How augmented reality increases engagement through its impact on risk and the decision process

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Abstract

Augmented reality (AR) overcomes one of the main limitations of e-commerce, such as the pre-purchase trial. The consumer can virtually see how a product is integrated into the real world through this technology. Therefore, AR may reduce the perceived risk of buying a product online. Despite existing research, the impact of AR on the consumer decision process needs to be further explored. Consequently, this research aims to understand the impact of AR on the perception of risk and the purchase decision process, considering decision comfort and decision confidence. Through a between-subjects experiment, the results show that AR reduces the risk of online shopping. However, it has no direct effect on the decision process. Reducing risk and the comfort it brings generates decision confidence and satisfaction with the shopping experience. This satisfaction will generate engagement towards the online shop platform. The research highlights the process through which AR impacts the decision-making process. The implications for AR marketing theory and managerial implications in the age of the metaverse are discussed.

Keywords

Augmented reality; comfort; confidence; engagement; perceived risk; metaverse.

Funding information

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Citation:

Introduction

Augmented Reality (AR) and Virtual Reality (VR) are interactive technologies that can improve the consumer's overall experience[1]. VR fully replaces reality by constructing a completely artificial digital environment, while AR integrates virtual elements into the real world[2]. Apart from the interactivity AR provides[3], AR adds an essential advantage to online shopping in virtual testing of the product, allowing a product-based experience placed in a real-world environment. AR applications have increased with more than 1 billion active users worldwide by 2022[4]. At the same time as its use has spread, in the retailing sector, more and more e-commerce companies from different fields are implementing AR either on their website or in their applications (e.g., Ikea, Rayban, Toyota or Madison Reed). For example, Ikea Place allows visualising products from its catalogue in the home space through AR, seeing how it would look integrated with the rest of the room's decoration. In the cosmetic sector, well-known companies such as L'Óreal, Maybelline and NYX allow the virtual testing of their products, observing how the product would look on consumers' faces through Virtual Try-on (VTOs), which are based on AR technology. Therefore, virtual consumption through AR may increase satisfaction along the consumer journey and the level of sales[1,5].

One of the main limitations of online commerce is the product trial prior to purchase. This aspect is partially solved with AR. Despite being a virtual trial, the consumer can see how the product would look, facilitating the ability to imagine the result of the purchase they are thinking of making[6,7]. Given that this limitation is one of the main aspects that increase the risk of buying online[8], including AR in an e-commerce shop could affect the perceived risk of buying the product online. In line with the BICK FOUR framework, AR can be used to generate greater conviction in the decision taken[9]. In this sense, the assistance that VTOs provide can also help increase the comfort and confidence of the consumer's decision, as they can virtually observe the result of the chosen product. Furthermore, this virtual consumption experience can improve consumer satisfaction with the online shop design, leading to loyalty behaviours such as engagement[10].

Previous research has shown how AR favours the engagement generated with the online shop[11-14]. These studies have focused on explaining how these consequences are generated through aspects such as interactivity, vividness, utilitarian and hedonic benefits, usefulness or customisation. However, little attention has been given to how AR may affect risk. Concerning risk, previous research postulates how the use of AR affects perceived risk[15]. The research has merely postulated how AR may affect different dimensions of perceived risk (social, financial, psychological, performance, physical and time risk). However, these propositions were not empirically tested. Other research in this area has considered perceived risk with the product, analysing the indirect positive influence of AR on purchase intention through product risk and the attractiveness of the store[16]. However, participants were not exposed to an AR experience, but they were shown screenshots showing the use of AR. In this sense, it is necessary to consider that human-technology interaction involves activity levels and cognitive processes that can influence the evaluation, attitudes and intentions caused by technology[17,18]. Therefore, the lack of empirical work analysing the impact of AR on risk highlights the need for further research in this direction. Moreover, the previous studies mentioned above have not explored the consequences of decreasing risk through the use of AR in the evaluation of the decision made. In this sense, previous authors have already highlighted the need for research on AR and the decision making process[19]. Consequently, to shed light on this issue, this study analyses the impact of AR on online purchase risk and decision evaluation. The impact of AR on the evaluation of the decision made is analysed through two concepts (decision comfort and decision confidence). The importance of these aspects on customer satisfaction and engagement with the online shop are also analysed, considering control variables such as product involvement, product knowledge and AR privacy concern.

The research contributes to understanding how AR affects online purchase risk and decision evaluation, extending the knowledge of the consequences that it generates[15]. It demonstrates how AR affects risk and the mechanism through AR impacts the decision evaluation. Understanding this mechanism contributes to the call for research into how AR can generate conviction in the consumer's decision[9]. Moreover, the research highlights the relative importance of aspects of the decision, such as comfort and confidence with the decision, revealing the role of each of them in the engagement creation process. Furthermore, knowledge of the most important aspects of satisfaction and engagement provides valuable business insights. Understanding the key factors allows knowing which aspects to improve the design in online environments with AR and, consequently, improve the consumer experience.

Literature Review and Proposed Research Framework

Previous research has been based on different theoretical frameworks to study the impact of AR on engagement. For example, research based on co-creation has shown how providing authentic experiences increases customer engagement[20]. Also, in line with equity theory, consumer participation has a negative effect on engagement[21]. Equity theory builds on the foundations of cognitive dissonance theory[22] and is applied to exchange relationships[23]. The theory proposes that individuals consider their ratio of inputs to outcomes against the perceived ratio of inputs to outcomes of a comparable reference person, group or institution[24]. Research in AR that has built on this theoretical foundation has postulated that using AR reduces engagement intention[21]. However, this previous research compared a high consumer participation process (VTO) with a low participation process (in-store service). As this study compares online shopping experiences (No AR vs AR), consumer participation in the two scenarios is similar. Therefore, it is expected that the improved experience for decision evaluation caused by AR and the reduction of risk improve customers' outcomes of the shopping experience, leading to engagement with online commerce.

In addition, the theoretical framework of the model proposed in this research is in line with the theory of technological adoption. This theory allows us to understand the potential consequences of using AR. Technology adoption theory posits that user evaluation of technology mediates relationships between technology attributes and resulting behaviours[25]. Research based on technology acceptance theories has shown that perceived ease of use and usefulness have affected brand engagement positively[11]. Attributes such as interactivity or vividness have also been shown to be relevant in generating engagement[13]. Table 1 shows a summary of the AR literature related to this research.

**Table 1. Summary of AR literature related to the study**

Source	Research framework	Independent variables	Mediators / moderators	Dependent variables	Conclusions
Alimany, Deans & Gnoth, 2017[15]	Perceived risk	No AR / AR	-	Perceived risk (social, financial, psychological, performance, physical, time)	One of the main advantages of AR is to reduce the perceived risk associated with a purchase decision. It is postulated that shopping with AR decreases the perceived risk in the different dimensions, compared to shopping without AR.
McLean & Wilson, 2019[11]	Customer brand engagement, TAM	Interactivity, vividness, novelty	Ease of use, usefulness, enjoyment, subjective norm, brand engagement, purpose	Satisfaction, brand usage	AR attributes and technology acceptance attributes increase brand engagement.
Bonnin, 2020[16]	Attractiveness store, perceived risk	No AR / AR	Utilitarian evaluation, hedonic evaluation, product risk, attractiveness of the online store, AR familiarity	Patronage intention	AR indirectly affects patronage intention through product risk and the attractiveness of the online store. This effect is reinforced when people become more familiar with AR.
Christ-Brendemühl & Schaarschmidt, 2021[21]	Equity theory	Customer participation	Fairness perceptions	Engagement intentions, negative WOM intentions	Customer participation positively affects negative WOM and has a negative effect on engagement intentions.
Heller et al., 2021[26]	Technology-enabled engagement process	Visual appeal, information fit-to-task	Spatial presence, cognitive engagement, emotional engagement, value-in-use	Service reuse likelihood, WOM	Framework of the technology-enabled engagement process integrates multiple stages of customer engagement, as a service-centric process.
Nikhasemi et al., 2021[13]	Stimulus-Organism-Response model, Uses and Gratification Theory, Technology continuance theory	Interactivity, quality, vividness, novelty	Utilitarian and hedonic benefit, engagement, psychological inspiration, inspirational intention, customisation	Intention to use AR, willingness to pay a price premium	The impact of utilitarian and hedonic benefits on AR app engagement is non-linear. Customisation moderates the relationships between stimulus and organism variables.
This research	Equity theory, technology adoption theory	No AR / AR	Risk of buying online, decision comfort, decision confidence, satisfaction	Web engagement	AR decreases the risk of buying online, but it does not directly affect decision comfort and confidence. Instead, decision comfort increases satisfaction directly and through decision confidence.

In our research, the presence or not of AR act as a technology attribute of the system that affects user evaluation of the shopping experience. This study considers perceived risk, decision comfort, decision confidence and satisfaction mediate the relationship between technology attributes and outcome behaviour.

The effect of AR on user evaluations leads to behaviours closely related to technology adoption, such as engagement with the online shop.

Consequently, the research model proposed is shown in Figure 1.

Figure 1: Research Model Proposed

Research model proposed
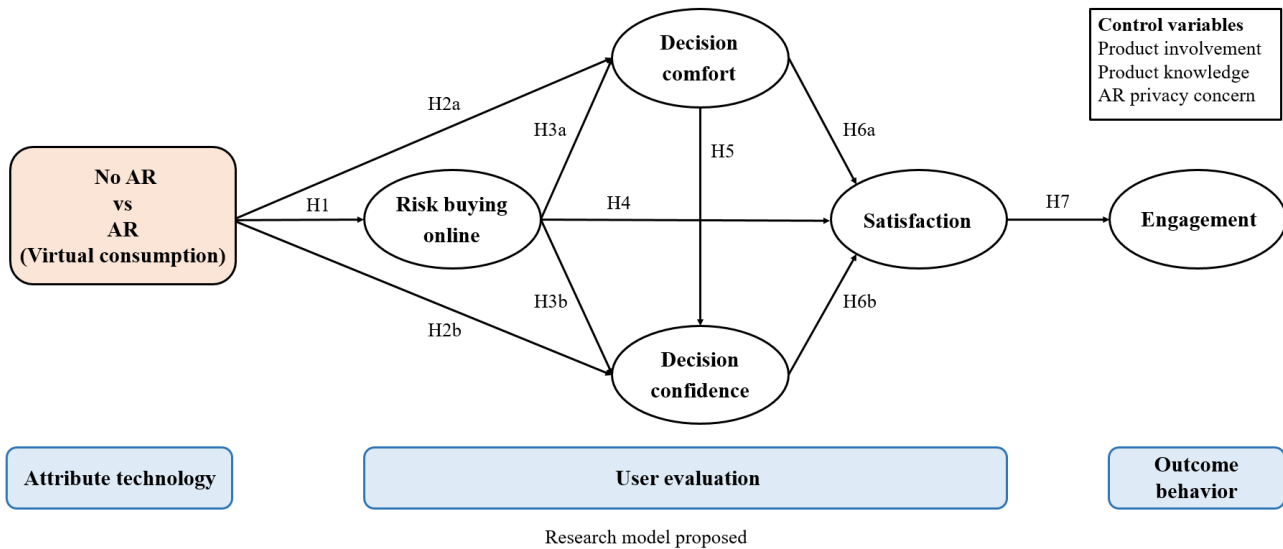
Hypotheses Development

Perceived risk is defined as consumers' perceptions of the uncertainty and adverse consequences of purchasing a product or service[27]. In other words, perceived risk is the expectation of a loss and its consequences. This aspect is an important avenue of research that can help explain technology adoption and consumer perceptions and behaviour. Understanding factors that can decrease perceived risk is crucial for online commerce[28].

To decrease perceived risk, online retailers can use extrinsic signals, such as warranties (not directly related to web design) or intrinsic signals, such as physical surroundings[29]. Among the intrinsic signals, AR is an interesting option[16]. One of the main causes of perceived product risk in online shopping is that consumers cannot test the product prior to purchase. The intangibility of products presented online leads to difficulties in assessing product characteristics. This fact leads to the existence of a perceived risk of buying online[30]. In the case of the cosmetics sector, AR, through virtual testing, can help reduce this risk, allowing them to see how the product looks on their face in a pretty real way.

H1: The use of AR (vs No AR) reduces the risk of buying online.

Consumers experience emotional changes when making purchase decisions. Decision comfort is the degree of psychological (and physiological) ease, satisfaction and well-being one feels about a specific decision. In other words, decision comfort reflects a person's feeling of being "good or agreeable" while making a specific decision[31]. Decision comfort is an emotional response to the decisions and choices made. Interactive technologies (e.g. AR) can contribute to consumer comfort as a vital function in the service interaction. AR technology can create a space where consumers can experience virtual products in the real world and provide consumers with a sense of "being there" that promotes positive consumer perceptions and further influences their emotional reactions when making decisions[32].

Decision confidence is the clarity with which the consumers understand their preferences and the extent to which those preferences are believed to be correct[33]. Consumers use AR not only because they expect the technology provides them with an enhanced experience when shopping online, but also because they expect to reduce uncertainty when making purchases[34]. Decision aids such as AR can induce greater confidence in the consumers' decisions. Through the aid of AR, the consumers can observe how the product alternatives presented fit their preferences, leading to a higher degree of perceived confidence resulting from the decision made. When the consumer can appreciate the different alternatives presented, confidence in the consumer's decision can increase[35].

H2a: The use of AR (vs No AR) increases the decision comfort.
H2b: The use of AR (vs No AR) increases the decision confidence.

Consumers' uncertainty affects their emotions and feelings when faced with a purchase decision. When the consumer perceives risk when buying a product, this generates negative emotions that can affect the consumer's well-being when making the decision[36]. This fact can affect the decision comfort. Similarly, the consumer's confidence in the decision is also affected by the risk the consumer perceives to exist. Confidence integrates elements of competence that imply that the consumer feels able to make the right decision without making a mistake[37]. Therefore, if the consumer perceives a low risk in the decision to be taken, it will favour the existence of confidence in the decision taken.

H3: The risk of buying online has a direct negative effect on (a) decision comfort and (b) decision confidence.

The risk of shopping online involves perceiving potential losses when purchasing decisions[27]. Satisfaction is defined as the psychological or emotional state resulting from the cognitive assessment of confirmation between expectations and outcomes[38]. Online shopping risk is an aspect that is highly valued and commonly considered by consumers when evaluating their shopping experiences. If consumers perceive risk during their shopping experience, this is an aspect that they will rate negatively when evaluating their online shopping experience.

H4: The risk of buying online has a direct negative effect on satisfaction.

Confidence in the decision arises when the consumers have considered the certainty with which the chosen option matches their preferences. Affective aspects such as decision comfort can affect decision confidence[39]. Decision confidence can result from internal processes, inferences and intuition. According to feelings as information theory, emotional reactions can be cognitively assessed, and the resultant beliefs are influenced as a result[40]. Therefore, if a consumer develops positive emotions due to decision comfort, this may influence their cognitive evaluations. In other words, positive emotional states such as decision comfort can be positively valued during cognitive processes. In line with this, it may positively affect decision confidence.

H5: Decision comfort has a direct positive effect on decision confidence.

Customer value evaluation is derived from the shopping experience[41]. Satisfaction with the online shopping experience includes everything from searching for information to receiving the product and the service offered afterwards[42]. Decision comfort implies a state of well-being and peace of mind for the consumer. This well-being will help the consumers be satisfied with the shopping experience they have enjoyed. Confidence in the decision implies that the consumers feel sure about the decision they have finally made during the search phase and evaluate alternatives throughout the customer journey. Therefore, this confidence that the consumer feels will cause them to be satisfied with the shopping experience they have had by evaluating it positively.

H6a: Decision comfort has a direct positive effect on satisfaction.
H6b: Decision confidence has a direct positive effect on satisfaction.

When interacting with a digital system, engagement is a quality of user experience characterised by the depth of an actor's cognitive, temporal, affective, and behavioural investment[43]. Thus, determining which aspects of users' interactions with digital applications indicate user engagement is key. Previous research has shown how AR's inspiration may lead to engagement behaviours[44]. This inspiration is linked to exploratory behaviour, which increases web usage[9]. Concerning the web experience, satisfaction involves the overall evaluation of the shopping experience on a website[45]. This evaluation includes both cognitive and affective aspects. Therefore, if consumers are satisfied with the online experience, they will likely develop engagement behaviours towards the online shop.

H7: Satisfaction has a direct positive effect on engagement.

Materials and Methods

Sample

Online questionnaires were created for data collection. Two academics specialising in immersive technologies reviewed the survey. A pre-test with 11 volunteers was conducted to check for any potential misunderstandings. This reinforced the translational and content validity[46].

An online between-subjects experimental design was used. Participants were contacted via a market research agency and were randomly assigned to one scenario (No AR vs AR). Participants were economically rewarded for their participation. They had to access an e-commerce shop of a specific beauty brand and complete the following task. They were asked to imagine that they were interested in buying a lipstick, and they could explore the different shades available in the online shop. Therefore, the study was only conducted by women due to the product's characteristics. Participants in the No-AR group could not use the VTO function of the shop, while those in the AR group could use it. Figure 2 shows examples of the conditions. Control questions were asked to confirm that the participants had experimented properly (whether they had used AR or not, indicate the steps to use the VTO function in the AR group...). Questions to check the participants' attention were also included.

Finally, 256 predominantly young North American women successfully participated in the study (No-AR group=128; AR group=128; Mage=33.06; SD=8.99). Therefore, the sample size is appropriate for the experimental design carried out[47]. Furthermore, the sample is representative of the USA online shopping population who buys beauty products online[48]. 61.72% were between 18-35 years old, 25.78% were between 36-45 years old, and 12.50% were over 45 years old.

Figure 2: Examples of experimental conditions
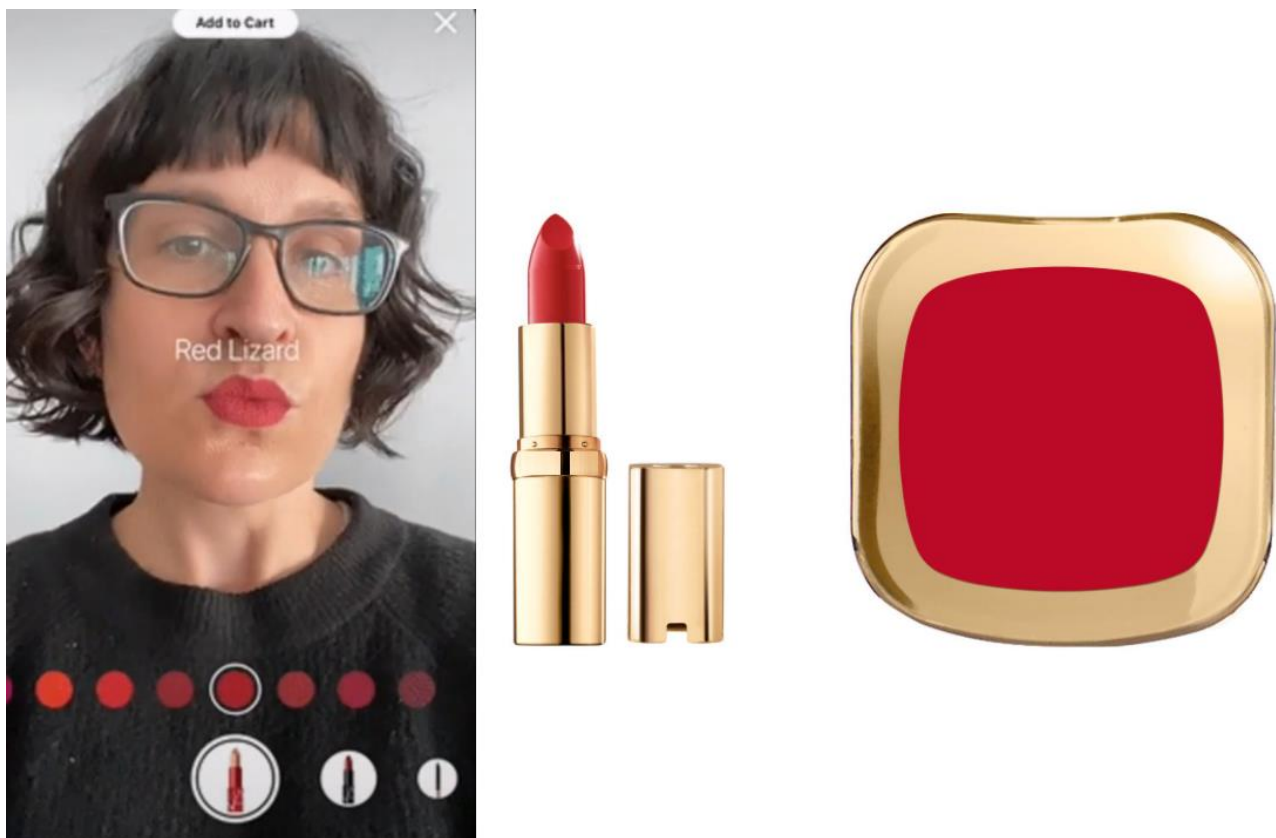
Examples of experimental conditions

Measurement and data validity

To ensure content validity, the variables under study were measured using scales validated in previous literature, adapting them to the study context. To ensure the robustness of the results, control variables related

to the product and the consumer were included in the proposed model. Product involvement reflects a person's perceived relevance of a consumption object based on needs, values, and interests[49]. In addition, product knowledge is the information the consumer holds to clearly know a product[50]. These variables were included due to their possible relationship with variables linked to the decision evaluation based on the results of previous studies[51,52]. Finally, the consumer's AR privacy concern refers to the worry that personal data may be used by others in unpredictable ways when using AR. This aspect was also included as a control variable due to the effect that this aspect could have on the evaluation of experience (satisfaction) and engagement[53]. The scale items and the sources are presented in table 2. All scale items were measured on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree).

The data collection method through surveys used in the study may cause non-response bias. To check the absence of non-response bias, the responses of early and late respondents were compared. Two groups (early and late respondents) were created according to the time taken to complete the questionnaire. The early respondents' group comprised 80% of participants who had completed the survey most quickly, and the late respondents' group comprised the remaining 20%. The mean value of each reflective construct of this research was calculated, and t-tests were used to compare the two groups. No significant differences were found between groups ($p>0.05$). Therefore, it can be concluded that non-response bias is not an issue in this research.

Since the data were collected using a single web-based survey and the self-reported answers related to each construct were conceptual, common method bias could be a potential problem. To minimise common method bias, respondents were assured of anonymity before taking part in the survey[54]. In addition, an unrotated principal axis factoring analysis was conducted[55]. The results reveal that the first factor accounted for less than 50% of the variation in the data (36.12%). This indicates that the common method variance is not a major threat in this study.

Table 2. Scale items and convergent validity

	Factor
Risk of buying online (Adapted from Stone & Grønhaug)[56] (α=0.918; CR=0.948; AVE=0.858)	
RISK1. Buying this product on this website makes me concerned that I will experience some kind of loss if I buy it	0.903
RISK2. If I buy the product on this website, I will think I made a mistake when I use it.	0.934
RISK3. Buying this product on this website could cause me problems not knowing how it will fit me	0.941
Decision comfort (Parker et al., 2016)[31] (α=0.923; CR=0.952; AVE=0.868)	
COMF1. I am comfortable with choosing this product	0.951
COMF2. I feel good about choosing this product	0.943
COMF3. I am experiencing negative emotions about choosing this product (r)	*0.621*
COMF4. Although I do n t know if this product is the best, I feel comfortable with the choice	0.898
Decision confidence (Tan et al., 2012)[57] (α=0.961; CR=0.975; AVE=0.928)	
CONFID1. I am confident that the decision made is indeed the best for me	0.960
CONFID2. I am certain that I have made the best choice for me	0.962
CONFID3. I am positively sure that the decision made is really the best choice for me	0.967
Satisfaction (Adapted from Flavián et al., 2006)[37] (α=0.950; CR=0.964; AVE=0.869)	
SAT1. Using this website to purchase the product is a correct decision	0.881
SAT2. The experience that I have had with this website has been satisfactory	0.949
SAT3. In general terms, I am satisfied with the information that this website shows me	0.944
SAT4. In general, I am satisfied with the information I have received from the website	0.953
Engagement (Adapted from O'Brien et al., 2018)[43] (α=0.932; CR=0.952; AVE=0.832)	
ENG1. I was absorbed in the shopping experience	0.909
ENG2. The shopping experience was rewarding	0.888
ENG3. The time I spent using the app just slipped away	0.921
ENG4. I felt interested in this shopping experience	0.929
Product involvement (Adapted from Zaichkowsky, 1985)[58] (α=0.762; CR=0.863; AVE=0.678)	
INV1. I am interested in this product	0.813

INV2. This product is important for me	0.843
INV3. This product is relevant to me	0.814
Product knowledge (Adapted from Smith & Park, 1992)[59] (α=0.830; CR=0.898; AVE=0.747)	
KNOW1. I feel very knowledgeable about the product I just examined	0.851
KNOW2. If I had to purchase the product, I would need to gather very little information in order to make a wise decision	0.791
KNOW3. I feel very confident about my ability to judge these products	0.943
AR privacy concern (Adapted from Rauschnabel et al., 2018)[60] (α=0.968; CR=0.977; AVE=0.913)	
PRIV1. I am concerned about my privacy when using AR	0.965
PRIV2. I have doubts about how well my privacy is protected while using AR	0.954
PRIV3. My personal information would be misused when the camera is running	0.953
PRIV4. AR would collect too much information about the user	0.950

Note: item in italics was removed during the validation process; (r): reverse item.

Results

Scales validity

Table 2 shows information according to the reliability of the measurement instrument. The Cronbach's alphas for all the variables were higher than the minimum level criterion of 0.70[61]. An analysis of the factorial loads showed that each item exceeded the 0.70 criterion[62]. Also, the composite reliability of the constructs was greater than 0.90, so they far exceeded the minimum level of 0.70[61]. Convergent validity was evaluated through the average variance extracted (AVE) indicator. This exceeded the recommended threshold of 0.50[63].

Finally, we assessed the model's discriminant validity by verifying that the inter-construct correlations were lower than the square roots of the AVEs of each variable[63]; and by analysing the Heterotrait-Monotrait Ratio (HTMT), which returned values below 0.85 for all variables[64]. As all pairs of constructs met this criterion, it can be concluded that the model has an acceptable level of discriminant validity. Table 3 shows these values.

Table 3. Discriminant validity

Variables	1	2	3	4	5	6	7	8	9
(1) No AR / AR	**N.A**	0.508	0.321	0.307	0.167	0.256	0.000	0.000	0.000
(2) Risk of buying online	-0.487	**0.927**	0.421	0.368	0.088	0.051	0.255	0.307	0.102
(3) Decision comfort	0.309	-0.389	**0.931**	0.769	0.470	0.335	0.053	0.150	0.062
(4) Decision confidence	0.301	-0.348	0.725	**0.963**	0.450	0.332	0.048	0.128	0.073
(5) Satisfaction	0.163	0.079	0.441	0.431	**0.932**	0.677	0.308	0.394	0.092
(6) Engagement	0.246	-0.047	0.312	0.317	0.640	**0.912**	0.430	0.322	0.041
(7) Product involvement	0.000	0.212	0.016	0.033	0.263	0.366	**0.823**	0.503	0.113
(8) Product knowledge	0.000	0.270	0.135	0.124	0.361	0.305	0.418	**0.863**	0.242
(9) AR privacy concern	0.000	0.100	-0.062	-0.082	-0.088	-0.038	-0.100	-0.217	**0.954**

Notes: *The diagonal elements (in bold) are the square roots of the AVEs. Above the diagonal elements are the HTMT values. Values below the diagonal elements are the inter-construct correlations.*

Test of hypotheses

The structural model was evaluated using PLS-SEM. Bootstrapping analysis with 5000 subsamples was performed[65]. The normalised fit index (NFI) was 0.84, slightly below the 0.90 value recommended in the literature[66]. The model's residual root-mean-square standard (SRMR) was 0.075, less than 0.080, indicating a good level of fit based on the previous literature[66]. Collinearity was also assessed, and the results confirmed that all the variance inflation factors (VIFs) were below the 3.3 thresholds proposed in the literature[65]. Table 4 shows the results of the relationships developed.

Table 4. Results of structural analysis

	Risk of buying online	Decision comfort	Decision confidence	Satisfaction	Engagement
	DEPENDENT VARIABLES				
No AR / AR	-0.487*	0.112 n.s	0.059 n.s		
Risk of buying online		-0.406*	-0.070 n.s	0.218*	
Decision comfort			0.672*	0.319*	
Decision confidence				0.249*	
Satisfaction					0.582*
Product involvement	0.123 n.s	0.000 n.s	0.018 n.s	0.130*	0.211*
Product knowledge	0.255*	0.252*	0.040 n.s	0.169*	0.015 n.s
AR privacy concern	0.167*	0.033 n.s	-0.023 n.s	-0.020 n.s	0.038 n.s

Note: *=p<0.05; n.s=not significant

The results show that AR reduces the risk of buying online, compared to an online shopping experience without AR (H1 supported). However, the use of AR does not significantly affect decision-related variables such as decision comfort or decision confidence (H2a and H2b not supported). The risk of buying online negatively affects decision comfort (H3a supported) but not decision confidence (H3b not supported). In addition, it directly affects satisfaction (H4 supported). The decision comfort positively affects decision confidence (H5 supported) and satisfaction (H6a supported). The decision confidence also positively affects satisfaction (H6b supported). Finally, satisfaction has a positive effect on engagement (H7 supported).

Decision comfort is shown to have weak explanatory power ($R^2=0.224$), while the risk of buying online ($R^2=0.349$), decision confidence ($R^2=0.537$), satisfaction ($R^2=0.362$) and engagement ($R^2=0.453$) have moderate explanatory power[67]. In addition to R^2, Q^2 measures to assess the predictive relevance of models were analysed[65]. All values were above 0. Thus, the model has good predictive relevance. Figure 3 shows the results of the study.

Figure 3: Results of the contrasted model
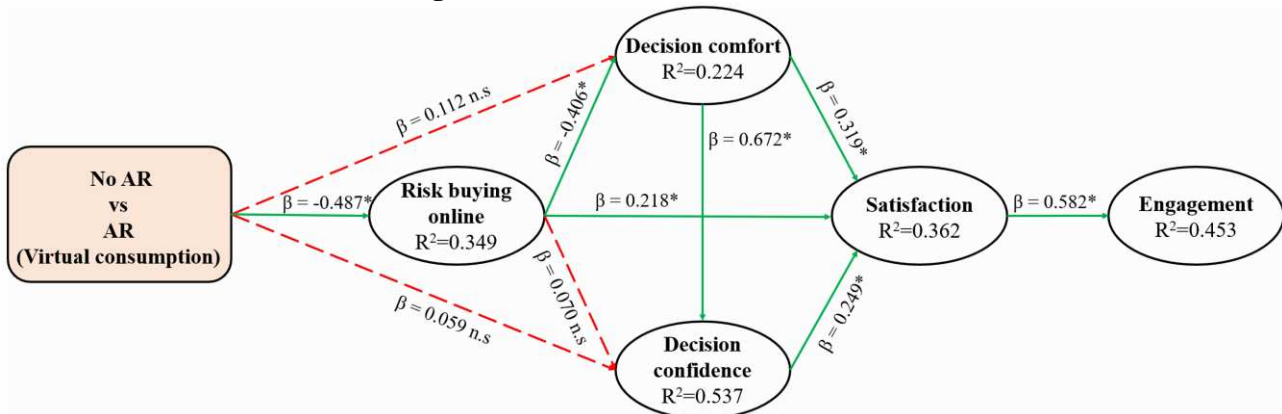
Notes: solid lines = supported relationships; dotted lines = not supported relationships; * = coefficients significant at 0.05 level; n.s = not significant

Post-hoc analysis: indirect effects

Because of the results obtained, a mediation analysis was conducted to evaluate the mechanisms further influencing the AR in the decision-making process. The indirect effect of the risk of buying online on the relationship between the use or not of AR and decision comfort was significant (95% confidence interval [0.126, 0.282]). As the direct effect of the use of AR (vs not use of AR) on decision comfort was insignificant, the risk of buying online fully mediates the relationship. On the other hand, risk of buying online does not mediate the relationship between the use of AR (vs not use of AR) and decision confidence (95% confidence

interval [-0.023, 0.088]). In addition, decision comfort fully mediates the relationship between the risk of buying online and decision confidence (95% confidence interval [-0.379, -0.178]). Finally, the risk of buying online and decision comfort mediate the effect of the use of AR (vs not use of AR) and decision confidence (95% confidence interval [0.084-0.194]). The results are shown in Table 5.

Table 5. Indirect effects

Relationship	Path coefficient	Bias-corrected confidence interval	p-value
No AR / AR → risk of buying online → decision comfort	0.198	(0.126,0.282)	<0.001
No AR / AR → risk of buying online → decision confidence	0.034	(-0.023,0.088)	0.230
Risk of buying online → decision comfort → decision confidence	-0.273	(-0.379, -0.178)	<0.001
No AR / AR → risk of buying online → decision comfort → decision confidence	0.133	(0.084, 0.194)	<0.001

Robustness tests

To assess the robustness of the results, we included some control variables in the analysis mentioned above. In this sense, product involvement positively affects satisfaction and engagement. Product knowledge affects the risk of buying online, decision confidence and satisfaction. The AR privacy concern increases the risk of buying online. However, it has to be highlighted that when controlling for these variables, the results of the hypotheses developed remain stable. Then, the absence of non-linear effects was verified. First, regression equation specification error test (RESET) was applied on the latent variable scores[68]. In addition, quadratic effects were included in the critical regressions[69]. After a bootstrapping analysis with 5000 samples, no significant non-linear effects were found. Therefore, the developed model is robust.

Discussion

The use of AR improves the shopping experience during product choice through risk reduction. Risk reduction generates a higher degree of comfort and confidence, resulting in a satisfactory experience during the search and evaluation of alternatives. This satisfaction results in engagement with the online website. Engagement results in a pleasurable shopping experience, which is likely to lead to increased usage and adoption of the AR[14,21]. The greater product knowledge increases risk perception when buying online. Due to the type of product it may be the case that higher product knowledge implies the perception of greater risk because the colours shown either in the images in the traditional online store or through the VTO do not resemble reality.

AR does not directly impact variables related to the decision, such as the degree of comfort or confidence in it, but it does so by reducing risk. First, the consumers have to perceive that they are buying a product in a process in which there is little risk to generate positive impressions or sensations during the product choice. However, this risk reduction is capable of generating satisfaction in itself. Next, consumers evaluate the advantages and disadvantages of their online shopping experience. When consumers perceive a lower level of risk in online purchases, they enjoy a more satisfactory experience, as one of the negative aspects of the experience has been reduced. Being comfortable and relaxed with the decision is essential to provide satisfactory experiences. In this sense, comfort with the decision increases satisfaction directly and through confidence in the decision. If the consumers are comfortable with the decision, it indicates confidence in the decision made[31,70].

The research makes several theoretical contributions to the AR literature. First, it is found that virtual consumption through AR directly impacts consumers' perceptions (risk of buying online) but not consumers' evaluations of their decision process (comfort and confidence with the decision). Reducing the perception of online shopping for those products improves the evaluation of the decision process by increasing comfort with the decision. Second, reducing the risk of buying online has been identified as a key aspect in the research context, as it directly improves the evaluation of the experience by directly affecting satisfaction. Likewise,

the other key aspect identified is decision comfort. Decision comfort affects satisfaction both directly and indirectly through decision confidence. Therefore, decision comfort is a key variable for the generation of satisfactory e-commerce experiences that are capable of generating engagement ultimately. It contributes to the knowledge of the effects of the decision process on satisfaction and engagement with the web[19]. In this sense, it shows how AR can generate engagement. Previous research based on equity theory shows that AR generates lower engagement than service in a physical shop[21]. This research demonstrates that, in an online shopping context, the improved experience evaluation provided by AR can increase engagement.

E-commerce companies should consider implementing virtual consumption experiences through AR tools for both web and mobile apps. In the beauty sector, including this technology could increase the number of visits to the shop, leading to higher sales[5]. In addition, the consumer will perceive less risk in the decision, making their choice easier and improving their well-being by increasing their comfort and confidence with the decision. Therefore, including AR in online shop environments could benefit both consumers and the company. Consumers could enjoy a more valued experience, which would enhance the engagement they have with the online shop, thus making them want to visit the online shop more often. On the other hand, companies from the beauty sector could achieve a higher level of sales due to the increased number of visits. In addition, as a consequence of the engagement generated towards their website, e-commerce companies could also see increased revenue from another source. The increased number of visitors to their website will increase the value of the ad placements on that website. Therefore, they could earn higher advertising revenues by increasing the advertisements' reach due to the increased traffic to their online environments.

Apart from including virtual consumption experiences, other actions could be taken. It is important to increase the comfort and confidence that consumers may have with their decision. Including relevant information clearly in the online shop could contribute to this[31,70]. Furthermore, including product comparators in the shop can make it more pleasant and increase confidence in the decision made, especially when comparing objective product attributes[71]. In addition, it is important that the company in the beauty sector context conveys security and confidence in managing the information collected with AR. This aspect is particularly important in this context because of the gathering of facial information from consumers using AR. Displaying how the information collected is handled before using AR could help convey security and transparency to consumers[60]. E-commerce companies should also introduce messages to encourage AR by their consumers to facilitate their decision making. Promotional campaigns could also encourage consumers to use the AR functions available. The good experience they would get could lead consumers to use the online commerce again due to the engagement generated.

Limitations and Future Research Lines

The study has been conducted on a single e-commerce site. Future studies could be developed on other online stores with a different web design or mobile apps to extend the results' generalisation to other contexts. Likewise, VTO makes it possible to address the pre-purchase test of cosmetic products. Future studies could examine the impact of AR on the perception of online shopping for other products and evaluate the decision made. For example, products in which the importance of attributes that cannot be tested through AR, such as the comfort in the case of furniture like sofas or chairs could be examined.

Some control variables, such as product knowledge, show a surprising preliminary effect on the perceived risk of buying the product online. Although knowledge of the product may make the consumer more aware of the risks involved in buying this type of product online, future work could examine this identified effect in more detail. The causes could be analysed in greater depth and explore if this fact is similar for all products or if there are specific attributes which influence the greater product knowledge resulting in a higher risk perception.

Finally, AR is often used for interactivity and enjoyment without a specific use for purchasing decisions. The effect of technology can change over time. Analysing how AR impacts perceptions during shopping when consumers use it more frequently could help to understand the relevance of the experience with the technology.

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