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The effects of augmented reality on consumer responses in mobile shopping: The moderating role of task complexity

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ABSTRACT

Augmented reality (AR) solutions help facilitate consumers' direct examinations, enhancing their shopping experiences in the digital commerce context. This study examines consumer responses to AR in mobile shopping. It investigates the relationships among perceived media richness, interactivity, telepresence, utilitarian and hedonic values, and behavioral intentions. Furthermore, it explores whether these relationships differ depending on consumers' perceived task complexity. A total of 279 mobile application users participated in the online survey. The participants were guided to answer an online questionnaire after utilizing an AR mobile application to purchase a jewelry product. The findings reveal that media richness and interactivity positively influence telepresence, and telepresence increases behavioral intentions through perceived utilitarian and hedonic values. The effect of interactivity on telepresence and the impact of telepresence on utilitarian value are higher for consumers with low task complexity perception. By contrast, the impact of telepresence on hedonic value is higher for consumers with high task complexity perception. The results suggest practical implications for mobile retailers that apply advanced AR technology in retailing.

1. Introduction

Over the last few years, digital commerce has become an essential segment of global retailing due to advancements in technologies, digitalization, the use of mobile devices, and globalization. The COVID-19 pandemic has accelerated the digital transformation as many consumers have switched from physical shopping channels to a digital one [1]. Therefore, consumers' need for seamless omnichannel experiences has increased. Concurrently, retailers have improved traditional techniques, such as pictures, videos, and website design, developing new strategies to enhance consumers' sensory experiences in digital environments. One of the latest technologies gaining popularity and accelerating the digital shift is augmented reality (AR), defined as "a technology which allows computer-generated virtual imagery to exactly overlay physical objects in real time" [2] (p. 193). AR creates virtual images through the consumers' smartphone camera by overlaying the virtual product, thus providing a virtual try-on function. For instance, Warby Parker has created a mobile app that allows consumers to try-on glasses using AR. Consumers select a pair of glasses in this mobile app and focus their smartphone cameras on their faces. Then, the smartphone camera creates an overlay by placing the image of the glasses onto the virtual version of their faces. Consumers feel as if they are wearing the selected glasses by previewing how the glasses would look on their faces without visiting the physical retail store. A recent survey has shown that AR is ranked as the most useful technology for shopping online.

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Furthermore, product presentation using the AR function has a 94% higher conversion rate than product presentation without AR [3]. The adoption of AR technology makes consumers' digital shopping experience more efficient, providing visual and tactile information about products. Furthermore, AR is an interactive and immersive technology that enhances consumers' shopping experiences [4]. As such, many retailers such as IKEA, Home Depot, Sephora, Kohl's, and Levi's have successfully employed AR technology, and luxury brands such as Gucci and Louis Vuitton have also adopted AR for mobile shopping [3]. For example, Kohl's collaborates with Snapchat to provide consumers with Kohl's AR virtual closet. Using a smartphone, consumers can browse Kohl's digital showroom on Snapchat. They can try a dress using the AR function and purchase it without leaving the Snapchat app. To compensate for the inability to socialize in digital environments, using AR technology, Levi's has created a co-watching video app where friends can shop together [3].

Despite the increasing popularity of AR and its benefits for consumers and retailers, little is known about whether AR, as an immersive technology, provides realistic virtual try-on experiences. Its overall impact on consumers' shopping outcomes is unclear. According to Roundtable Learning [5], the AR experience is less immersive, and AR users have a greater possibility to be distracted than those experiencing virtual reality (VR) [6]. Since consumers use AR for digital shopping more frequently than VR [7,8], digital retailers must understand the role of telepresence, correctly assessing the degree to which consumers "feel real" while using AR [9]. As technology is more immersive, the level of telepresence that consumers experience increases [6]. Hence, the purpose of this study is to examine various factors that enhance telepresence, such as media richness and interactivity, potentially compensating for the less immersive characteristics of AR.

This study addresses an opportunity to experience products that consumers browse, using innovative AR technology based on the insights of telepresence theory [9]. The purpose of this study is to examine how perceived media richness and interactivity of AR influence telepresence, which further influences consumers' value and behavioral intentions. Previous research has used telepresence theory to examine VR effects [10,11]. However, studies on the impact of telepresence in the context of AR are limited [12]. This study contends that examining how AR influences telepresence may be critical for assessing consumers' shopping values. Furthermore, previous research has not explored the perceived utilitarian and hedonic values of telepresence using AR technology in the digital shopping context and thus, this study examines that. It also investigates whether the perceived level of task complexity moderates the relationship between media richness/interactivity and telepresence and the relationship between telepresence and utilitarian/hedonic values (see Fig. 1 for the conceptual model). The findings of this study will provide valuable insights to researchers and digital retailers on the significance of telepresence derived from AR and the effects of telepresence on consumer values and behavioral intentions in a digital shopping context.

2. Background and hypotheses

2.1. Telepresence theory

Telepresence theory postulates that information is conveyed from a sender to a receiver through mediated environments, which, in turn, influence telepresence [9]. Telepresence refers to "the extent to which one feels present in the mediated environment, rather than in the immediate physical environment" [9] (p. 6). Telepresence in a digital context has been defined as digital experiences that feel more real than offline experiences [13]. More recently, telepresence has been used to describe an entranced state achieved with the use of new technologies [14]. Previous researchers have described the effects of telepresence in diverse contexts. For example, telepresence generated from a virtual model feature used for product presentation increases shopping enjoyment, purchase intention, and patronage intention in online shopping [15]. In mobile shopping, the adoption of VR technology helps consumers experience telepresence, increasing playfulness and behavioral intentions [11]. Hence, this study investigates ways to increase telepresence using AR to create more immersive environments, ultimately increasing behavioral intentions.

From the retail technology perspective, scholars have identified factors that help develop telepresence [6,9,16]. Media richness and interactivity are crucial for stimulating telepresence [9]. Media richness, often referred to as "vividness," is the degree to which

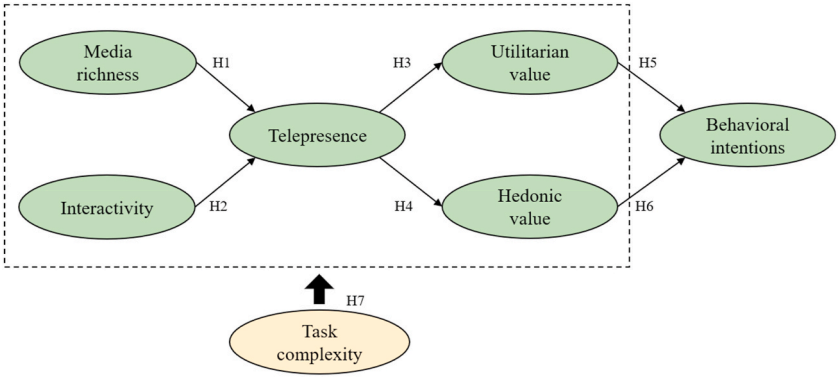

Fig. 1. Conceptual model of this study.

technology produces sensory information. According to media richness theory [17], media may range from lean to rich. Consumers prefer to use rich media to reduce product uncertainty and facilitate communication. Incorporating AR into the media richness theory, AR technology may provide a rich sensory experience of the product. As multiple sensory channels among the five senses are activated and the quality in each sensory channel is dense, consumers perceive media richness [18]. For example, television is greater in media richness than radio is, because the number of sensory channels activated is larger for television (i.e., visual and auditory) than for radio (i.e., auditory only). In addition, televisions that provide high resolution images are higher in media richness than those with standard-level resolution images [16]. In digital retailing, media richness often indicates how product information is delivered to consumers. High-quality product pictures and AR may help consumers perceive media richness because vivid product presentation provides more informational cues and activates multisensory modalities [19].

In contrast, interactivity refers to the degree to which consumers control technology while they shop in a virtual space [18]. In digital retailing, consumers perceive greater interactivity when they can customize the product design features [20]. In addition, interactivity is related to the number of clicks needed to obtain specific information and the time taken for sending messages [21], the use of AR or VR functions [22], enlarging images, and playing video [23].

According to Kim and Ko [16], both media richness and interactivity of VR increase telepresence. Klein [18] has shown a positive relationship between media richness and telepresence and between interactivity and telepresence in an online advertising context. Similarly, in this study, if more high-quality sensory modalities are stimulated and if consumers can easily control virtual try-on experiences through AR, they may perceive greater media richness and interactivity. Thus, the following hypotheses were developed:

H1. Perceived media richness will positively influence telepresence.

H2. Perceived interactivity will positively influence telepresence.

2.2. Telepresence and consumer values

Consumer value is defined as the difference between perceived product quality and perceived cost [24]. However, previous research has proposed that the concept of consumer value is more complex, subjective, and multidimensional [25]. The most frequently used shopping value may be divided into utilitarian and hedonic dimensions, and consumers' purchasing decisions result from these two shopping values [26,27].

Utilitarian value refers to an overall evaluation based on the functional aspects of products or services, whereas hedonic value is related to consumers' pleasant and enjoyable shopping experiences [28]. Perceived efficiency and sufficient information presentation increase consumers' utilitarian value when assessing the quality of travel websites [29]. Entertaining experiences and the emotional worth obtained while browsing websites provide hedonic value [29]. For example, hotel websites providing information that stimulates sensory experiences using pictures of hotel rooms, facilities, and beautiful scenery around the hotel can satisfy both utilitarian and hedonic values. The proposed images not only provide hotel information (i.e., utilitarian attributes) but also influence consumers' emotional states (i.e., hedonic attributes) [30]. This study contends that consumers perceive greater utilitarian and hedonic values if mobile shopping apps using AR provide product information more precisely through virtual try-on and add more fun to shopping experiences.

Previous research exploring the relationship between telepresence and perceived value is limited. Although telepresence has been shown to influence hedonic value positively, the relationship between telepresence and utilitarian value is controversial. According to Ongsakul et al. [31], telepresence positively influences utilitarian and hedonic values for tourism websites. Website quality increases telepresence and facilitates consumers' information seeking behavior, increasing utilitarian value. Concurrently, telepresent website quality makes consumers' experience enjoyable, increasing hedonic value.

In contrast with Ongsakul et al. [31], Lim [32] and Beuckels and Hudders [33] have found a positive relationship only between telepresence and hedonic value in online shopping. Telepresence has been shown to increase hedonic value when examining the effects of VR technology. However, the utilitarian value is higher in a retail website without VR [10] because VR relates more to consumers' entertainment during the shopping processes than to functional product information. Similarly, Han et al. [11] have demonstrated a positive relationship between telepresence and hedonic value for VR shopping only.

Unlike VR, AR offers virtual try-on, which delivers functional information about products [34]. Furthermore, telepresence helps consumers perceive more information about the products. They may develop positive attitudes toward the products because telepresence provides anticipatory consumption experiences [35,36]. Therefore, this study hypothesizes that telepresence experienced through AR influences both utilitarian and hedonic values:

H3. Telepresence will positively influence utilitarian value.

H4. Telepresence will positively influence hedonic value.

2.3. Perceived values and behavioral intentions

Behavioral intentions are defined as "what a person intends to do" in an online shopping context [37] (p. 101) and have been extensively investigated in the e-commerce literature as crucial determinants of actual purchases [38]. According to Zeithaml, Berry, and Parasuraman [39], behavioral intentions can be favorable or unfavorable. For example, recommending a product or store and revisiting a store are favorable behavioral intentions, whereas negative word-of-mouth (WOM) and switching stores are unfavorable intentions.

Many previous studies have found positive relationships between utilitarian value and behavioral intentions, and between hedonic value and behavioral intentions. For example, Hanzaee and Rezaeyeh [40] have suggested that the perceived utilitarian and hedonic values in fast-food restaurants positively influence behavioral intentions, such as positive WOM and revisit intentions. Ongsakul et al. [31] have confirmed the effects of perceived utilitarian and hedonic values on behavioral intentions in a tourism website. The same relationship holds in the VR service industry. Users who perceive greater utilitarian and hedonic values using VR devices have greater continuance intentions [41]. In this study, behavioral intentions are the intentions to recommend a website, purchase a product, and revisit a website; hence, the following hypotheses were developed:

H5. Utilitarian value will positively influence behavioral intentions.

H6. Hedonic value will positively influence behavioral intentions.

2.4. Task complexity

According to the theory of task complexity [42], how individuals perceive complexity when performing a task varies substantially. Individuals process information partially or fully depending on their level of complexity perception, thus affecting the quality of the task. In other words, individuals perceiving a level of complexity, knowledge, or skills to complete a task beyond their capacities may experience information overload [43]. Furthermore, information overload distracts individuals' attention, affecting memory and recognition [44] and inducing low performance quality [42]. In the context of digital shopping, if consumers perceive high complexity when processing product information using the AR function, their attention to the primary task is distracted, lowering their understanding of the product information.

By contrast, consumers who perceive low complexity when using AR can easily compare product alternatives presented on a mobile app and understand whether a product suits their needs. More specifically, media richness and interactivity may exceed consumers' cognitive capacity if they perceive high complexity when utilizing AR technology. This phenomenon may generate lower telepresence. A lower level of telepresence, in turn, may negatively influence their utilitarian and hedonic values. Therefore, the following hypothesis was developed:

H7. The effects of media richness and interactivity on telepresence are more significant for consumers who perceive low complexity than for those who perceive high complexity. Furthermore, the impact of telepresence on perceived hedonic and utilitarian values is more significant for consumers who perceive low complexity than for those who perceive high complexity.

3. Materials and methods

3.1. Participants characteristics

An online survey was employed using a research company in this study to collect data. According to Statista [1], Asian countries often use a mobile channel for shopping. In particular, mobile transactions generate 65% of e-commerce sales in South Korea. Therefore, consumers in South Korea were deemed appropriate for this study. A total of 279 female consumers participated in the study. The average age was 33.56 ($SD = 7.90$); 37.3% participants were in their 20s ($n = 104$), 35.5% in their 30s ($n = 99$), and 27.2% in their 40s ($n = 76$). Approximately 49.5% of the participants were single ($n = 138$) and 50.5% married ($n = 141$). The majority of the participants (70.6%, $n = 197$) had a bachelor's degree, 17.2% ($n = 48$) had a high school degree, and 11.8% (n = 33) had a master's degree or higher. In terms of occupation, office workers accounted for 47% (n = 131), followed by housewives at 19% ($n = 53$), professionals at 11.8% ($n = 33$), and students at 9.7% (n = 27).

3.2. Procedure

An invitation email including explanations regarding the research objective, instructions to use an accessories shopping app, and the survey link was sent to female jewelry shoppers (especially necklaces and earrings) who had mobile shopping experiences. To achieve external validity, an existing mobile app, "LoLoZem," was used (link is available in Appendix 1). LoLoZem offers fashion products, and AR technology is available for necklaces, earrings, baseball caps, eye glasses, hair pins, scarves, and watch. Once consumers click on a product they want to browse, their mobile camera turns to selfie mode. The product consumers have chosen and their faces are superimposed and can evaluate how the product looks on their faces (screenshot of the LoLoZem app is available in Appendix 2). According to Sedaily [45], the conversion rate from browsing to actual purchase has increased three-fold since LoLoZem adopted AR technology, indicating the stability of the mobile app.

Participants who agreed to take the survey were linked to the instructions to download the mobile app. After downloading the LoLoZem mobile app, they browsed earrings or necklaces and tried one of the products they liked using the AR function. To remove any potential effects that the AR operates slightly different depending on product types, participants were asked to browse necklaces and earrings only. If they have any problems downloading the mobile app or using the AR function, they were guided to contact the research company. After participants finished their shopping, they were guided to complete the survey questions based on their AR experience. At the end of the survey, participants were requested to write the price of the jewelry they decided to purchase.

3.3. Instrument development

All measurement scales were adapted from previous research, with satisfactory reliability (Cronbach's αs >.70). Media richness was assessed using five items adapted from Kim and Ko [16]) and Yim et al. [46] and interactivity was measured with four items in line with Yim et al. [46]. Three items for telepresence were adapted from Kim et al. [7] and the six items for utilitarian and hedonic values were adopted from Childers et al. [29]. Behavioral intentions was measured using three items from Park and Yoo [22] (see Table 1). Face validity was also evaluated by three academic experts and two mobile shoppers who were familiar with AR. The questionnaires were assessed on the criteria that the scale captured cognitive states derived from consumers' AR experiences. Lastly, the four items for task complexity were adapted from Gupta et al. [43]. Participants rated their answers using a 7-point Likert-type scale (from 1 = "strongly disagree" to 7 = "strongly agree").

4. Results

4.1. Preliminary analyses

An exploratory factor analysis (EFA) was conducted to test the dimensionality of the variables: media richness, interactivity, telepresence, utilitarian value, hedonic value, behavioral intentions, and task complexity. All variables yielded one factor. The reliability of the measurements showed internal consistency for the scales (all Cronbach's *alpha*s were greater than.80) (see Table 2). To test the moderating role of task complexity, the mean score of task complexity was averaged and the median was calculated (Med = 3.00). A median split was used to divide the groups into a high task complexity group (N = 137, 49.1%) and a low task complexity group (N = 142, 50.9%). The results of the t-test showed that the two groups had significantly different task complexity scores (M_{high} = 4.29, SD_{high} = 0.91; M_{low} = 2.02, SD_{low} = 0.67; t = −23.85, df = 277, p < .001).

4.2. Confirmatory factor analyses and metric invariance tests

Confirmatory factor analysis (CFA) was used to assess the convergent validity of the measurements. One item from the three hedonic value items was deleted based on the measurement model specification [47]. The fit indices of the measurement model revealed a satisfactory fit to the data: $\chi 2(172) = 340.65$, $p < .001$, root mean square residual (RMSEA) = 0.06, Tucker-Lewis Index (TLI) = 0.95, comparative fit index (CFI) = 0.96, goodness-of-fit index (GFI) = 0.90, adjusted goodness-of-fit index (AGFI) = 0.86. Significant critical ratio (CR) values for the factor loadings showed that convergent validity was achieved (see Table 2). Furthermore, the values of the average variance extracted (AVE) were greater than the coefficients of squared correlations, and the values of correlations were lower than 0.90, supporting discriminant validity (see Table 3). Therefore, the measurement model containing six latent variables and 21 observable variables was used to test the proposed hypotheses. This study compared paths from media richness and interactivity to telepresence and from telepresence to utilitarian and hedonic values across high and low task-complexity groups. Measurement invariance (MI) was tested using multi-group CFA. The first step of the MI test was to examine configural invariance. The

Table 1
Variables and measurements.

Variable	Measurement scales	Adapted from
Media Richness	I thought the product information provided by AR was vivid	Kim and Ko [16], Yim et al. [46]
	I thought the product information provided by AR was rich	
	I thought the product information provided by AR was detailed	
	I thought the product information provided by AR was clear	
	I thought the product features provided by AR were well-defined	
Interactivity	I was in control of my navigation through the AR technology	Yim et al. [46]
	I had some control over the content of the AR technology that I wanted to see	
	I was in control over the pace to watch products	
	The AR technology could respond to my specific needs quickly and efficiently	
Telepresence	I had a sense of the products when I tried on the product using AR	Kim et al. [7]
	I felt I was trying on the products on the mobile app	
	I felt that the products could almost be touched	
Utilitarian Value	Using this app improves my performance in evaluating the product during online shopping	Childers et al. [29]
	I find the app to be useful for online shopping	
	Using the app enhances my effectiveness in online shopping for jewelry	
Hedonic Value	The online shopping experience with the app makes me feel good	
	The online shopping experience with the app is exciting	
	The online shopping experience with the app is enjoyable	
Behavioral Intentions	I would purchase the product that I evaluated in this mobile app providing the AR function	Park and Yoo [22]
	I would recommend this mobile shopping app to a friend or family	
	I would return to this mobile shopping app for jewelry	
Task Complexity	I found this to be a complex task	Gupta et al. [43]
	This task was mentally demanding	
	This task required a lot of thought and problem solving	
	I found this to be a challenging task	

Table 2
Results of the confirmatory factor analysis.

Variable	Unstandardized factor loadings	Standardized factor loadings	Critical Ratio
Media Richness (α = .87)			
M1	.94	.70	12.57
M2	.88	.79	14.87
M3	.99	.83	16.01
M4	.86	.69	12.23
M5	.85	.70	12.59
Interactivity (α = .95)			
I1	.88	.86	17.80
I2	1.01	.94	20.93
I3	1.07	.93	20.23
I4	.91	.90	19.27
Telepresence (α = .88)			
T1	.82	.76	14.17
T2	.88	.75	13.82
T3	.87	.79	15.10
Utilitarian Value (α = .81)			
U1	.99	.78	14.39
U2	1.10	.84	15.55
U3	1.11	.90	17.31
Hedonic Value (α = .82)			
H1	.99	.80	16.32
H2	1.15	.87	14.53
Behavioral Intentions (α = .91)			
B1	1.09	.87	17.96
B2	1.10	.91	19.15
B3	1.10	.84	16.90

Table 3
Correlations and AVEs of latent constructs.

Constructs	(1)	(2)	(3)	(4)	(5)	(6)
(1) Media richness	**.55**					
(2) Interactivity	.48 (.23)	**.83**				
(3) Telepresence	.51 (.26)	.69 (.48)	**.59**			
(4) Utilitarian value	.47 (.22)	.50 (.25)	.55 (.30)	**.71**		
(5) Hedonic value	.53 (.28)	.64 (.41)	.67 (.45)	.42 (.18)	**.70**	
(6) Behavioral intentions	.37 (.13)	.65 (.43)	.60 (.36)	.58 (.34)	.59 (.35)	**.76**

Diagonal values in bold represent the AVE; correlations (squared correlations).

results showed that the forms of the measurement models were the same across the high and low task-complexity groups, supporting configural invariance. Second, metric invariance was tested by measuring the equality of factor loadings between the high and low task-complexity groups. The chi-square differences between the full metric invariance model and the baseline model (i.e., non-restricted model) were significant for the comparisons between task-complexity groups [$\chi^2_d(21) = 56.74, p < .001$]; hence, the full metric invariance model was rejected. Therefore, the partial invariance model was evaluated against the baseline model. The chi-square differences were non-significant; thus, the partial metric invariance model was supported [$\chi^2_d(11) = 14.85, p < .19$].

4.3. Hypothesis testing

Single-group structural equation modeling (SEM) was used to test Hypotheses 1–6. This study addressed the effects of media richness and interactivity on telepresence, the influence of telepresence on hedonic and utilitarian values, and the impact of hedonic and utilitarian values on behavioral intentions. Overall fit indices revealed a satisfactory fit to the data: $\chi^2(180) = 407.05, p < .001$, TLI = 0.94, CFI = 0.95, GFI = 0.88, AGFI = 0.84, and RMSEA = 0.07. The path coefficients of the SEM revealed a significant and positive impact of media richness ($\beta = 0.23$) and interactivity ($\beta = 0.57$) on telepresence, significant and positive impacts of telepresence on utilitarian ($\beta = 0.74$) and hedonic ($\beta = 0.91$) values, and significant and positive impacts of utilitarian ($\beta = 0.43$) and hedonic ($\beta = 0.50$) values on behavioral intentions (see Fig. 2). Therefore, H1–H6 were supported.

H7 examines the moderating effect of task complexity in the relationships among media richness, interactivity, telepresence, hedonic value, and utilitarian value. By conducting multi-group SEM analysis, this study tested the equality of the individual path coefficients across the high and low task-complexity groups. The path coefficient from interactivity to telepresence was significantly higher in the low task-complexity group than in the high task-complexity group [$\chi^2_d(1) = 5.85, p < .05, \beta_{low} = 0.72 > \beta_{high} = 0.47$]. However, the path from media richness to telepresence was not significantly different between the two groups. The path coefficient from telepresence to utilitarian value was significantly higher for the low task-complexity group than for the high task-complexity group [$\chi^2_d(1) = 3.93, p < .05, \beta_{low} = 0.91 > \beta_{high} = 0.53$]. However, the coefficient from telepresence to hedonic value was

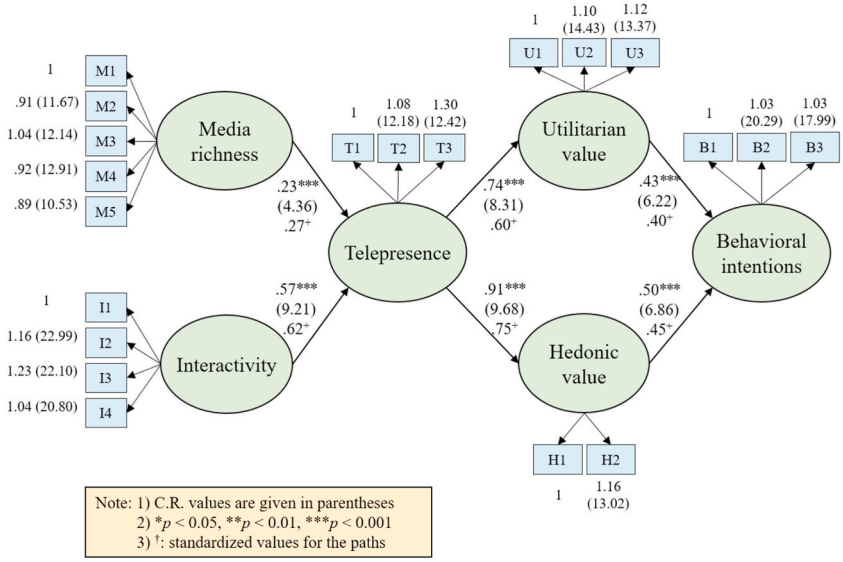

Fig. 2. Results of hypothesis testing for H1–H6.

Table 4
Summary of the results.

Hypotheses	Relationships	Results
H1	Media richness → Telepresence	Supported
H2	Interactivity → Telepresence	Supported
H3	Telepresence → Utilitarian value	Supported
H4	Telepresence → Hedonic value	Supported
H5	Utilitarian value → Behavioral intentions	Supported
H6	Hedonic value → Behavioral intentions	Supported
H7	Moderating effects of task complexity	Partially supported

significantly higher in the high task-complexity group than in the low task-complexity group [$\chi^2_d(1) = 5.33, p < .05, \beta_{low} = 0.74 < \beta_{high} = 1.24$]. Therefore, H7 was partially supported. Results of the hypothesis testing are summarized in Table 4.

5. Discussion

This study examines two predictors of telepresence when consumers use AR technology for digital shopping. In addition, it investigates the effects of telepresence on behavioral intentions through perceived utilitarian and hedonic values. The study's findings suggest that AR's media richness and interactivity positively influence telepresence (H1 and H2). Consumers who perceive media richness and interactivity experience greater telepresence. In other words, while consumers use AR during their online shopping, the degree to which consumers perceive sensory information of the products and control AR for virtual try-on influences their feeling as if the virtual try-on is real and they are present in the virtual store. Overall, the study's results support previous evidence that media richness and interactivity significantly influence telepresence [9,18].

The results further reveal that telepresence stimulated by media richness and interactivity significantly increases behavioral intentions through consumers' perceived values (H3 and H4). Consumers who feel that shopping with AR in the virtual space is similar to real physical shopping, allowing inspections of the products, experience greater utilitarian and hedonic values. In addition, consumers who experience greater telepresence perceive AR technology as satisfactory in showing the functional features of a product. Furthermore, they perceive that shopping with AR is entertaining and fun. Hence, they exhibit greater intentions to purchase the product, recommend the mobile app to friends or family, and revisit the mobile app offering AR technology (H5 and H6).

Lastly, the study's results reveal whether individuals' perceived task complexity moderates the relationships between media richness and telepresence, interactivity and telepresence, telepresence and utilitarian value, and telepresence and hedonic value (H7). Interactivity has a significantly different effect on telepresence for the high and low task-complexity groups. However, the impact of media richness on telepresence does not differ between the two groups. Interactivity is a critical predictor of telepresence for consumers in both high and low task-complexity groups. The effect is significantly greater for consumers in the low task-complexity group. The perception that the consumer can control AR technology for a product trial is more likely to increase the feeling of reality for consumers who perceive low task complexity than those perceiving high task complexity.

Concerning the moderating roles of task complexity in the relationship between telepresence and perceived values, the effect of telepresence on utilitarian value is greater for consumers with low complexity perception than those who perceive high complexity. In

other words, the perception that AR experience is real is more likely to facilitate understanding of the product's functional features and increase utilitarian value for the low task-complexity group. However, in contrast with the proposed hypothesis, the effect of telepresence on hedonic value is greater for consumers with high complexity perception. Perhaps consumers in a high complexity group experience difficulties in perceiving product-related value (i.e., utilitarian value) despite realistic AR experiences. However, they can enjoy the AR function without focusing on the product (i.e., increasing the hedonic value). This finding can be explained by Jiang and Benbasat's study [48], which reported that product presentation providing more sensory cues, such as videos, is more attractive and enjoyable. This experience is less likely to be affected by consumers' inattention due to the high task complexity. Similarly, AR technology allows consumers to experience sensory cues and engage with them. Thus, consumers' hedonic value is less likely to be affected by high task complexity, whereas high complexity negatively influences utilitarian value.

Another possible explanation for this result lies in the individual's level of product involvement. Consumers' high involvement and telepresence may help them perceive low complexity in AR and increase their motivation to process product information, thus increasing utilitarian value. However, low involvement and telepresence may increase complexity perception and reduce motivation to process product-related information. Moreover, according to the elaboration likelihood model [49], consumers in a low involvement group are more likely to be persuaded by peripheral cues (e.g., entertaining features of AR) rather than central cues (e.g., product information), ultimately increasing hedonic value. Further research should investigate an individual's level of product involvement and perceived task complexity to precisely identify their moderating roles in the relationship between telepresence and perceived values.

6. Conclusions

The current research findings offer practical and theoretical implications helping researchers and digital retailers assess the effectiveness of AR technology. First, this study contributes to the extant literature on AR and virtual experiences by supporting telepresence theory [9] and media richness theory [17]. The study's findings highlight the significance of telepresence when consumers use AR for digital shopping, showing that telepresence increases behavioral intentions through perceived utilitarian and hedonic values. In other words, telepresence allows consumers to feel as if they are trying on the product displayed on the website. Previous research on telepresence has focused on VR experiences in digital shopping [7,10,16]; however, studies on the effects of telepresence of AR on consumer responses are limited. Telepresence is critical for shopping with AR, helping provide realistic virtual try-on experiences, perceived as substitutes for the real experience. This study provides empirical evidence that telepresence increases perceived value in AR, for which limited evidence exists in the literature. Thus, the study contributes to filling the gap in research regarding telepresence and consumer responses.

This study's findings help digital retailers precisely assess the importance of telepresence by offering evidence that telepresence increases perceived value and behavioral intentions. Digital retailers need to adopt interactive and vivid AR technology to help consumers evaluate products and enjoy online shopping. The results of this study provide a valuable opportunity for digital retailers to address consumers who are not fully satisfied with the quality of AR, uncovering the potential for better use of AR [50]. Although this study uses jewelry products to test the effects of AR, the results may be extended to other product categories, such as cosmetics, glasses, shoes, and furniture. Following the COVID-19 pandemic, consumers' anxiety about physical shopping has increased, and physical try-on of jewelry, glasses, and cosmetics is more difficult due to hygiene concerns. The effective use of AR can help consumers virtually test various products and assist them in decision-making.

This study has the limitation of only addressing female consumers in South Korea. Although this group represents a typical sample of digital shoppers [1], they may not describe other groups' digital shopping behaviors for jewelry products. Future research should test different groups of consumers to enhance the generalizability of this study's results. This study only uses jewelry to test the effects of AR on consumer responses because jewelry products are familiar to most female consumers and easily applied to consumers' faces using AR technology. Future research may need to consider other product categories, such as shoes or furniture, to further support the findings of this study.

Lastly, as previously mentioned, future research needs to examine the moderating effects of task complexity and involvement in the relationship between telepresence and hedonic value. This study assumes that the contradictory finding in this respect may partially result from the impact of an individual's involvement level, in addition to task complexity. Thus, exploration of the role of involvement may provide valuable insights for scholars and practitioners.

Author contribution statement

Jungmin Yoo: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

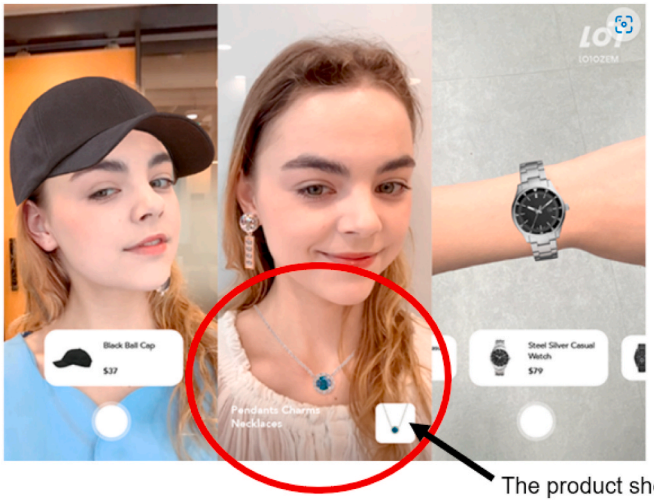
The data that has been used is confidential.

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

A.1. Links to mobile application.
Warby Parker: https://www.warbyparker.com/app.
IKEA: https://apps.apple.com/us/app/ikea-place/id1279244498.
Home Depot: http://www.homedepot.com/c/SF_Mobile_Shopping.
Sephora: https://apps.apple.com/us/app/sephora-cosmetics-fragrance/id1472335881.
Kohl's: https://apps.apple.com/app/id472014516.
Levi's: https://apps.apple.com/gb/app/levis/id1270092335.
LoLoZem: https://apps.shopify.com/lolozem-webar?locale=ko.
A.2. Screenshot of AR app.



AR technology in LoLoZem is available for necklaces, earrings, baseball caps, eye glasses, hair pins, scarves, and watch. This study used earrings or necklaces only [51].

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