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The Effect of Augmented Reality Interactivity on Consumer Brand Engagement — A Chain Mediating Model

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Abstract: - The use of augmented reality (AR) technology has changed the way companies and consumers engage with brands. Although some theoretical literature points out that the interactivity of augmented reality helps to improve consumer brand engagement, there is a lack of systematic empirical research on how the interactivity of augmented reality affects consumer brand engagement through process mechanisms. Based on the understanding of existing research gaps, relying on the theory of social presence and brand authenticity and 368 online questionnaire data, we constructed a structural equation model containing the chain mediation effect, and explored the chain mediation effect of social presence and perceived brand authenticity, as well as the moderating effect of psychological ownership and self-consistency. The results indicated that (1) augmented reality interactivity had a significant positive effect on consumer brand engagement; (2) social presence and perceived brand authenticity had a significant positive effect on consumer brand engagement; (3) social presence and perceived brand authenticity partially mediated between augmented reality interactivity and consumer brand engagement, and together they acted as a chain mediator; and (4) Psychological ownership positively moderates the relationship between social presence and consumer brand engagement; (5) Self-congruence positively moderates the relationship between perceived brand authenticity and consumer brand engagement; and (6) Consumer brand engagement has a significant positive effect on word-of-mouth communication and brand use intention. This study enriches the research on the interface between augmented reality technology and brand management, and provides practical significance for enterprises to utilize AR technology for brand marketing.

Keywords: Augmented reality interactivity; Consumer brand engagement; Brand authenticity; Social presence; Self-congruence; Psychological ownership

I. INTRODUCTION

Due to rapid technological advancements, companies now have a wider range of digital initiatives to present their products in a more convincing manner. Augmented Reality (AR) as an emerging technology has garnered significant attention from numerous enterprises. Research by Piancatelli have indicated that enterprises have transformed the manner in which consumers acquire products and services by harnessing AR technology[1][1]. Cosmetic firms like Dior and Gucci have implemented AR mirrors, affording clientele the opportunity to engage in virtual facial makeup experiences. Many Chinese companies, including Baidu, Tencent, JD.com, Taobao, and Dewu, have actively ventured into artificial intelligence domains such as Augmented Reality (AR), Virtual Reality (VR), Extended Reality (XR), and Metaverse. Recent market research forecasts an AR market size of $300 billion by 2025, with $11.4 billion allocated to the retail sector [1][2]. Thus, AR technology has become a new branding and marketing tool for enterprises to interact with customers uniquely and vividly [1][3]. In this context, exploring how AR technology promotes digital branding, supports advertising campaigns, and enhances consumer shopping experiences has become a forefront issue in the marketing field.

Augmented Reality is characterized as a digital technology that integrates computer-generated data, including images and auditory components, with real-world environmental data derived from the user. Essentially, AR serves as a means to seamlessly superimpose virtual information into a user's perceptual reality, as elucidated by Arindam[1][4]. Previous research has demonstrated that the interactivity of AR applications significantly affects consumer attitudes and behavioral intentions[1][5]. While the majority of scholars have delved into the examination of how AR interactivity influences consumer behavior, there has been limited research exploring how these effects influence consumer brand engagement in an AR context. Investigating the process mechanisms help better understand how consumer brand engagement is driven through AR interactivity.

In a dynamically competitive market, retaining customers for the long term is a challenging task, and businesses need to focus on developing strong consumer brand relationships. Therefore, the concept of Consumer Brand Engagement (CBE) has garnered escalating attention from both researchers and managerial circles.

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Perceived brand authenticity, viewed as a consumer's perception of a brand's authenticity, has become an important purchasing criterion beyond factors like product quality and cost[1][6]. Previous research has examined the influence of brand authenticity on consumer brand engagement[1][7], but whether AR interactivity can act as a precursor to brand authenticity has not been explored. Understanding the role of AR interactivity in attracting consumers in a more comprehensive way becomes essential for managers. Although perceived brand authenticity can indeed function as a pivotal antecedent variable for Consumer Brand Engagement (CBE), it fails to provide a comprehensive elucidation of a fundamental determinant in consumer-brand associations, specifically, self-congruence. Self-congruence accentuates the harmonious alignment between a consumer's self-concept and the brand's image. Several scholars have proffered empirical support for the favorable impact of self-congruence theory on consumer behavior[1][8]. Nevertheless, research concerning self-congruence as a moderating variable within AR environments remains notably underexplored, necessitating further inquiry and investigation.

The social presence theory suggests that a medium's social presence influences a recipient's understanding of the content produced by the sender, thereby enhancing the feelings consumers experience during social interactions, which could potentially increase their involvement in online brand engagement activities produced by companies[1][9]. At present, research exploring the influence of social presence on consumer brand engagement predominantly concentrates on social media and online shopping websites. There exists a scarcity of research that delves into the role of social presence in consumer brand engagement within augmented reality environments. Managers should provide consumers with reasons to improve product attitudes and enhance purchase intentions, such as by increasing consumers' psychological ownership. Psychological ownership can describe the feeling that something belongs to "me"[1][10]. Brengman and Van demonstrated that AR technology can elicit a heightened sense of ownership when compared to conventional e-commerce experiences via smartphones[1][11]. Despite its manifest significance, the body of marketing literature pertaining to psychological ownership remains limited[1][12], and there is a dearth of research exploring how psychological ownership in AR environments influences the impact of social presence on consumer brand engagement. This study, in an augmented reality context, will examine the role of social presence in consumer brand engagement from the perspective of Social Presence Theory, revealing the mechanisms and boundary conditions through which social presence affects consumer brand engagement, and further clarifying the moderating effects of psychological ownership on social presence.

In summary, current research on augmented reality brand marketing primarily focuses on consumer attitudes and behavioral responses, but there is no systematic explanation or empirical research regarding the potential mechanisms through which augmented reality interactivity affects consumer brand engagement. Therefore, this study constructs a structural equation model that includes a chain-mediated effect to theoretically reveal why and how augmented reality interactivity, social presence, and perceived brand authenticity affect consumer brand engagement and explores the positive word-of-mouth and brand usage intentions generated by CBE. Furthermore, this study delves into the moderating impacts of psychological ownership on social presence, as well as self-congruence on perceived brand authenticity, within the augmented reality milieu. The findings of this research enrich the related studies on augmented reality marketing, expand the existing literature pertaining to the precursors and outcomes of consumer brand engagement within augmented reality environments, and provide meaningful guidance and insights for managers to effectively use augmented reality for brand marketing.

II. THEORETICAL REVIEW AND RESEARCH HYPOTHESES

A. Augmented Reality Interactivity and Consumer Brand Engagement

Augmented Reality (AR) is widely regarded as an exceptionally promising technology within the retail and e-commerce domains. This technology empowers consumers to superimpose virtual products onto their own bodies or into their immediate surroundings, thereby creating a perceptual experience that seamlessly integrates these products with the tangible world[1][13]. In general, human behaviors involve extent elements of interaction, and interactions with people, environments, the internet, advertisements, and various other objects are all about interactivity[1][14]. Augmented reality technology, for example, possesses the capacity to introduce three-dimensional virtual content, encompassing images, objects, or informational elements, and seamlessly integrate them into a consumer's tangible real-world environment. Earlier studies have demonstrated that augmented reality technology generates a heightened degree of interactivity when juxtaposed with other forms of digital media [1][15]. This elevated interactivity level exhibits a close association with consumers' experiences and serves as a substantial catalyst for evoking emotional, behavioral, and cognitive responses in consumers[1][3]. This paper posits that in scenarios involving consumers' engagement with augmented reality technology, the interplay between the physical and virtual realms facilitates the presentation of a more varied and enhanced content in a

blended state between the tangible real world and the virtual domain, ultimately culminating in a distinctive user experience.

Consumer Brand Engagement (CBE) has garnered escalating attention in both practical and scholarly domains in recent years. Previous research by Brodie has shown that consumer engagement is a psychological state or behavioral expression of customers[1][16]. This psychological state of engagement arises through consumer interaction and co-creation with a specific brand. Behavioral expressions of consumer engagement occur when individuals are willing to engage in interactive experiences with an object, such as a brand, organization, or stakeholder. Hollebeek[1][17]incorporated Brodie[1][16]definition of CBE, amalgamating insights from three theoretical frameworks to expound upon the concept of CBE. These frameworks encompass relationship marketing, the service-dominant logic perspective, and social exchange theory. The authors scrutinized various facets of consumer brand engagement and formulated a novel definition for it, specifically as "consumer involvement in brand-related activities that yield positive cognitive, emotional, and behavioral brand-related responses." They operationalized CBE as a multifaceted construct encompassing dimensions of cognition, affect, and activation. The advancements in digitization have propelled the integration of AR into marketing strategies across multiple touchpoints in the consumer journey, spanning both offline and online domains[1][3].

Although offline retail environments provide consumers with numerous sensory-rich opportunities, the online retail space still lacks a genuine and interactive multisensory experience. Fan contended that through the integration of AR[1][18], retailers can bridge the divide between offline and online experiences, harmonizing the two realms and enabling consumers to maintain realistic product expectations. Therefore, in this study, AR is considered to have advanced in visualizing and interactivity with online products, resulting in higher consumer engagement compared to traditional offline marketing experiences. Consequently, this study puts forth the following hypothesis:

H1: Augmented Reality interactivity positively influences consumer brand engagement.

B. The Mediating Role of Social Presence

The concept of social presence initially emerged as a stable attribute of media and was defined as the importance of relationships in mediated interpersonal interactions, focused mostly on the idea of "perceiving the presence of others"[1][19]. The term "social presence" came from theories of interpersonal interaction in the field of social psychology. According to McLean and Osei-Frimpong[1][9], social presence can be broken down into three levels: mutual social presence, also known as interpersonal social presence, which clarifies the dynamic interaction between participants; subjective social presence, which is represented by judgments of the accessibility of others' psychological behaviors; and individual perception of a shared sense of co-presence. Augmented reality makes internet purchasing more personalized when compared to conventional offline shopping. Lots of online merchants have made an effort to give customers satisfying augmented reality buying experiences in recognition of the importance of "shopping as an experience". Although there are restrictions when employing augmented reality as a commerce channel, interventions made through social presence can forge deeper and richer connections with customers. A qualitative study on the connection between social presence and CBE was also carried out by Pongpaew[1][20], and the results showed that businesses with highly functional social presence on their Facebook pages promoted different CBE (cognition, emotion, and behavior) dimensions. In the augmented reality marketing environment, this study considers social presence as a stimulating perception, which can accelerate consumers' imaginative and social interaction capabilities in the physical world. This strong sense of social presence can influence consumers' psychology and behavior through certain mechanisms. Therefore, we propose the following hypotheses:

H2: Social presence positively influences consumer brand engagement.

H3: Social presence mediates the relationship between augmented reality interactivity and consumer brand engagement.

C. The Mediating Role of Perceived Brand Authenticity

Due to market homogeneity, consumers tend to favor authentic consumption experiences when making purchasing decisions[1][21]. Therefore, it is essential to comprehend the connection between improving customer brand experiences and interactions and brand authenticity. Consumers' subjective evaluations and judgments of a brand's authenticity are referred to as consumers' perceived brand authenticity (PBA) [1][22]. Through diagnostic data and cues offered by brand marketing communication, consumers assess brand authenticity in marketing operations.

Brand authenticity is not about the quality of the product itself but rather about how the product aligns with the core values of the brand. Bruhn[1][23]proposed four dimensions of perceived brand authenticity: (1) continuity, indicating long-term stability; (2) originality, referring to perceptions of creativity and innovation; (3) credibility, focusing on reliability and keeping promises; and (4) naturalness, reflecting perceptions of sincerity. Conceptually, PBA is closely related to the traditional brand, both of which reflect the potential for a brand's sustained existence in the future. The conceptualizations of PBA advanced by Bruhn and Kumar serve as the foundational frameworks employed in this research[1][7][1][23].

Previous research has found that positive interactions with a brand can make consumers feel more respected and increase trust in the brand[1][8], forming the theoretical foundation for the relationship between interactivity and authenticity. Because trust and authenticity are positively related, this suggests that augmented reality interactivity may enhance consumers' perception of brand authenticity. Furthermore, other studies have demonstrated a strong effect of interaction on authenticity. For instance, research by Moon[1][24]during the COVID-19 epidemic discovered that interaction improved people's perceptions of authenticity in a favorable way. However, in the case of augmented reality, more research on the link between interaction and authenticity is required. According to prior studies, customers are more attracted to and prefer authentic products, which promotes a development of consumer-brand interactions[1][25]. Brand authenticity provides consumers with targets for self-assessment, including control (i.e., a willingness to respond to individual sovereignty), connection (to places, others, and social interaction), and morality (judging their "true selves" based on their moral values). Numerous studies have affirmed that brand authenticity holds the potential to exert a positive impact on brand choice likelihood, foster brand attachment, commitment, and loyalty[1][26][1][27], thereby promoting the extension of consumer-brand relationships. According to Fritz[1][28], brand attachment refers to emotional ties and reactions to the brand that may be brought on by quality, emotional experiences, or brand trust. Stronger emotional bonds are fostered by perceived brand authenticity, which also improves consumer loyalty and raises tolerance for unfavorable brand experiences. Based on the aforementioned findings, the research predicts that consumer assessments of the brand and continued customer engagement would be impacted by customers' perceptions of the authenticity of brand AR digital interaction initiatives. Therefore, this study proposes the following hypotheses:

H4: Perceived brand authenticity has a positive impact on consumer brand engagement.

H5: Perceived brand authenticity mediates the relationship between augmented reality interactivity and consumer brand engagement.

D. The Chain Mediating Role of Social Presence and Perceived Brand Authenticity

Based on the social presence - perceived brand authenticity model, this study posits that there are two pathways through which augmented reality interactivity influences consumer brand engagement: social presence and perceived brand authenticity. On one hand, the brand experience facilitated by augmented reality interactivity immerses consumers in an environment conducive to social interaction, positively impacting social presence. Positive cognitive, emotional, and behavioral responses arising from social presence contribute to brand relationships, trust, and satisfaction, leading to positive gains in consumer brand engagement. On the other hand, perceiving augmented reality interactivity engages consumers in a highly interactive social environment. Continuous bidirectional interaction makes consumers feel more respected, which increases trust in the brand. The feeling of being respected becomes more prominent, thereby enhancing perceived brand authenticity, fostering stronger emotional bonds, and consequently exerting a positive influence on consumer brand engagement activities. Furthermore, Jin[1][29]revealed a positive correlation between social presence and brand trust. Therefore, higher levels of social presence may reduce the social distance between consumers and the brand, enhancing emotional connections, which may positively impact consumers' perception of brand authenticity. Hence, this study proposes the following hypothesis:

H6: Augmented reality interactivity positively influences consumer brand engagement through the chain mediating role of social presence and perceived brand authenticity.

E. Consumer Brand Engagement and Consumer Behavioral Responses

Following Baker[1][30]definition of word of mouth as "the exchange of information between two or more non-commercially motivated consumers," this study defines brand-related word-of-mouth communication as information exchange among consumers, particularly regarding brands. Word-of-mouth promotion, especially among brands, is seen as a crucial component of customer interactions in the literature on consumer engagement marketing[1][31]. Consumer interactions make it possible to recommend goods and services and exchange brand knowledge. Such exchanges facilitate social interactions for consumers and other stakeholders, creating more

opportunities and collectively generating more positive consumer experiences[1][32]. Word of mouth may influence customer choice positively in the context of augmented reality marketing since individuals seek out word of mouth to eliminate uncertainty in their purchases.

According to Harrigan[1][33], brands that consumers believe are relevant to their cognition, emotions, and behavior are more likely to be interacted with by them. Owing of the higher spiritual value, some brands are preferred by customers. Positive attitudes and confidence in the brand, influenced by consumer brand engagement, affect brand usage intent. consumers only maintain emotional contact with brands in social media contexts, which results in greater motivation future plans to use the brand[1][17].Additionally, researchers have noted that consumer brand engagement strengthens the bond among consumers and brands[1][16]. Therefore, consumer engagement with a brand via augmented reality smartphone apps could enhance this relationship, which may in turn influence their intent to use the brand.

Based on this, the following hypothesis is proposed:

H7a: Consumer brand engagement has a positive impact on word of mouth.

H7b: Consumer brand engagement has a positive impact on brand usage intent.

F.   The Moderating Role of Psychological Ownership

The theory of psychological ownership comprises cognitive and emotional dimensions and can explain the individual's connectedness to objects in a business context. Psychological ownership, which is defined by Fan[1][18], is a relationship that represents the level of intimacy among a person and an object (tangible or intangible). Gineikiene[1][34]posit that psychological ownership is rooted in an individual's inherent drive to establish connections between various entities and their self-identity, perceiving these entities as extensions of themselves. At the heart of psychological ownership lies the sensation of possessing the target object, encapsulated by the query, "I feel that this thing is mine." This sentiment signifies a profound connection between the individual and the object. In situations characterized by high psychological ownership, individuals experience a strong sense of connection with objects, while in contexts with low psychological ownership, they struggle to establish such a connection. Furthermore, a wealth of research robustly substantiates the tendency of individuals to favor objects they discern as endowed with a dimension of psychological ownership. Kamleitner and Feuchtl[1][35]further elucidated this phenomenon by positing that consumers forge emotional bonds with these focal objects.

The present study hypothesizes that psychological ownership is poised to significantly enhance consumer preferences. Consumers may perceive products designed by companies as contributions they have made to the design process, thereby fostering a heightened sense of authorization and responsibility in the decision-making process. This perception of psychological ownership has the potential to engender positive attitudes. Carrozzi[1][12]conducted a recent study that demonstrated how augmented reality (AR) contributes to the cultivation of consumer psychological ownership. This study believes that AR technology allows consumers to virtually touch products, superimposing virtual images into real contexts, thereby enhancing the tangibility of products. Therefore, consumers using AR applications may experience higher psychological ownership, strengthening interaction and communication between consumers and products. Based on this, the following hypothesis is proposed:

H8: Psychological ownership positively moderates the influence of social presence on consumer brand engagement.

G.   The Moderating Role of Self-Congruence

According to Zogaj[1][36]formulation of the self-congruence theory, consumers evaluate their self-concept in connection to a product's consumer image. As defined by Malär[1][37], self-congruence can be measured as "the degree to which consumers perceive alignment between a brand's image and their own self-concept". Self-Congruence is a symbolic concept that captures the perceived resemblance between an individual's personality and an organization's personality[1][38]. Hence, self-congruence is founded on perceiving the brand as a holistic concept that goes beyond the brand's physical attributes. Prior research has underscored the positive impact of Self-Congruence on individual behaviors, such as brand loyalty, because a higher degree of Self-Congruence engenders a sense of alignment and accord with the brand[1][39]. Consequently, Self-Congruence strengthens the bond between consumers and the brand. Within the realm of augmented reality interaction, this study posits that a greater alignment between a consumer's self-concept and the brand image corresponds to a stronger emotional connection between the consumer and the brand. This heightened connection could further encourage participatory behaviors as an expression of emotional attachment. As a result, consumers may exhibit an increased willingness to engage with a brand they perceive as authentic. Accordingly, the following hypothesis is proposed:

H9: Self-Congruence positively moderates the influence of perceived brand authenticity on consumer brand engagement.

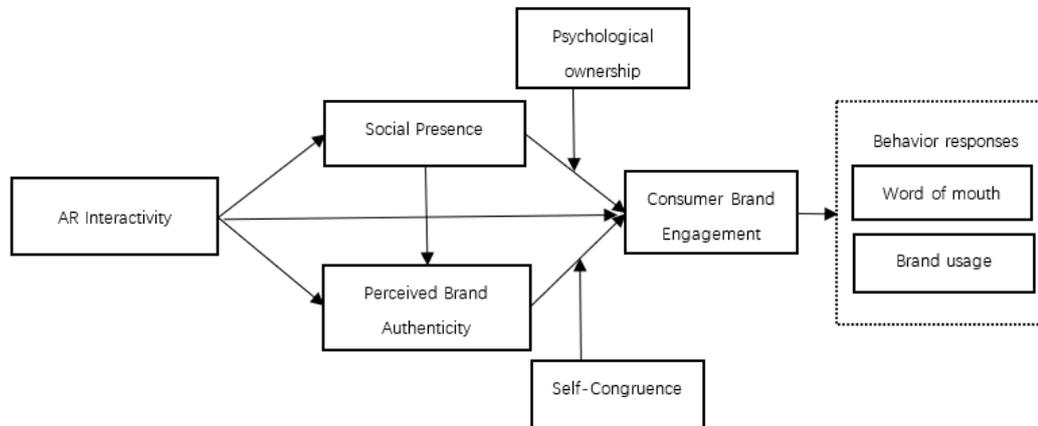The conceptual model of this study is shown in Figure 1:

Fig.1. Conceptual Model

III. EMPIRICAL RESULTS

H. Sample and Variable Measurement

The subjects of this research were individuals who have used or are familiar with AR technology and have had shopping experiences related to it. We collected a total of 496 questionnaires online through Wenjuanxing (One of the largest online data platforms in China). Following the exclusion of incomplete and randomly answered questionnaires, we obtained 368 valid responses, resulting in an effective response rate of 74.2%. The effective sample size is approximately 8.3 times the number of measurement items. Table 1 displays the demographic characteristics of the sample. Among the questionnaires received, the majority (71%) were completed by respondents aged 20-29. Furthermore, it is noteworthy that 94% of the respondents possessed a bachelor's degree or higher. Approximately 48.4% of the respondents identified as students, while the remaining 51.6% were from various professions, with teachers and researchers, as well as corporate employees, being the main occupational categories. Regarding the frequency of AR usage, the majority of respondents reported using AR technology multiple times per month and expressed confidence in their AR usage. Additionally, most respondents cited motivations for using AR, including browsing, information searching, product purchasing, and entertainment.

In this study, research variables were assessed using a 5-point Likert scale, which was subjected to refinement and improvement through the process of reverse translation and group discussions. The measurement scale for augmented reality interactivity was adapted from Hasan[1][40], consisting of 5 items. The scale for social presence, consisting of 4 items, was adapted from Algharabat[1][42]. The measurement scale for perceived brand authenticity was primarily adapted from Bruhn[1][23], containing 14 items. The consumer brand engagement scale, which comprised 6 items, was adapted from Kumar and Kaushik[1][7]. The psychological ownership scale was adapted from Yuan[1][42]and included 3 items. The Self-Congruence scale was primarily adapted from Kumar and Kaushik[1][7] containing 4 items. The word-of-mouth scale was adapted from Park[1][43]and included 4 items. The brand usage intention scale was adapted from Hollebeek[1][17]and included 4 items.

I. Reliability and Validity Analysis

The data were analyzed using SPSS 25.0 and AMOS 25.0 software. As depicted in Table 2, the Cronbach's α values for the primary variables in this study exceed 0.7, the factor loadings for each variable surpass 0.5, and the composite reliability (CR) values are also greater than 0.7, indicating strong reliability for each variable. Furthermore, the composite reliability for each variable exceeds 0.8, signifying a high level of internal consistency. Regarding validity, theconfirmatory factor analysis (CFA) was conducted. The fit indices for the measurement model indicate a favorable fit (CMIN/DF = 1.164, RMSEA = 0.021, RMR = 0.034, IFI = 0.987, TLI = 0.985, CFI = 0.987).

Table 3 presents the results of the discriminant validity test, displaying the correlation coefficients between variables. The diagonal of the table shows the square root of the average variance extracted (AVE) for each variable. It can be observed that the square root of AVE for each variable is greater than the absolute value of its corresponding correlation coefficient, indicating that each variable has good discriminant validity.

Table 1. Demographic statistics of survey samples (n = 368).

Sample characteristics	Classification criteria	Number	Proportion/%	Sample characteristics	Classification criteria	Number	Proportion/%
Gender	male	195	53.0%	Monthly income/yuan	Less than 3,000	170	46.2%
	Female	173	47.0%		3000-5999	53	14.4%
Age	Under20	13	3.5%		6000-8999	68	18.5%
	20-24years old	165	44.8%		More than 9,000	77	20.9%
	25-29years old	98	26.6%	Frequency of AR Usage	Multiple times per day	22	6.0%
	30-40years old	63	17.1%		Once per day	43	11.7%
	Over40	29	7.9%		Multiple times per week	82	22.3%
Education	Junior or below	22	6.0%		Once per week	42	11.4%
	Underguaduate	181	49.2%		Multiple times per month	179	48.6%
	Master	120	32.6%	Confidence in AR Usage	Extremely confident	53	14.4%
	Doctor	45	12.2%		Confident	153	41.6%
Occupation	Full-time studen	178	48.4%		Average	113	30.7%
	Full-time student	74	20.1%		Not confident	37	10.1%
	Civil servant	15	4.1%		Extremely not confident	12	3.3%
	Enterprise staf	64	17.4%	Motivation for AR Usage	Browsing, Information Search	207	56.3%
	Professional	13	3.5%		Purchase	242	65.8%
	Other	24	6.5%		Fun/Entertainment	205	55.7%
					Other	33	9.0%

Table 2. Measurement Items and Validity Assessment(n=368).

α, CR, AVE	Measurement items	Factor loadings
AR interactivity α=0.924 CR=0.923 AVE=0.707	By interacting with the virtual product demonstration in the augmented reality application, I can have a deep understanding of the product.	0.851
	Virtual product demonstration in augmented reality applications has remarkable interactive function.	0.844
	I can interact with virtual product demonstrations in augmented reality applications to get information that suits my specific needs.	0.830
	The interaction with virtual product demonstration in augmented reality application is excellent.	0.847
	I can accurately describe how I interact with augmented reality applications.	0.834
Social presence α=0.912 CR=0.912 AVE=0.721	Augmented reality applications give me a sense of physical interaction with objects.	0.848
	Augmented reality applications create a sense of warmth in interpersonal communication.	0.837
	Augmented reality applications make me feel like I am interacting with objects (or people).	0.865
	Augmented reality applications provide me with a sense of realism and vividness.	0.848
PBA- Credibility α=0.844 CR= 0.850 AVE=0.653	When I use augmented reality applications, I feel that this brand is trustworthy.	0.816
	When I use augmented reality applications, I believe that this brand will not betray me.	0.815
	I feel that this brand demonstrates its higher value proposition through augmented reality.	0.794

PBA-Continuity α=0.883 CR=0.892 AVE=0.674	I think this brand has a historical background.	0.811
	I think this brand is timeless.	0.801
	I think this brand can withstand the test of time.	0.828
	I think this brand can thrive in the ever-changing trends.	0.844
PBA-Originality α=0.896 CR=0.878 AVE=0.644	I find this brand to be distinct from others.	0.838
	I think this brand can stand out in competition with other brands.	0.797
	I think this brand is unique.	0.817
	I find this brand distinctly different from others.	0.755
PBA-Naturalness α=0.832 CR=0.844 AVE=0.643	I think this brand doesn't appear fake.	0.829
	I believe this brand leaves a genuine impression.	0.775
	I think this brand leaves a natural impression.	0.802
Consumer brand engagement α=0.910 CR=0.910 AVE=0.629	When I use this brand, I feel very positive.	0.792
	Using this brand makes me feel very happy.	0.715
	When I use this brand, I feel very good.	0.818
	Compared to other brands, I spend more time using this brand.	0.815
	Whenever I use a product, I usually choose this brand.	0.811
	This brand is one of the brands I usually use.	0.803
Self-Congruence α=0.898 CR=0.898 AVE=0.689	The message conveyed by this brand aligns with my self-perception.	0.869
	The personality of this brand is close to my own personality.	0.828
	I feel like this brand knows my thoughts, like a mirror image of myself.	0.835
	I feel an emotional connection with this brand.	0.786
Psychological ownership α=0.898 CR=0.899 AVE=0.748	When I use augmented reality applications, I feel like the target object (or part of the target) is mine.	0.896
	I feel a strong sense of personal ownership of the products in augmented reality applications.	0.838
	I feel like these products belong to me.	0.86
WOM α=0.892 CR=0.893 AVE=0.675	I would speak positively about this online retailer/brand to others.	0.828
	I would recommend this online retailer/brand to people seeking my advice.	0.819
	I would encourage friends and relatives to do business with this online retailer/brand.	0.812
	I want to share information about this online retailer/brand's products or services with my friends on social media.	0.827
Brand Usage Intent α=0.890 CR=0.891 AVE=0.671	After getting to know this brand, I believe that using this brand is meaningful.	0.839
	Even if another brand offers the same features as this brand, I am more inclined to use this brand because I have experienced it through the AR app.	0.824
	If there are other brands equally as good as this brand, I still prefer to use this brand because I have had an AR app experience with it.	0.801
	If another brand is indistinguishable from this brand in any aspect, it seems wiser to use this brand because I have gained insights about it through the AR application.	0.812

Table 3. Correlations and Discriminant Validity Test

Variable	ARI	SP	PBA	CBE	PO	SC	WOM	BUI
ARI	0.841							
SP	0.583***	0.849						
PBA	0.57***	0.555***	0.714					
CBE	0.507***	0.496***	0.596***	0.793				
PO	0.118*	0.268***	0.161*	0.328***	0.865			
SC	0.287***	0.306***	0.388***	0.463***	0.237***	0.830		
WOM	0.184**	0.226***	0.279***	0.257***	0.173**	0.234***	0.822	
BUI	0.123**	0.187**	0.275***	0.294***	0.129**	0.187**	0.587***	0.819

Note: ***p < 0.001,**p < 0.01,*p < 0.05; Diagonal cells in bold report the square root of AVE

J. Structural Equation Model and Path Analysis

The measurement model demonstrated a strong fit (CMIN/DF = 1.718, RMSEA = 0.044, RMR = 0.085, IFI = 0.965, TLI = 0.960, CFI = 0.964). Table 4 presents the results of SEM regression estimates.

Table 4 . SEM Regression Estimates

Path	Hypotheses	Estimate	S.E.	C.R.	P
ARI→CBE	H1	0.176	0.056	2.686	0.007**
ARI→SP	*	0.583	0.054	10.725	***
ARI→PBA	*	0.374	0.045	5.417	***
SP→PBA	*	0.337	0.045	4.916	***
SP→CBE	H2	0.171	0.056	2.64	0.008**
PBA→CBE	H4	0.406	0.099	5.449	***
CBE→WOM	H7a	0.282	0.063	4.889	***
CBE→BUI	H7b	0.312	0.064	5.421	***

Note: ***$p < 0.001$,**$p < 0.01$,*$p < 0.05$.

The results indicate that the path coefficients of augmented reality interactivity on consumer brand engagement are significantly positive ($\beta = 0.176$, $P < 0.01$), confirming Hypothesis H1. Similarly, the path coefficients of social presence on consumer brand engagement are significantly positive ($\beta = 0.171$, $P < 0.01$), validating Hypothesis H2. Additionally, the path coefficients of perceived brand authenticity on consumer brand engagement are significantly positive ($\beta = 0.406$, $P < 0.001$), confirming Hypothesis H4. Furthermore, the path coefficients of consumer brand engagement on word-of-mouth are significantly positive ($\beta = 0.282$, $P < 0.001$), verifying Hypothesis H7a. Finally, the path coefficients of consumer brand engagement on brand usage intention are significantly positive ($\beta = 0.312$, $P < 0.001$), confirming Hypothesis H7b.

K. Mediation Effects Testing

To test for mediation and chain mediation effects, we conducted Bootstrapping analysis in Amos 25.0. We performed 5000 repeated samplings on the valid samples to construct a 95% bias-corrected confidence interval. The results are presented in Table 5.

Table 5. AMOS Mediation Analysis Results

	Bootstrap(Bia-corrected 95%)					
Effect types	Effect	SEffect	BootSE	BootLLCI	BootULCI	Percentage of Total Mediation Effect
Total effect	0.438	0.507	0.058	0.389	0.62	
Direct effect	0.152	0.176	0.07	0.049	0.325	
Total indirect effect	0.286	0.331	0.057	0.225	0.447	
ARI→SP→CBE	0.086	0.1	0.039	0.029	0.185	30.07%
ARI→PBA→CBE	0.131	0.152	0.048	0.069	0.265	45.80%
ARI→SP→PBA→CBE	0.069	0.08	0.027	0.036	0.147	24.13%

The results indicate that the path coefficient for Augmented Reality Interactivity → Social Presence → Consumer Brand Engagement is 0.086, with a standard error of 0.039, and a 95% confidence interval of [0.029, 0.185]. Since the interval does not include 0, the indirect effect is significant, supporting Hypothesis H3. Similarly, the path coefficient for Augmented Reality Interactivity → Perceived Brand Authenticity → Consumer Brand Engagement is 0.131, with a standard error of 0.048, and a 95% confidence interval of [0.069, 0.265], which does not include 0, indicating a significant indirect effect and supporting Hypothesis H5. Moreover, the chained mediation path Augmented Reality Interactivity → Social Presence → Perceived Brand Authenticity → Consumer Brand Engagement has a path coefficient of 0.069, with a standard error of 0.027, and a 95% confidence interval of [0.036, 0.147], not including 0. This demonstrates a significant chained mediation effect, confirming Hypothesis H6.

L. Moderation Effect Testing

To test moderation effects, this study conducted multilevel hierarchical regression analysis, controlling for gender, age, and education. We further examined the moderating effect of Psychological Ownership (PO) on the relationship between Social Presence and Consumer Brand Engagement, as well as the moderating effect of Self-Concordance (SC) on the relationship between Perceived Brand Authenticity and Consumer Brand Engagement. The results are presented in Table 6.

Table 6. Results of Moderated Hierarchical Regression

Variable	CBE					
	Model1	Model 2	Model 3	Model 4	Model 5	Model 6
Control variable						
Gender	0.005	-0.002	0.004	0.01	-0.002	0.001
Age	0.039	0.039	0.05	0.043	0.034	0.037
Education	0.034	0.019	0.019	0.048	0.065	0.063
Independent variable						
SP	0.459***	0412***	0.509***			
PBA				0.520***	0.424***	0.476***
Moderating variable						
PO		0.195***	0.215***			
SC					0.292***	0.282***
Interaction term						
SP×PO			0.344***			
PBA×SC						0.122**
R2	0.213	0.347	0.36	0.272	0.347	0.36
△R2	0.204	0.338	0.349	0.264	0.338	0.349
F	24.5***	23.898***	33.269***	33.929***	38.52***	33.792***

Note: ***$p < 0.001$,**$p < 0.01$,*$p < 0.05$.

From Model 2, it can be observed that psychological ownership has a significant positive impact on consumer brand engagement (β=0.195, $p<0.001$). Building upon Model 2, Model 3 includes the interaction term of social presence and psychological ownership. The table reveals that the interaction term between social presence and psychological ownership significantly and positively influences consumer brand engagement (β=0.344, $p<0.001$). This indicates that an increase in psychological ownership enhances the positive impact of social presence on consumer brand engagement, thus supporting Hypothesis 8. From Model 5, Self-congruence has a significant positive effect on consumer brand engagement (β=0.292, $p<0.001$). Expanding upon Model 5, Model 6 introduces the interaction term between perceived brand authenticity and Self-congruence. The table shows that the interaction term between perceived brand authenticity and Self-congruence significantly and positively affects consumer brand engagement (β=0.122, $p<0.01$). This suggests that an increase in Self-congruence strengthens the positive impact of perceived brand authenticity on consumer brand engagement, thus confirming Hypothesis 9.

Table 7. The Moderating Effects of Psychological Ownership at Different Levels

	Psychological Ownership	Effect	Boot SE	BootLLCI	BootULCI
	M-1SD	0.203	0.042	0.120	0.286
SP-CBE	M	0.440	0.039	0.363	0.517
	M+1SD	0.676	0.056	0.566	0.786

Table 8. The Moderating Effects of Self-congruence at Different Levels

	Self-Congruence	Effect	Boot SE	BootLLCI	BootULCI
	M-1SD	0.474	0.058	0.360	0.587
PBA-CBE	M	0.584	0.060	0.466	0.702
	M+1SD	0.694	0.086	0.525	0.863

Tables 7 and 8 further illustrate the moderation effects of social presence on consumer brand engagement at different levels of psychological ownership and the moderation effects of perceived brand authenticity on consumer brand engagement at different levels of Self-congruence. Additionally, moderation effect graphs (Figures 2 to 3) are plotted. Table 7 reveals that for both low and high levels of psychological ownership, the confidence intervals do not include 0, and the p-values for the impact of social presence on consumer brand engagement are significant, with slopes of 0.203 and 0.676, respectively. This indicates that compared to low

levels of psychological ownership, high levels of psychological ownership enhance the influence of social presence on consumer brand engagement, providing further support for Hypothesis 8. Table 8 shows that for both low and high levels of Self-congruence, the confidence intervals do not include 0, and the p-values for the impact of perceived brand authenticity on consumer brand engagement are significant, with slopes of 0.474 and 0.694, respectively. This suggests that relative to low levels of Self-congruence, high levels of Self-congruence strengthen the influence of perceived brand authenticity on consumer brand engagement, reaffirming the validity of Hypothesis.
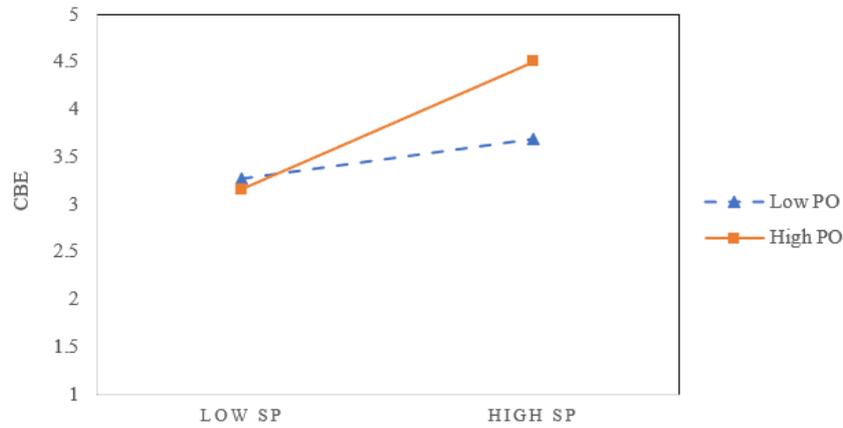
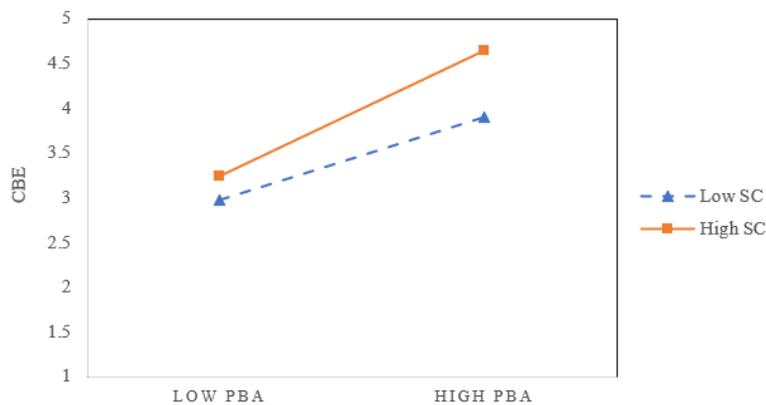Fig. 2. Moderation Effects Plot of Presence and Psychological Ownership

Fig.3. Moderation Effects Plot of Perceived Brand Authenticity and Self-Congruence

IV. CONCLUSION

A. Research Conclusions

Due to the relatively new nature of augmented reality (AR) as a marketing channel, some businesses may have limited capabilities in accurately tracking and evaluating the impact of their AR marketing activities. This study delves into the determinants of consumer brand engagement within the realm of AR brand activities, scrutinizes the strategies brands can employ for effective marketing initiatives, and further probes into the favorable outcomes stemming from Consumer Brand Engagement (CBE). This paper utilizes structural equation modeling to unveil the mechanisms by which AR interactivity, social presence, and perceived brand authenticity impact consumer brand engagement. Drawing from empirical findings, the following conclusions are derived:

Firstly, AR interactivity exerts a beneficial influence on consumer brand engagement. The advancement of digital technology has facilitated the deployment of AR technology at various touchpoints in the consumer journey. This technology enriches the exchange of information between consumers and products through increased interaction, creating a closer connection between consumers and brands, thereby enhancing consumer brand engagement.

Secondly, social presence and perceived brand authenticity partially mediate and jointly play a chain-mediating role in the relationship between AR interactivity and consumer brand engagement. In comparison to

traditional offline shopping, the AR online shopping experience is characterized by a higher degree of personalization. The heightened interactivity offered by AR technology fosters increased empathy and immersion among consumers. The dynamic images and anthropomorphic content featured in the application create an illusion of real face-to-face communication, resulting in a unique experiential dimension. Moreover, this facilitates genuine social interaction and the exchange of information. As consumers perceive a sufficient level of social presence, they tend to manifest more positive cognitive, emotional, and behavioral responses, thereby propelling consumer brand engagement. Similarly, the interactivity of AR technology endows consumers with a perception of brand authenticity, leading consumers to set self-judgment goals and thereby promoting the extension of consumer-brand relationships and the development of stronger emotional connections. Thus, consumers' perception of the authenticity of AR interactive initiatives by brands drives consumer evaluations of the brand and ongoing brand engagement. Therefore, the higher level of social presence brought about by AR interactive technology can reduce the social distance between consumers and brands, enhance consumers' perception of brand authenticity, and thereby promote consumer brand engagement.

Thirdly, consumer brand engagement positively influences consumer word-of-mouth and brand usage intentions. Through AR technology, consumer brand engagement enables consumers to convey brand ideals and recommend products and services. This communication allows consumers and other stakeholders to enjoy social interaction and brand engagement, strengthening the relationship between consumers and brands, and promoting more positive word-of-mouth and brand usage intentions.

Fourthly, psychological ownership and self-congruence act as moderators. Psychological ownership positively moderates the impact of social presence on consumer brand engagement. In AR brand activities, consumers imagine that the products designed by companies are products to which they have contributed. Due to the embedded interaction and immersive embodied experience of AR technology, consumers develop psychological ownership of physical products. This heightens consumers' social identification and their sense of shared responsibility with the object during the decision-making process, resulting in positive emotional, cognitive, and behavioral responses. Consequently, it amplifies the influence of social presence on consumer brand engagement. Self-Congruence serves as a positive moderator for the impact of perceived brand authenticity on consumer brand engagement. When consumers evaluate AR products, they compare their self-concept with the consumer image represented by these products. Self-Congruence is fundamentally symbolic, delineating the extent to which consumers embrace brands that align with their self-concept. The heightened interactivity of AR technology imparts a substantial visual and cognitive impact on consumers, expediting the alignment process between consumers' self-concept and brand image. This, in turn, reinforces the emotional bond between consumers and brands while elevating their perception of authenticity. This further induces engagement behaviors that reflect emotional connections.

V. DISCUSSION

A. Theoretical Contributions

In the past, research into the utilization of augmented reality (AR) technology within the realm of brand marketing has been sparse. This paper advances the study of augmented reality technology in brand marketing, and the conceptual model integrates AR interactivity, social presence theory, perceived brand authenticity theory, psychological ownership theory, Self-Congruence theory, and other consequences of Consumer Brand Engagement (CBE), presenting a fresh dimension in AR research. Additionally, this paper provides a robust theoretical perspective on the relationship between augmented reality and brand engagement. The findings of this study offer insights into the potential mechanisms behind AR's role in facilitating brand relationship management, brand engagement, and deeper research in the field of augmented reality. The specific theoretical contributions are as follows:

Firstly, this study makes substantial contributions to the literature on social presence theory and psychological ownership theory. It validates the mediating role of social presence, thereby expanding the research on the mediating mechanism between AR interactivity and consumer brand engagement. Moreover, it provides valuable insights into the application of social presence theory to enhance our understanding of consumer brand engagement and its implications within the context of AR interactive technology. The high interactivity of AR technology enhances consumers' social presence, leading to positive cognitive, emotional, and behavioral responses, which serve as antecedents to consumer brand engagement. To gain a deeper insight into the dynamics of how social presence impacts consumer brand engagement, this study investigates the moderating influence of psychological ownership. This study makes a valuable contribution by confirming the moderating impact of

psychological ownership on consumer brand engagement and its interplay with social presence in shaping consumer word-of-mouth and brand usage intentions. These findings provide valuable insights for the augmented reality marketing literature. Secondly, psychological ownership, as a moderating variable, enhances interaction between businesses and consumers through consumer brand engagement practices, building consumer-brand relationships. This paper provides a new avenue for businesses to manage their brand and communicate with consumers and leverage brand content through AR digital initiatives related to their brand.

Secondly, this study contributes to the literature on perceived brand authenticity theory, Self-Congruence theory, and consumer brand engagement. This research is the first to examine how perceived brand authenticity influences consumer brand engagement in the context of augmented reality and validates the mediating role of perceived brand authenticity, expanding the research on the mediating mechanism between AR interactivity and consumer brand engagement. To do so, this study takes PBA's four dimensions (credibility, continuity, novelty, and naturalness) into account to assess its role as a whole in influencing CBE. This specific area of research has not been explored in the context of augmented reality thus far. Therefore, this study offers a novel perspective, discussing the role of PBA in influencing CBE and advancing the understanding of the theory of brand authenticity. The research findings suggest that PBA is a critical antecedent in assessing whether brands successfully engage consumers. Thus, this study extends the applicability of brand authenticity theory to the context of augmented reality, bringing significant benefits to brand marketing practices for businesses. Furthermore, this study examines the moderating effect of Self-Congruence on consumer brand engagement in the augmented reality context. The findings of this paper supplement the theory of Self-Congruence in augmented reality scenarios and enhance the understanding of how Self-Congruence influences consumer brand engagement through the perception of brand authenticity, providing a more comprehensive insight into the motivators behind consumer brand engagement.

Thirdly, our study broadens the research on consumer brand engagement and advances further theoretical developments in the field. This study, however, adopts a brand marketing perspective of augmented reality and considers AR interactivity as a preceding variable, introducing social presence and perceived brand authenticity as chain mediators. It identifies and tests the mechanism through which AR interactivity affects consumer brand engagement behavior. On one hand, this study introduces perceived brand authenticity as a mediating variable, based on brand authenticity theory, injecting new theoretical support for explaining the relationship between AR interactivity and consumer brand engagement, further enriching the theoretical framework between variables. Building on the findings of previous scholars, where CBE's antecedents encompass consumer emotional, cognitive, and behavioral responses, this study similarly highlights perceived brand authenticity as a crucial facilitating factor in consumer brand engagement. On the other hand, social presence offers a novel perspective and theoretical basis for explaining consumer brand engagement, enhancing the understanding of social presence. As a perception of individuals' social interaction and co-presence abilities, social presence is both a cognitive and emotional response to AR interactivity. Furthermore, social presence, as a perception experience of AR technology, embodies and enhances the mediating role (AR interactivity and consumer brand engagement), enriching the range of antecedents and explanations for consumer brand engagement.

B. Managerial Implications

Firstly, this study holds practical significance for businesses looking to implement AR marketing and brand engagement through mobile applications. The research highlights for managers the capacity of AR to impact consumers' sense of social presence, perceived brand authenticity, and ultimately, consumer brand engagement. For managers, it is essential to recognize that AR's interactive technology empowers consumers to control and manipulate products in a world that combines virtual and real, offering clear, vivid, and detailed content presentation. This provides consumers with engaging stimuli and enriching digital media experiences, influencing cognitive processing. Therefore, managers should ensure that app developers harness the attributes of AR interactivity when developing applications for their consumers and clearly communicate the unique experiences offered by the brand application's AR functionality. Precisely communicating the value proposition offered by these AR functionalities empowers consumers to actively interact with and customize technology to meet their specific requirements. This facilitates the visual simulation and conceptualization of product usage during the decision-making process. Similarly, AR presents opportunities for managers to guide consumers in their decision-making journeys, obviating the necessity for consumers to rely on their imagination to envision product appearances. Consequently, by affording consumers augmented reality (AR) experiences that allow them to observe products through the seamless fusion of real and virtual environments, rather than solely depending on their imagination to conjure mental representations of products and experiences, it fosters favorable perceptions

of brand authenticity and social presence. Ultimately, this fosters consumer engagement outcomes, including positive word-of-mouth recommendations and intentions to use the brand.

Secondly, the findings of this study suggest that social presence functions as a conduit for consumer brand engagement activities. In this context, the study underscores that as social presence is contingent upon media richnessx`, managers should take into account consumer behavioral intentions and cognitive or emotional states. They should also offer the requisite tools and practical features within their AR applications to augment interaction and emotional connections between the brand and consumers. Brands should employ AR technology that piques consumer interest and curiosity to inspire their participation in brand-related social interactions. Considering the paramount importance of social presence in consumer brand engagement, it is imperative for managers to adopt AR technology as a means to strengthen brand relationships and interactions with consumers. Moreover, in order to sustain a high level of interactivity, it is essential to curate diverse product information that captivates consumers and prompts them to provide feedback, thus fostering an environment where consumers can openly share their perspectives and experiences.

Thirdly, constructing perceived brand authenticity, especially as consumers continually encounter a multitude of competitive brands, presents a significant challenge. However, managers can use AR's interactive technology to allow consumers to engage with the brand and communicate with them, thereby increasing consumers' feelings of respect and trust, which will facilitate interaction among consumers to convey authenticity. The bedrock of brand authenticity is built upon credibility, continuity, novelty, and naturalness (Bruhn et al., 2012). Therefore, it is imperative for managers to craft marketing messages that resonate with consumers as genuine and authentic. Brands should steadfastly adhere to their core principles and values, refraining from making unrealistic promises in an effort to attract a more loyal consumer base.

Fourthly, enhancing consumer psychological ownership and perceived Self-Congruence are crucial. This study has identified that psychological ownership and Self-Congruence, cultivated by businesses through the use of AR applications, can act as moderators in influencing the relationship between social presence and perceived brand authenticity on brand engagement. When consumers actively participate in deeply interactive and captivating AR brand experiences, they tend to develop a stronger sense of ownership towards the product and a heightened awareness of self-concept associated with the product. Brands should provide consumers with a clear understanding of the product's appearance to facilitate consumer brand engagement activities, thereby infusing AR marketing with brand authenticity and promoting the improvement of business brand-consumer relationships. During the interaction, managers should focus on addressing consumers' needs for social presence and customize AR product content to meet these needs. Furthermore, concerning the transformative innovation appeal of organizations, managers should utilize consumers' positive emotional appeals to attract consumers and provide AR functionalities that meet consumer needs, guiding and stimulating their interest in participating in such AR brand interactions. This can be achieved through the use of AR technology, short video media, and other creative information. In fact, as psychological ownership and Self-Congruence facilitate brand interaction, organizations should understand and utilize methods for enhancing brand engagement, word-of-mouth, and brand usage intentions through augmented reality marketing and other media campaigns.

C. Limitations and Future Research

This study has several limitations. Firstly, the content of the survey questionnaire was filled out by participants based on their recent AR usage experiences, rather than immediately after using different brands' AR mobile applications. Consequently, there may be a certain degree of bias in relation to consumers' choices in real-world scenarios. Future research could employ experimental methods for questionnaire surveys, such as providing subjects with on-site AR technology equipment and spaces to assist them in expressing their authentic feelings after using AR technology, followed by questionnaire completion, to more accurately predict consumers' perceptions and behaviors when participating in brand activities using AR technology.

Secondly, this study primarily focused on the impact mechanisms of AR interactivity technology on consumer brand engagement. Factors such as AR entertainment, personalization, and anthropomorphism, which also influence consumer brand engagement, have not been explored. Furthermore, the potential impact of different specific dimensions of perceived brand authenticity and social presence on consumer brand engagement was not examined in this study. Future research should delve deeper into these aspects for a comprehensive understanding.

Finally, this research was confined to the study of AR technology. Future research could consider conducting cross-scenario studies involving various contexts such as social media networks and virtual reality to effectively

control potential confounding factors. This would enable a comparison of the causal relationships and underlying mechanisms among social presence, perceived brand authenticity, and consumer brand engagement.

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