positive relationship between interactivity and vividness of AR and purchase intention.

Media usefulness refers to a medium's ability to provide consumers with sufficient information for evaluating products and reducing the possibility of poor choices in virtual shopping (Kim and Forsythe, 2008). VR-based product experiences strengthen consumers' product knowledge (Daugherty et al., 2008). Shopping through VR enables consumers to effectively examine products with vivid and realistic images, as if they were in a real-world shopping environment. The combination of a naturalistic environment and vivid product presence increases consumers' perceived usefulness (Kim et al., 2021). AR, which is based on VR systems, is expected to provide consumers with similar functions in educating them more efficiently through high interactivity and vividness (Yim et al., 2017).

Due to the lack of a realistic shopping environment, digital commerce faces the challenge of consumers' limited physical interaction with products (Li et al., 2001; Steinmann et al., 2014). AR compensates for this weakness by combining the real and virtual worlds to reduce consumers' perceived product risk and increase buying intention by providing a sense of presence (Kumar and Srivastava, 2022). AR increases consumers' perceived product performance when the telepresence level is high, allowing them to virtually evaluate the product (Baytar et al., 2020). Thus, AR is inferred to be useful in helping consumers process product information and trigger purchase intention with its technological capabilities, including interactivity and vividness. AR also enhances utilitarian value by offering a more convenient product examination process (Plotkina and Saurel, 2019) and faster responses and realistic visualizations (Kim and Forsythe, 2008). Visual cues play a role in determining consumer decision process (Filieri et al., 2021). As consumers consider the use of AR in online shopping more informative (Yuan et al., 2021), the interactivity and vividness features of AR allow consumers to perceive AR as a useful medium for product evaluation. The perceived usefulness positively influences consumers’ adoption intention (Esfahbodi et al., 2022). Therefore, AR is believed to increase the purchase intention.

Media enjoyment is related to the hedonic value of AR in this study. Studies in video games have revealed that a more interactive game setting generates a higher degree of enjoyment for players because interactivity is highly related to perceived control in the virtual world (Nicholas et al., 2000; Klimmt et al., 2007). The close relationship between vividness and enjoyment was examined by Heeter

(2000), who found that individuals experience a stronger sense of enjoyment when communicating with computer-generated user images. Studies in advertising confirmed that vivid images trigger a higher level of enjoyment (Yim et al., 2012a, 2012b). According to previous research based on the technology acceptance model, AR features, such as interactivity and vividness, are related to consumers' hedonic value and perceived enjoyment (e.g., Ivanov et al., 2023; McLean and Wilson, 2019; Pantano et al., 2017; Plotkina and Saurel, 2019; Yan et al., 2024). With the assistance of interactivity and vividness, AR generates a sense of immersion for consumers and leads to a more positive attitude towards AR (Yim et al., 2017). Consumer attitude is acknowledged to have positive impacts on purchase intention (Hartmann and Apaolaza-Ibáñez, 2012; Lim et al., 2017). Therefore, interactivity and vividness are expected to increase AR-based marketing purchase intention through the perceived higher media usefulness and media enjoyment of AR, as hypothesized:

H1a. The positive effect of interactivity of AR on purchase intention is mediated by media usefulness.

H1b. The positive effect of the interactivity of AR on purchase intention is mediated by media enjoyment.

H2a. The positive effect of the vividness of AR on purchase intention is mediated by media usefulness.

H2b. The positive effect of the vividness of AR on purchase intention is mediated by media enjoyment.

2.3.2. Consumer engagement

Consumer engagement is a psychological state created by interactive and co-creative customer experiences with an object (Brodie et al., 2011). Engagement in AR positively influences consumers' satisfaction and usage intention (Arghashi and Yuksel, 2022; McLean and Wilson, 2019). Engaged consumers have a more positive attitude and understanding of the features that increase their intention to stay with the brand (Molinillo et al., 2020; Wang, 2020; Yuan et al., 2020).

Previous research has established the importance of utilitarian factors and enjoyment in positively influencing consumer engagement (McLean, 2018), such that if a "market" was perceived as more efficient, consumer engagement would increase (Sun et al., 2023). For example, Sun et al. (2023) found that a priori disclosure of sponsorship helps the video to be more efficient in increasing consumer engagement. In the context of AR, studies have found that when perceived usefulness is high, consumers experience a stronger sense of engagement (Arghashi and Yuksel, 2022). This finding aligns with the notion that AR's unique features, such as interactivity and vividness, enhance consumers' visualization of products and perceptions of the retail shopping experience, leading to increased consumer engagement (Owyang, 2010). Therefore, we hypothesize:

H3a. Media usefulness has a positive relationship with consumer engagement.

In addition to usefulness, enjoyment induced by interactivity and vividness has been found to lead to greater engagement (McLean and Wilson, 2019). AR's ability to create novel and immersive experiences contributes to a more enjoyable retail shopping experience, which in turn triggers positive consumer behavior and engagement. This notion is supported by the findings of Yim et al. (2017), who demonstrated that AR apps generate more novelty, immersion, enjoyment, and usefulness compared to web-based apps, resulting in increased consumer purchase intentions and positive attitudes towards AR. Furthermore, Nikhashemi et al. (2021) illustrated that AR's unique features enhance consumers' perception of benefits, which can improve consumer engagement and inspiration. Thus, we propose:

H3b. Media enjoyment has a positive relationship with consumer engagement.

Existing literature has consistently demonstrated the positive impact of consumer engagement on various brand-related outcomes, including purchase intention (Brodie et al., 2011; Hollebeek et al., 2014; Molinillo et al., 2020; Wang, 2020). Engaged consumers tend to have a more positive attitude towards the brand and a better understanding of its features, which in turn increases their intention to stay with the brand (Molinillo et al., 2020; Wang, 2020). Prior studies have confirmed that AR has a significant potential to enhance consumers' behavioral intentions (e.g., Park and Yoo, 2020; Rese et al., 2017).

AR apps have been found to create more novelty, immersion, enjoyment, and usefulness compared to web-based apps, leading to increased consumer purchase intentions and positive attitudes towards AR (Yim et al., 2017). Moreover, Nikhashemi et al. (2021) illustrated that AR's unique features improve customers' perception of benefits, which can enhance consumer engagement and inspiration, ultimately resulting in increased consumer intention to use AR apps and willingness to pay a price premium. This finding suggests that consumer engagement, fostered by AR's unique attributes, can positively influence purchase intention. Prior studies have confirmed that consumer engagement positively influences brand usage intent (e.g., Harrigan et al., 2018; Hollebeek et al., 2014; Obilo et al., 2021). Building on these findings, we hypothesize:

H4. Consumer engagement has a positive relationship with purchase intention.

AR's unique features, like interactivity and vividness, enhance product visualization and perceptions of the retail experience, boosting consumer engagement, which in turn fosters a more positive attitude towards the brand and a better understanding of its features, increasing the intention to stay with the brand (Molinillo et al., 2020; Wang, 2020). This suggests that consumer engagement mediates the positive effects of media usefulness on purchase intention. Therefore, we hypothesize:

H5a. The positive effect of media usefulness of AR on purchase intention is mediated by consumer engagement.

Similarly, AR's ability to create novel and immersive experiences contributes to a more enjoyable retail shopping experience, which in turn triggers positive consumer behavior and engagement. As consumer engagement facilitates consumers' beliefs about brand value and purchase intention (Hollebeek et al., 2014). This suggests that consumer engagement mediates the effect of media enjoyment on purchase intention. Thus, we propose:

H5b. The positive effect of media enjoyment of AR on purchase intention is mediated by consumer engagement.

Fig. 1 illustrates the conceptual framework along with the corresponding hypotheses.

3. Method

This study was conducted in China. AR technology has become popular among consumers and is widely used by retailers and marketers. For example, according to People's Daily Online (2020), one out of every three young people in China use the DEWU app, which offers an AR try-on function that allows consumers to virtually try on shoes. DEWU is an online fashion shopping community, with authentic fashion online shopping and a fashion life community as its two core services. Users can install the DEWU app on their smartphones, browse products from different brands, particularly shoes, and use the AR try-on function introduced in 2020 to evaluate products before making a purchase decision. Therefore, DEWU was selected to investigate the proposed hypotheses.

The population of this study includes Chinese online consumers who have experience shopping with AR technology. Due to the infeasibility of accessing the entire statistical population, this study employed non-probability sampling, enabling researchers to collect data from a large sample efficiently and cost-effectively while maintaining a satisfactory degree of randomness. Data collection was conducted through a structured online questionnaire from August 5th to August 15th, 2021. The questionnaire was distributed on social media using a convenience sampling method. A total of 357 questionnaires were received, but responses from individuals with no AR experience were removed, resulting in 308 valid responses. Of these, 33% were male and 67% were female. Additionally, 16% of respondents reported purchasing from online platforms at least once per day, 51% did so 3–5 times per week, 31% less than 3 times per week, and 2% did not specify.

The body of the questionnaire was divided into three sections. The first section focused on respondents' online buying experiences and habits. The second section addressed the evaluation of each variable in this study. The questionnaire began with screening questions such as "Do you have augmented reality experience?" and "Have you experienced shopping with augmented reality?" Constructs were measured using a five-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). A total of 23 items were used to measure six latent constructs. Interactivity, vividness, media usefulness, and media enjoyment were measured using adapted scales from Yim et al. (2017). A four-item scale for measuring consumer engagement was adapted from Hollebeek et al. (2014). Purchase intention was measured using three items from Chen and Chang (2018). The final step was to acquire fundamental demographic data.

All scales were adapted from existing studies and translated into Chinese. To ensure and improve the quality of the translated questionnaire, 15 marketing students from a university in the United Kingdom, who were native Chinese speakers and proficient in English, were invited to participate in a pilot study through an online questionnaire. The sample size of 15 met the recommended sample size of 12 for pilot studies (Julious, 2005). They completed a paper-based pre-test questionnaire and provided feedback to the researchers. The translation was further modified based on the pilot study feedback, and a student English translator was invited to review the translated questionnaire.

4. Results

4.1. Measurement model

This study utilized the KMO Bartlett's test to check sampling adequacy. The KMO value was 0.946, which is considered an excellent result as it exceeded the threshold of 0.5 (Hair et al., 2017). Since all the data were collected within one survey containing all variables, there was a possibility of common method bias. To address this concern, this study conducted an exploratory factor analysis with Harman's single-factor test using SPSS 28. The results showed that a single factor explained 49% of the variance, which is below the recommended threshold, indicating that common method bias was not a problem. Measurements of each variable were adopted from the literature and modified accordingly. Reliability for each construct was measured using Cronbach's alpha, which ranged from 0.77 to 0.90, all above the minimum standard of 0.7, indicating high reliability.

4.2. Mediating effect of media perceptions

This study employed Hayes (2017, Model 4) to test H1 and H2, which propose that media perceptions mediate the relationship between interactivity and vividness and purchase intention. First, the research tested the direct effect of AR features on media

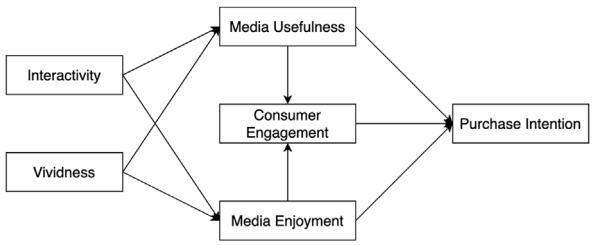

Fig. 1. Conceptual framework.

perceptions and the effect of media perceptions on purchase intention. Considering the demographic differences among participants, their gender, age, and level of education are controlled. The results showed significant positive impacts of interactivity on media usefulness ($\beta = 0.305$, $t = 5.422$, $p < 0.001$) and media enjoyment ($\beta = 0.561$, $t = 9.123$, $p < 0.001$), and vividness on media usefulness ($\beta = 0.489$, $t = 8.514$, $p < 0.001$) and media enjoyment ($\beta = 0.362$, $t = 5.753$, $p < 0.001$). Both media usefulness ($\beta = 0.359$, $t = 6.838$, $p < 0.001$), media enjoyment ($\beta = 0.360$, $t = 7.758$, $p < 0.001$), and engagement ($\beta = 0.363$, $t = 6.732$, $p < 0.001$) were significantly related to purchase intention (see Table 1).

Next, Hayes PROCESS Model 4 with 5000 bootstrapping samples was used to test H1 and H2. Hayes Model 4 is used for a single mediation test, which allows for the assessment of indirect effects of an independent variable (X) on a dependent variable (Y) through one mediator (M). The specific paths analyzed in Model 4 are 1) path a: the effect of X on M; 2) path b: the effect of M on Y; 3) path c': the direct effect of X on Y; 4) path c: the total effect of X on Y, which is the sum of direct effect (c') and indirect effect (a*b). To examine the mediating effect (M) on the relationship between the independent variable (X) and dependent variable (Y), the following formula is used to test the total effect: $c = c' + a*b$.

The results revealed a significant indirect effect of the impact of interactivity on purchase intention through media usefulness ($b = 0.274$, 95% CI = [0.184, 0.369]) and media enjoyment ($b = 0.269$, 95% CI = [0.169, 0.371]), supporting H_{1a} and H_{1b}. Furthermore, the direct effects of interactivity on purchase intention in presence of the media usefulness ($b = 0.269$, $p < 00.001$) and media enjoyment ($b = 0.274$, $p < 00.001$) are also found significant. Hence, media usefulness and media enjoyment partially mediated the relationship between interactivity and purchase intention. Then, results showed a significant indirect effect of the impact of vividness on purchase intention through media usefulness ($b = 0.289$, 95% CI = [0.187, 0.409]) and media enjoyment ($b = 0.350$, 95% CI = [0.214, 0.489]), supporting H_{2a} and H_{2b}. The direct effects of vividness on purchase intention in the presence of the media usefulness ($b = 0.176$, $p < 00.001$) and media enjoyment ($b = 0.116$, $P = 0.04$) are significant, indicating a partial mediation (see Table 2).

4.3. Mediating effect of consumer engagement

To first test H_3, that media usefulness and media enjoyment will positively influence consumer engagement, the study conducted regression analysis by SPSS 28. Results revealed that consumer engagement was significantly affected by media usefulness ($b = 0.359$, $t = 6.838$, $p < 0.001$) and media enjoyment ($b = 0.360$, $t = 7.758$, $p < 0.001$), supporting H_{3a} and H_{3b}. Consumer engagement was also found to have a significant impact on purchase intention ($b = 0.363$, $t = 6.732$, $p < 0.001$), supporting H_4 (see Table 1). Participants' gender, age, and educational level were controlled for the above analysis.

Hayes PROCESS Model 4 with 5000 bootstrapping samples was used for testing H_{5a} and H_{5b} by using the same formula: $c = c' + a*b$. Same as the previous analysis, participants' demographic information, including gender, age, and education level, were set as control variables. Results showed a significant indirect effect of impact of media usefulness on purchase intention through consumer engagement ($b = 0.284$, 95% CI = [0.190, 0.386]), supporting H_{5a}. The direct effects of media usefulness on purchase intention in the presence of consumer engagement ($b = 0.282$, $p < 00.001$) is significant, indicating a partial mediation. Similarly, results revealed a significant indirect effect of the impact of media enjoyment on purchase intention through consumer engagement ($b = 0.252$, 95% CI = [0.161, 0.347]), supporting H_{5b}. The direct effects of media enjoyment on purchase intention in the presence of the consumer engagement ($b = 0.254$, $p < 00.001$) is significant, indicating a partial mediation (see Table 2).

This study additionally tested the sequential mediating effect that AR features (interactivity and vividness) were sequentially mediated by media perceptions (media usefulness and media enjoyment) and consumer engagement on purchase intention. To test the above serial mediating relationships, Hayes PROCESS Model 6 with 5000 bootstrapping samples was adopted. Hayes Model 6 is used for testing serial mediation, which allows for the assessment of indirect effects of an independent variable (X) on a dependent variable (Y) through the sequential mediator (M1 and M2). The formula used in model 6 is $c = a1*b1 + a2*b2 + a1*d*b2 + c'$, in which c is the total effect, a1 and a2 is the effect of X on M1 and M2, b1 and b2 is the effect of M1 and M2 on Y, d is the effect of M1 on M2, and c' is the direct effect of X on Y. Similarly, gender, age, and education level were controlled. Results showed the significant indirect effect of interactivity on purchase intention through media usefulness and consumer engagement ($b = 0.126$, 95% CI = [0.076, 0.189]), and the indirect effect of interactivity on purchase intention through media enjoyment and consumer engagement ($b = 0.121$, 95% CI = [0.071, 0.179]). The indirect effect of vividness on purchase intention through media usefulness and consumer engagement ($b = 0.116$, 95% CI = [0.066, 0.177]), and the indirect effect of vividness on purchase intention through media enjoyment and consumer engagement ($b = 0.139$, 95% CI = [0.082, 0.211]) are also found to be significant.

Table 1
Direct effect results.

Path	β	t	R^2
Interactivity → Media usefulness	0.305***	5.422	0.514
Vividness → Media usefulness	0.489***	8.514	
Interactivity → Media enjoyment	0.561***	9.123	0.559
Vividness → Media enjoyment	0.362***	5.753	
Media usefulness → Engagement	0.359***	6.838	0.538
Media enjoyment → Engagement	0.360***	7.758	
Media usefulness → Purchase intention	0.196***	3.711	0.539
Media enjoyment → Purchase intention	0.178***	3.736	
Engagement → Purchase intention	0.363***	6.732	

Table 2
Mediating effect results.

Indirect effect path	Total effect	Direct effect	Indirect effect	95% CI		t
				Lower	Upper	
IN → MU → PI	0.543	0.269	0.274	0.184	0.369	5.756
VI → MU → PI	0.466	0.176	0.289	0.187	0.409	5.129
IN → ME → PI	0.543	0.274	0.269	0.169	0.371	5.185
VI → ME → PI	0.466	0.116	0.350	0.214	0.489	4.952
MU → CE → PI	0.566	0.282	0.284	0.193	0.392	5.646
ME → CE → PI	0.505	0.254	0.252	0.168	0.349	5.262
IN → MU → CE → PI	0.543	0.150	0.130	0.077	0.196	0.196
VI → MU → CE → PI	0.466	0.023(n.s)	0.118	0.068	0.182	0.182
IN → ME → CE → PI	0.543	0.161	0.126	0.075	0.187	0.187
VI → ME → CE → PI	0.466	−0.018(n.s)	0.142	0.084	0.216	0.216

Notes: IN = interactivity; VI = vividness; MU = media usefulness; ME = media enjoyment; CE = consumer engagement; PI = purchase intention; n.s = no significance.

5. Discussion

The purpose of this study is to investigate how AR can be effectively utilized as a tool in online shopping through the use of an online survey. The research focuses on two key AR features—interactivity and vividness, which are aspects of telepresence that significantly influence consumer engagement by affecting media perceptions, including usefulness and enjoyment. The results showed that both interactivity and vividness significantly impact media usefulness, enjoyment, and purchase intention. Media usefulness was a stronger mediator between interactivity and purchase intention, while media enjoyment more significantly mediated the effect of vividness.

Additionally, the study highlighted the importance of consumer engagement in AR contexts. Positive media perceptions significantly boosted consumer engagement, which in turn increased purchase intentions. A key finding is the sequential mediation effect: media perceptions and consumer engagement sequentially mediate the relationship between interactivity, vividness, and purchase intention. This indicates that AR features influence consumers' perceptions and psychological states, ultimately enhancing purchase intentions, and extending previous research on AR's impact on consumer attitudes and behaviors (Heller et al., 2019; Lin and Huang, 2024).

5.1. Theoretical contributions

The current study makes several significant contributions to the digital marketing literature, addressing inconsistencies and gaps in understanding the underlying mechanisms through which AR influences consumer perceptions and behavioral intentions. First, this study extends the application of telepresence theory (Steuer et al., 1995) to consumer online shopping behavior, providing a more granular understanding of the key components that drive consumer perceptions and behavioral intentions. While previous research has indicated the positive effect of telepresence on perceived product performance in AR (Baytar et al., 2020), the current study refines the idea by focusing on interactivity and vividness as specific and instrumental elements of AR-based online shopping. This study advances previous findings in the context of product image design on a retailing platform (Fiore et al., 2005), by demonstrating the critical role of interactivity and vividness in enhancing telepresence within AR contexts, thereby extending the application of these concepts to a novel and increasingly relevant digital marketing domain.

Second, the study reveals the mediating role of media perception in the relationship between AR attributes and consumer behavioral intentions, challenging the existing focus on flow experience as the primary mediator in AR-based marketing experiences (Arghashi and Yuksel, 2022; Kumar and Srivastava, 2022; Lin and Huang, 2024). By identifying media usefulness and media enjoyment as important mediators, this study highlights the significance of consumers' perceptions in shaping their behavioral intentions, corroborating previous research on the influence of consumers' attitudes toward new technology on their subsequent actions (Yim et al., 2017; Park and Yoon, 2020). These findings contribute to a better understanding of the underlying mechanisms through which AR influences consumer behavior, emphasizing the importance of considering both utilitarian (usefulness) and hedonic (enjoyment) aspects of AR in driving consumer engagement and purchase intentions.

Furthermore, the study advances our understanding of the mediating role of consumer engagement with innovative technology, demonstrating that consumer engagement mediates the relationship between media perceptions and purchase intention. The findings reveal that positive media perceptions stimulate a psychological state that drives consumers to take purchasing actions, and they confirm the sequential mediation effects, whereby media perceptions and consumer engagement sequentially mediate the relationship between interactivity, vividness, and purchase intention. These results align with previous research that has demonstrated the enhancing effect of engagement on consumers' experiences in virtual shopping (Arghashi and Yuksel, 2022; Heller et al., 2019; Lin and Huang, 2024; McLean and Wilson, 2019), contributing to the growing body of literature on the transformative potential of interactive and immersive technologies in shaping consumer behavior.

The theoretical implications of this study extend beyond the specific context of AR shopping, contributing to the broader discourse on the applications and implications of interactive and immersive technologies in various domains, such as education, healthcare, and entertainment. By focusing on the nuanced roles of interactivity, vividness, media perceptions, and engagement in shaping consumer behavior, the study provides a theoretical foundation for future research to explore how these technologies can be leveraged to enhance

user experiences, drive engagement, and influence behavior in diverse contexts.

5.2. Managerial implications

The findings of this study provide valuable insights for digital marketers looking to leverage AR technology to enhance consumer engagement and drive purchase intentions. By understanding the crucial role of interactivity and vividness in shaping media perceptions, marketers can develop AR experiences that optimize these attributes to foster positive attitudes and behaviors among consumers.

Given that AR features of interactivity and vividness enhance media usefulness, marketers should focus on providing utilitarian benefits through AR applications. Higher levels of AR media usefulness can foster more positive attitudes and directly influence consumer behaviors, making it essential for marketers to employ AR technology, especially in online shopping settings. As consumers often express concerns about the lack of physical interaction with products when shopping online (Li et al., 2001; Steinmann et al., 2014), AR can help alleviate these concerns by providing consumers with sufficient product information and the ability to evaluate products virtually. Marketers should prioritize AR features that enable consumers to receive detailed product information, such as AR try-ons, which can increase trust in the product (Arghashi and Yukse, 2022).

Furthermore, the study highlights the importance of media enjoyment in shaping consumer behavior intentions. Marketers should emphasize the hedonic value of AR experiences in retailing to create a more relaxing and satisfactory virtual shopping environment. Even without an actual purchasing option, providing consumers with a brief taste of the fun and engaging aspects of AR can increase their satisfaction and positive attitudes. By offering interactive and vivid shopping experiences through AR, consumers will perceive higher hedonic value, which can reduce their perceived risk toward online shopping (Kumar and Srivastava, 2022).

Recognizing consumer engagement as a crucial underlying mechanism for AR technology, marketers should apply AR on online platforms to attract more engaged customers and drive purchase actions. With higher levels of engagement, consumers become more connected to the brand, helping brands differentiate themselves from competitors and cultivate more loyal consumers. Marketers should focus on developing AR experiences that trigger engagement from consumers, as this can lead to increased purchase intentions and long-term brand loyalty.

To effectively implement these strategies, marketers should collaborate with AR technology providers and user experience designers to create seamless, interactive, and visually appealing AR applications. By investing in the development of high-quality AR experiences that prioritize interactivity, vividness, and user engagement, digital marketers can position themselves at the forefront of the rapidly evolving digital marketing landscape and reap the benefits of increased consumer satisfaction, trust, and purchase intentions.

5.3. Limitations and future research

The current study offers valuable insights into consumer perceptions of AR. However, several limitations warrant attention for future research. Firstly, relying on online surveys, while confirming relationships between variables, may not establish strong causal connections. Future studies should employ experiments or field studies for robust causal understanding and consider individual differences like personality or technology anxiety. Secondly, the study's sample from China may not represent more mature AR markets or consider cultural differences. Cross-cultural studies and investigations in mature markets are needed for generalizability. Additionally, future research should explore factors beyond interactivity and vividness, such as ease of use and social influence. Lastly, as AR technology evolves, longitudinal studies and exploration of synergies with other technologies can generate important insights into changing consumer behaviors.

CRediT authorship contribution statement

Jingyi Yang: Writing – original draft, Conceptualization. **Zhibin Lin:** Writing – review & editing.

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.

Appendix

Appendix a. Measurements of each construct

Variables	Items	Reference
Interactivity	1. The AR technology had the ability to respond to my specific needs quickly and efficiently in the e-commerce platform. 2. I was in control of my navigation through the AR technology in product presentation. 3. I had control of the AR technology I wanted to see the product information	Yim et al. (2017)
Vividness	1. The visual display of product information through AR technology was clear on the e-commerce platform. 2. The visual display of product information through AR technology was detailed on the in-commerce platform. 3. The visual display of products through AR technology was vivid in the e-commerce platform.	Yim et al. (2017)

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Variables	Items	Reference
	4. The visual display of products through AR technology was well-defined in the e-commerce platform.	
Media usefulness	1. The AR product presentation enhances my ability to make product choices more effectively.	Yim et al. (2017)
	2. Using AR technology in the e-commerce platform saves me time.	
	3. Using AR technology in the e-commerce platform improves the quality of my search for products.	
	4. The AR technology in the e-commerce platform enables me to acquire product information more quickly.	
	5. Overall, I find the AR in product presentation is useful in my shopping experience.	
Media enjoyment	1. I found that the AR product presentation was entertaining.	Yim et al. (2017)
	2. I found the AR product presentation experience enjoyable.	
	3. The online shopping experience with AR was pleasing.	
	4. The online shopping platform embedded with AR technology was fun to use.	
Customer engagement	1. This app gets me thinking about the brand.	Hollebeek et al. (2014)
	2. This app stimulates my interest in the brand.	
	3. I feel positive about the brand when I use the app.	
	4. I feel good when I use this app.	
Purchase intention	1. I plan to visit the brand's store when I need to purchase related products in the future.	Chen and Chang (2018)
	2. I plan to visit the brand's website to explore when I need to purchase related products in the future.	
	3. I plan to purchase the products of the brand after using the AR product presentation function.	

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