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Individuals with low self-esteem benefit most from interactivity in virtual try-on systems

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ABSTRACT

This study investigates how self-esteem and gender influence the potential of interactive augmented reality (AR)-based virtual try-on systems (VTOs) to improve the virtual product experience (VPE). In particular, we examine the impact of self-esteem and gender on the influence of varying levels of interactivity in virtual product presentation formats on two key determinants of VPE, i.e., user engagement and product enticement. In a between-subjects online experiment, 265 participants were randomly assigned to one of three interactivity conditions: no AR, low AR VTO, and high AR VTO. For each condition, they evaluated three products (eyewear) within an online store setting and indicated their subjective engagement and enticement. Results show that high AR interactivity significantly increased both engagement and enticement. Furthermore, self-esteem was positively associated with both VPE outcomes, and engagement increased with interactivity more strongly among individuals with lower self-esteem than among those with higher self-esteem. These findings extend current VPE frameworks by integrating psychological user characteristics and offer practical implications for the design of inclusive and user-centered product presentation formats.

1. Introduction

Advancing digitalization and technological innovations are expanding the possibilities for interactivity between humans and computers. Interactivity-enhancing technologies offer a variety of applications. For example, online store providers utilize innovative technologies to offer an interactive virtual product presentation as a unique selling proposition to attract new customers and improve their virtual product experience (VPE; Jiang & Benbasat, 2004), which, in turn, can positively impact economic variables such as purchase intention and willingness to pay (Animesh et al., 2011; Jiang & Benbasat, 2007; Petit et al., 2019; Yi et al., 2015). Previous work has shown that increasing the interactivity of the presentation format promotes important metrics of VPE such as engagement, i.e., the depth of consumers' immersion and enjoyment in the presentation (Webster & Ho, 1997; Yi et al., 2015), and enticement, i.e., the extent to which the presentation evokes curiosity and the desire for further product exploration in an offline "real-life" setting (Khaslavsky & Shedroff, 1999; Maloney, 2000; Menon & Soman, 2002; Yi et al., 2015).

One approach for offering an interactive VPE that has recently received increasing attention is using virtual try-on (VTO) systems for online product presentations, allowing customers to virtually interact with a specific product in a particular way (Chen et al., 2024). For example, instead of looking at static product pictures, customers can upload a photo of themselves (e.g., portrait picture) to an online store. The product, e.g, sunglasses, is then appropriately inserted into this photo. This provides customers with a preview of the product being applied as intended. Moreover, some VTOs use augmented reality (AR) to further increase the interactivity component offering highly interactive real-time virtual product presentations that provide an extraordinary VPE (Hilken et al., 2017; Merle et al., 2012; Rauschnabel et al., 2022; Riar et al., 2022; Zanger et al., 2022). Such AR-based VTOs can overlay products onto the user's live image, enabling realistic, real-time fitting and interaction. For instance, using AR-based VTOs, customers can virtually experience products such as glasses, clothing, or make-up (Javornik, 2016).

Recent studies investigating the impact of interactivity in product presentations on VPE have largely focused on the technological features that potentially enhance user experience by modifying levels of interactivity (e.g., photo-based low interactive AR-VTO vs. real-time high interactive live AR-VTO), while neglecting psychological factors that directly relate to how users perceive and evaluate their own appearance (Chen et al., 2024; Yi et al., 2015). In particular, self-esteem — a fundamental psychological trait indicating a person's positive or negative attitude toward the self (Rosenberg, 1965) — is uniquely relevant in the context of VTO, where users engage with realistic representations of themselves, making the experience inherently

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self-referential. Previous studies indicate that self-esteem significantly impacts how users experience interactivity and engagement with technology (Birk et al., 2015; De Laere et al., 1998; Javornik et al., 2021). Moreover, individual self-esteem can influence how people process self-related visual information, assess their appearance, and experience emotional reactions during VTO interactions. For example, previous work has shown that consumers with lower self-esteem, who are more sensitive to discrepancies between their actual and ideal selves, have a particularly positive attitude towards highly interactive AR-based VTO systems compared to consumers with high self-esteem (Javornik et al., 2021; Lavoye et al., 2023; Yim & Park, 2019). That is, prior findings suggest that the way people experience interactivity and engagement with technology depends on their self-esteem and that both interactivity and self-esteem can influence the VPE in VTOs (e.g., Chen et al., 2024; Javornik et al., 2021; Yi et al., 2015; Zare Ebrahimabad et al., 2024).

However, the interrelationship between interactivity, self-esteem, and VPE in VTOs remains underexplored, reinforcing the need for research that investigates how different levels of VTO interactivity interact with users' self-esteem to influence engagement and enticement as two main determinants of VPE (Yi et al., 2015).

Furthermore, while self-esteem has been shown to influence how people interact with technological systems, its effects do not occur in isolation. Gender, in particular, is an important factor that could influence this relationship. Previous research has consistently shown that men tend to report higher global self-esteem than women (Kling et al., 1999). At the same time, gender differences in attitudes toward technology use have been widely documented, with men generally holding more favorable attitudes toward technology than women (Cai et al., 2017). In addition, men and women can differ in their technology self-efficacy, i.e., their belief in their ability to effectively use technological systems, which can shape how they evaluate and engage with digital technologies such as Virtual try-on systems (Meyers-Levy & Maheswaran, 1991; Venkatesh & Morris, 2000). Given that self-esteem significantly impacts how users engage with technology (Birk et al., 2015; Jackson et al., 2010), it is plausible that the influence of self-esteem on consumer engagement and enticement in virtual product presentations may vary by gender. Indeed, previous work in the context of VTO systems has shown that gender can influence the effects of curiosity (a concept related to enticement) and user experience on attitudes toward technology (Chen et al., 2024). Therefore, considering the gender component as part of broader consumer diversity provides a more comprehensive understanding of how self-esteem interacts with the effect of interactivity on VPE. Addressing the gap in understanding the influence of self-esteem on user experience in interactive virtual environments, this study investigates how the interplay of self-esteem and gender moderates the effect of interactivity on engagement and enticement during virtual product presentations. In particular, we propose the following research question:

> RQ: *How do customers' self-esteem and gender influence the effect of interactivity on user engagement and product enticement in virtual product presentations?*

Accordingly, this study pursues three objectives: (1) to examine how different levels of interactivity in VTO systems affect user engagement and enticement; (2) to investigate how self-esteem moderates these effects; and (3) to explore whether gender further shapes the relationship between self-esteem, interactivity, and VPE. Taking the diversity of consumers into account, this paper contributes to the scientific literature by extending the current understanding of the relationship between interactivity-enhancing technology design elements and VPE in the context of VTO systems. Specifically, it integrates and advances the theoretical framework proposed by Yi et al. (2015) by incorporating psychological and consumer-specific individual characteristics as further variables affecting the relationship between interactivity and two critical determinants of VPE, i.e., user engagement and product enticement, in VTOs. The study complements previous research theories linking VTO interactivity and VPE (Yi et al., 2015) with findings on the relationships between self-esteem, gender, and user experience in VTOs (Cai et al., 2017; Chen et al., 2024). Thus, it provides a more comprehensive theory-based understanding of how diverse consumers varying in their level of self-esteem and gender experience interactivity in VTOs. From a practical perspective, the findings offer valuable insights for online retailers and technology developers aiming to apply value sensitive design principles (Friedman et al., 2013) to design VTO systems providing a comfortable, inclusive, and user-centered VPE for a diverse customer base.

2. Theoretical background

2.1. Interactive AR, user engagement, and product enticement

AR enhances real-world perception by overlaying virtual elements in real time (Milgram et al., 1995). This feature makes AR particularly effective for VPEs, where it helps to mitigate the intangibility of digital products by offering interactive and immersive experiences (McLean & Wilson, 2019). AR-based VPEs have been widely adopted in online and offline retail environments. For example, IKEA's AR application enables consumers to visualize furniture in their homes, bridging the gap between online and offline shopping (Rauschnabel et al., 2022). Similarly, beauty brands like Sephora allow consumers to try on makeup virtually, increasing purchase confidence (Javornik, 2016).

One fundamental feature of such AR applications is interactivity, which allows users to manipulate and explore virtual objects (McLean & Wilson, 2019; Qin et al., 2021; Yim et al., 2017). Research has shown that the interactivity of VR is higher than in websites (Mishra et al., 2021). Conceptually, interactivity is defined as "the extent to which users can participate in modifying the form and content of a mediated environment in real time" (Steinfield et al., 2008, p. 84). This pivotal affordance of AR could play a crucial role in enhancing user engagement and product enticement. User engagement refers to the depth of user involvement and enjoyment while interacting with a system (O'Brien & Toms, 2008). Psychological theories such as flow theory (Csikszentmihalyi & Csikzentmihaly, 1990) and cognitive absorption (Agarwal & Karahanna, 2000) suggest that highly engaging experiences occur when users are deeply involved and derive intrinsic enjoyment from technological interaction. In this regard, previous research confirms that interactive systems heighten engagement by offering control, flexibility, and real-time feedback (Teo et al., 2003). In the context of AR-based virtual product presentations, higher interactivity levels allow users to explore products dynamically, increasing their engagement (Jessen et al., 2020; Kumar, 2021; McLean & Wilson, 2019). For instance, interactive AR features such as rotating, zooming, or customizing a product can create a sense of agency, leading to heightened involvement and enjoyment. Hence, when users can actively manipulate virtual products rather than passively viewing static images, their level of engagement with the presentation increases.

Product enticement refers to the extent to which a product presentation stimulates interest and desire (Menon & Soman, 2002; Yi et al., 2015). Unlike engagement, which relates to sustained interaction, enticement focuses on initial attraction and curiosity. Research suggests that enticing designs trigger consumer curiosity, leading to increased interest in further exploring a product (physically) (Loewenstein, 1994; Maloney, 2000). A key mechanism behind enticement could be the relationship between interactivity and curiosity. According to Berlyne's 1954 theory of curiosity, users experience greater intrigue when they perceive richer novel stimuli. Transferring this to the context of AR, highly interactive environments offer users more exploration opportunities, that increase the potential of stimuli and thus their anticipated pleasure from interacting with the product (Jiang & Benbasat, 2007). In line with this, studies have found that sensory stimulation (e.g., through interactive product visualization) fosters vivid mental imagery, making the real product feel more tangible and desirable (Kim et al., 2021; Schlosser, 2003). For example, AR-based virtual product presentations allow consumers to visualize themselves using the product, leading to stronger emotional attachment and anticipation (Hilken et al., 2017). This effect is especially pronounced in VTO applications, where users can dynamically adjust product features and experience a real-time personalized interaction (Riar et al., 2022). propose the following hypotheses:

H1: User engagement increases with increasing AR interactivity levels of the virtual product presentation format.

H2: Product enticement increases with increasing AR interactivity levels of the virtual product presentation format.

2.2. The relationship between self-esteem, gender, and VPE

Self-esteem is usually defined as the evaluative component of self-knowledge, reflecting the degree to which individuals perceive themselves as likable, valuable, and competent (Brown, 1998; Orth & Robins, 2014; Tafarodi & Swann, 1995; Zeigler-Hill, 2013). High self-esteem is characterized by a positive self-image, whereas low self-esteem is associated with uncertainty or negative self-evaluations (Campbell et al., 1996). Self-esteem relates to the way individuals feel, think, and behave (for reviews, see, Baumeister, 2010; Harter, 1998; Zeigler-Hill, 2013), it influences how information is transferred between the person and their social environment, and it can serve as a buffering component to protect a person from negative experiences (Zeigler-Hill, 2013).

Self-esteem can influence the way individuals perceive certain experiences, especially when these have an impact on their self-perception. It is assumed that people strive to maintain and enhance their self-esteem through different strategies (Park & Crocker, 2013). Those with high self-esteem (HSE) focus on self-enhancement, seeking to reinforce their positive self-image, while those with low self-esteem (LSE) prioritize self-protection, aiming to prevent further decline (Baumeister et al., 1989). Self-protective tendencies include, e.g., avoiding attention, concealing weaknesses, and minimizing risk-taking. In principle, LSE individuals tend to adopt a generally cautious and conservative approach to their thoughts, experiences, and interactions (Josephs et al., 1992; Zeigler-Hill, 2013). For instance, behavioral science research has shown that self-esteem influences the way people behave when looking at themselves in a mirror, with HSE individuals looking at themselves for a shorter time than LSE individuals, which can be interpreted as a less cautious evaluation of their own face (Potthoff & Schienle, 2021).

One particular experience that is linked to self-esteem and self-perception is the evaluation of particular products that modify the individual's physical appearance (e.g., glasses, make-up, clothes). Thus, the way individuals experience the virtual presentation (i.e., VPE) of such products in online stores might be influenced by their individual self-esteem. Although, the direct relationship between self-esteem and certain metrics of VPE (i.e., engagement and enticement; Jiang & Benbasat, 2004) has not been investigated so far and is, therefore, relatively unclear, previous work shows that self-esteem can significantly affect related behavioral constructs.

For example, several studies indicate a relationship between self-esteem and consumer behavior, decision-making, technology use and metrics of user experience (Khare & Sadachar, 2014; Rucker et al., 2012; Wang et al., 2012). Some researchers see self-esteem as "one of the most important motivational drivers of consumer behavior and decision-making" (Banister & Hogg, 2004, p. 850). Furthermore, previous work investigating how self-esteem shapes user experience by affecting information system usage reveals mixed findings. Some studies showed that people with lower self-esteem tend to avoid face-to-face communications and prefer instant messaging tools and e-mail (Ehrenberg et al., 2008; Joinson, 2004).

Based on these findings, Wang et al. (2012) hypothesized that social networking site usage among students increases with decreasing self-esteem because they expected students with lower self-esteem would prefer online social interaction rather than face-to-face activities. However, the results of their quantitative study revealed the opposite effect (increased social networking usage with increasing self-esteem). Wang et al. (2012) explain the tendency of people with higher self-esteem to post more comments on social networks with the assumption that they are more confident in their opinions. In contrast, Tibber et al. (2020)—who conducted a detailed analysis of the relationship between self-esteem and cross-platform social media usage—found that individuals with low self-esteem indicated a significantly longer period (minutes) of daily social media use than those with higher self-esteem. In addition, Steinfield et al. (2008) identified self-esteem as a moderator of the relationship between social media usage and bridging social capital. Individuals with lower self-esteem tend to benefit more from using Facebook in terms of bridging social capital compared to those with higher self-esteem. Bringing the effect of self-esteem on information system usage and consumer behavior together, Alan et al. (2017) found that online shopping intention increases with increasing self-esteem.

In the context of technological readiness, Kim and Kim (2022) identified self-esteem as a predictor of technological readiness and readiness for change, moderated by the gender of the participants. The positive correlations between self-esteem and the two readiness constructs was stronger for men than for women. Furthermore, Jackson et al. (2010) report a positive relationship between IT use and self-esteem and they also found gender differences in the self-reported self-concepts of their participants. Gender differences in both self-esteem and technology use are rather the rule than the exception (Cai et al., 2017; Kling et al., 1999). The most common findings are that men usually tend to indicate higher values on self-esteem and technology use measures than women.

Moreover, self-esteem has been found to be an important predictor of user experience in mobile apps used for resource sharing with self-esteem positively correlating with user experience (Geng & Guo, 2022). In addition, there are some studies suggesting a relationship between self-esteem and concepts specifically related to user engagement and product enticement such as enjoyment and curiosity. For example, studies found that self-esteem positively correlates with people's enjoyment of work (Graves et al., 2012) and physical activity (Weiss, 2000) but also in virtual contexts, e.g., when interacting with play technologies (Birk et al., 2015), or using online learning programs (Pellas, 2014) and face swap apps (Ha et al., 2024). Similarly, Ha et al. (2024) found a positive relationship between self-esteem and curiosity in their study, which is a concept related to product enticement.

In summary, the common findings show that self-esteem significantly influences consumer behavior and decision-making as well as technology interaction, mainly indicating positive correlations between self-esteem and VPE-related concepts such as enjoyment, curiosity, user experience, and technology use. In addition, research also found important gender differences in self-esteem, technology use, and user experience. Taking these findings into consideration, we propose the following hypotheses:

H3: User engagement in virtual product presentations increases with increasing self-esteem.

H4: Product enticement in virtual product presentations increases with increasing self-esteem.

H5a: Self-esteem is higher for men than for women, enhancing user engagement more strongly among women than among men.

H5b: Self-esteem is higher for men than for women, enhancing product enticement more strongly among women than among men.

2.3. The relationship between self-esteem and the effect of interactivity on VPE

As outlined above, the interactivity level of the virtual product presentation has been shown to enhance the VPE in terms of user engagement and enticement (Yi et al., 2015; Zare Ebrahimabad et al., 2024). In addition, self-esteem, representing an individual's evaluative self-perception can affect users' experiences with interactive technologies. However, little is known about the interplay between interactivity and self-esteem in the context of VPE.

Related research has shown that LSE individuals benefit more strongly from interactive experiences on social media, as these platforms provide safer, more comfortable environments for self-expression and social connection compared to face-to-face interactions (Steinfield et al., 2008). Similarly, Javornik et al. (2021) found that AR-based virtual try-on mirrors influenced consumers' self-perceptions based on self-esteem levels differently, with LSE individuals experiencing greater satisfaction and reduced self-discrepancy. Supporting these findings, Dijkslag et al. (2024) indicated that AR face filters had stronger positive impacts on body satisfaction among those with lower self-esteem, suggesting heightened sensitivity to augmented representations among these individuals.

Moreover, Birk et al. (2015) show that interactivity affects motivational outcomes, including enjoyment and effort, differently depending on self-esteem. Specifically, LSE individuals experience increased enjoyment and motivation through interactive environments due to the support for autonomy and competence these provide. Similarly, De Laere et al. (1998) emphasize the importance of personalized feedback in human–computer interactions, showing that interactive feedback strongly influences self-appraisal processes.

In summary, these studies suggest that the positive effects of interactivity on engagement and enticement in VTO contexts might diminish as self-esteem increases. Individuals with HSE may not rely as much on external validation provided through interactive experiences, while individuals with LSE may find interactivity particularly beneficial.

Consequently, we propose the following hypotheses:

H6a: The positive effect of interactivity on user engagement in VTO decreases with increasing self-esteem.

H6b: The positive effect of interactivity on product enticement in VTO decreases with increasing self-esteem.

3. Method

We designed an online experiment involving three different conditions of virtual product presentation formats that varied in terms of their level of interactivity. Participants were randomly assigned to one of the presentation formats and indicated the level of engagement and enticement they experienced for each product presentation format. They also provided information about their individual self-esteem, gender, and other demographics. The experiment was part of a larger study and served as the basis for testing our hypotheses derived from the research model. The research model, including the hypotheses, is illustrated in Fig. 1. In the following, we describe the experiment in detail.

3.1. Participants

We conducted an a priori power analysis to determine the required sample size for the planned data analysis (analysis method: Generalized Linear Model; GLM). The analysis considered main effects and 2-way interactions as proposed by the research model (see Fig. 1). We used the following parameters for the power analysis: target power $(1-\beta)$ of 0.9, $\alpha = 0.05$, and a medium effect size defined as $\eta^2 \approx 0.06$ (Correll et al., 2020). Results indicated that a total sample size of approximately 264 participants is required to demonstrate the expected effects. To account for potential dropouts, maintain adequate statistical power, and facilitate additional exploratory analyses, a slightly larger sample size was targeted.

Participants were recruited using non-probability convenience sampling via the online research platform Prolific, which provides access to a diverse pool of participants. Our sampling frame consisted of Prolific users aged 18 years and older who are fluent in English. Participation was voluntary and participants gave informed consent for their data to be used for academic research.

Overall, 311 participants were recruited via the online research platform Prolific. After removing the data of those who dropped out, withdrew their consent and failed attention checks, 265 participants remained (124 female, 139 male; one person did not indicate their gender). The 265 participants were between 18 and 75 years of age (mean=34.9; SD=10.7). Median participation time was 19 min and 42 s. Each participant received compensation of $2.60. The study was conducted in accordance with the Code of Ethics and Professional Conduct of the Association of Information Systems (AIS) and complied with all relevant local regulations and institutional guidelines. Ethical approval for this study was obtained from the Institutional Review Board of the German Association for Experimental Economic Research e.V. (approval date: 2025/06/10; approval number: ZesJtzb9).

3.2. Study design and materials

To measure the dependent variables of our study, i.e., engagement, enticement, and interactivity (as a manipulation check), we embedded items from validated psychometric scales into an online survey. The details of these measures are described in the following section.

We manipulated the level of interactivity using a between-subjects design with three conditions: no AR (control), low AR interactivity, and high AR interactivity. In the no AR control condition, participants explored various eyeglass frames at an online store that presented products solely through static product photos. In the low AR interactivity condition, participants used a "Try Online" feature, where they could take a photo of themselves via their webcam or upload a picture. The system then virtually inserted the selected eyeglass frames into the photo(s), allowing participants to see how the frames might look on them. In the high AR interactivity condition, participants engaged with a live AR video function that enabled real-time visualization of the eyeglass frames on their faces like a virtual mirror. This live-video feature used facial recognition technology to detect and map the user's face, overlaying the frames with proper alignment and fitting. As participants moved their heads, the virtual frames adjusted accordingly, providing a dynamic and interactive product presentation. Table 1 summarizes the product presentation format for each condition.

To ensure realistic and market-relevant stimuli, we included visual product presentations from three well-known online eyewear retailers: Visionet, GlassesUSA, and Mister Spex. Visionet showcases its products through static photographs, reflecting a traditional online shopping experience. In addition to product photos, GlassesUSA provides an option for users to upload or take photos to virtually try on glasses, aligning with the low AR interactivity condition. Mister Spex offers a comprehensive live-video VTO system for its entire product range, employing AR and facial recognition technologies that enable users to view how frames fit from multiple angles. Although Visionet and GlassesUSA also offer VTO features, their availability was limited to a smaller selection of products at the time of the data collection, whereas Mister Spex provided this functionality across almost its entire range.

To maintain consistency across conditions, we selected three contemporary unisex eyeglass frames from popular brands that cater to diverse consumer preferences: an oval frame by Gucci, a rectangular frame by Nike, and a geometric frame by Calvin Klein. These frames were chosen to represent a range of styles — from the bold and luxurious Gucci design, to the sporty and practical Nike option, and

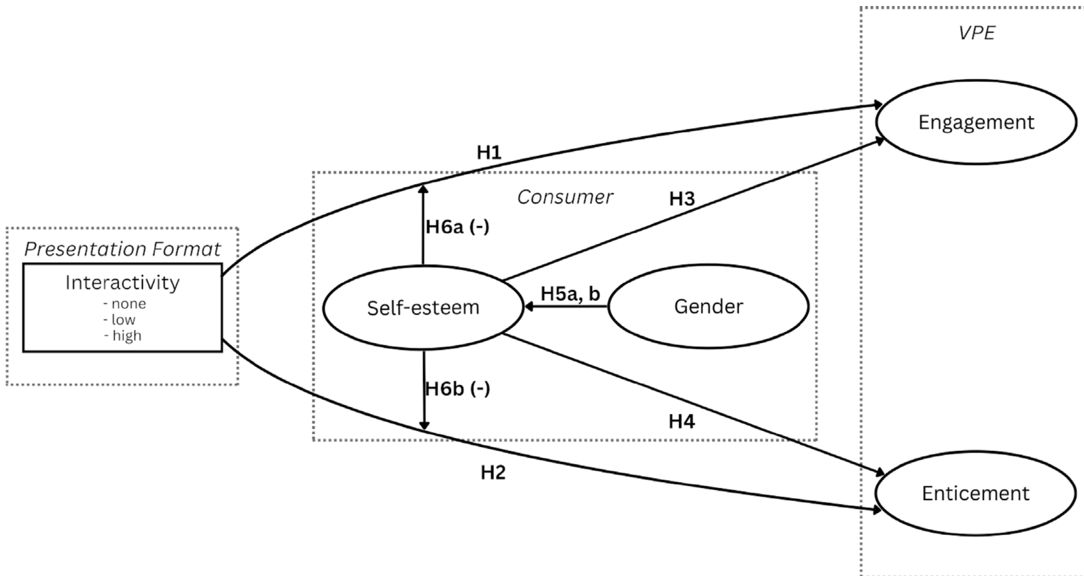

Fig. 1. Research model.

Table 1
Summary of the experimental conditions used in the study.

	No AR	Low AR	High AR
Product presentation	product pictures	product pictures + VTO: photo	product pictures + VTO: virtual mirror
Features	zoom	zoom (product pics)	zoom (product pics)
		+ static AR	+ dyn. real-time AR

the minimalist Calvin Klein aesthetic — ensuring broad appeal and familiarity among participants.

To ensure data quality, we incorporated three attention checks throughout the study. Firstly, participants completed a basic arithmetic task requiring them to sum two randomly generated numbers between 1 and 9 (e.g., 1 + 9). Secondly, they were asked to select a specific response option for one particular survey item (e.g.,"strongly disagree") to ensure attentiveness to instructions. Thirdly, at both the beginning and end of the survey, participants indicated their preferences between pairs of commonly known items (e.g., Coke or Pepsi, Apple or Android, city life or country life) on a seven-point scale. Participants who failed the first or second attention check were excluded from the study, while the third check served as an indicator of response consistency and overall data quality during analysis.

3.3. Measures

We followed the approach of Yi et al. (2015) and adapted scales from previous studies to measure our dependent variables engagement (Webster & Ho, 1997) and enticement (Menon & Soman, 2002). Accordingly, we measured engagement using six items and enticement using four items. We observed a reliability of $\alpha = 0.93$ and $\alpha = 0.94$ for the engagement and enticement scale, respectively. We further included two items to measure the perceived interactivity of the product presentation formats. Participants rated these items on a seven-point Likert scale ranging from "strongly disagre" to "strongly agree" ($\alpha = 0.89$).

Self-esteem was measured using Rosenberg's Self-Esteem Scale (Rosenberg, 1965). The scale includes ten statements and is based on self-assessment. Participants rate each statement on a four-point scale ranging from "strongly disagree" to "strongly agree." Higher scores indicate higher self-esteem. The reliability of the Self-Esteem Scale was $\alpha = 0.91$ in the current study. A complete list of all items reported in this study can be found in the supplementary material.

3.4. Procedure

The questionnaire was part of a comprehensive study and started with an introduction providing participants with essential information, including details about the inclusion of attention checks and the requirement to upload screenshots, which could potentially include their photo. Participants were then randomly assigned to one of three experimental conditions that varied in their level of interactivity: a no AR control condition, where they viewed standard product photos; a low AR interactivity condition, where they used a photo-based VTO function; or a high AR interactivity condition, where they engaged with a live-video VTO feature.

At the start of the experiment, participants answered demographic questions and provided information about their online shopping behavior (frequency), colorblindness, and whether they use glasses and/or sunglasses. They then explored three eyeglass frames presented through the online store's product presentation features. To ensure consistency across conditions, the products were shown in the same order: Calvin Klein, Nike, and Gucci. Participants navigated to the respective product pages via the provided links and were instructed to capture at least three screenshots (one per product) during their interaction with the online store features. The screenshots were used to confirm that the participants followed the instructions and that the product presentations were displayed correctly. Fig. 2 illustrates the sequence of the experimental tasks and the product presentations (please note that we have used license-free stock photos for this illustration to preserve the anonymity of the participants).

Following the product exploration, participants completed the study measures, which included items assessing engagement, enticement, interactivity (manipulation check), and self-esteem. After submitting their responses, they uploaded the required screenshots to a secure server and received a completion code to claim their compensation through Prolific.

3.5. Statistical analysis

To analyze the data, we first computed descriptive statistics to summarize the data of key variables. A one-way ANOVA was conducted

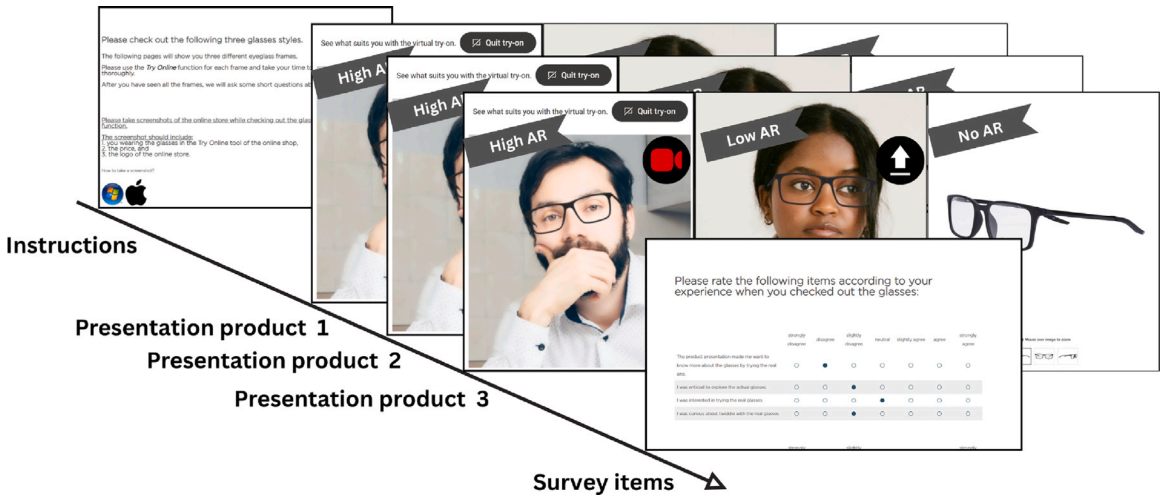

Fig. 2. Exemplary illustration of the experimental timeline. Interactivity levels were varied between subjects. High AR: live video VTO; low AR: photo-based VTO; no AR: product photos.

Table 2
Descriptive statistics of scale items. The Interactivity scale was used for testing our experimental manipulation of the interactivity of the product presentation format. Engagement and Enticement served as dependent variables, Self-esteem as an independent variable. SD = standard deviation.

Scale	Median	Mean	SD	Min	Max
Interactivity	6.00	5.50	1.34	1.00	7.00
Engagement	5.67	5.54	1.14	1.00	7.00
Enticement	5.50	5.07	1.47	1.00	7.00
Self-esteem	3.10	3.10	0.64	1.00	4.00

as a manipulation check to assess whether the experimental manipulation of interactivity across three levels was successful. To confirm the validity of the measures included in this study, we performed confirmatory factor analysis of the Interactivity, Engagement, Enticement, and Self-esteem items. Furthermore, the scales were analyzed based on (conditional) mean values of the respective items for each scale and participant. To test our hypotheses, we performed Generalized Linear Model (GLM) analyses, conducting separate models for each dependent variable (Engagement and Enticement). For the GLM analyses, we considered Interactivity (three levels) and Gender as factors, and Self-esteem as a covariate. All statistical analyses were conducted using the open-source statistics software JASP (version 0.18.3) and Microsoft Excel (version 2108).

4. Results

Table 2 shows the descriptive statistics for the key variables in the current study. The Interactivity scale, which was used to assess the experimental manipulation, has a relatively high median and mean, indicating that participants generally perceived the product presentations as interactive. Both Engagement and Enticement also show relatively high mean values, suggesting overall positive responses to the product presentation. Responses to the Self-esteem scale indicate positive self-esteem across participants.

4.1. Instrument validity

The results of the factor analysis showed that all items of the instruments loaded strongly onto their respective factors, with factor loadings ranging from 0.60 to 0.95 (Table 3).

For Interactivity, both items showed very high loadings (0.90 and 0.93), confirming that they reliably measure the perceived interactivity of the product presentation. The items for Engagement also demonstrated strong factor loadings (0.84 to 0.94), suggesting a consistent measurement of user engagement. Similarly, the Enticement factor exhibited high loadings (0.83 to 0.95), indicating that the scale effectively captures the enticement dimension.

The Self-esteem scale showed mostly high loadings between 0.77 and 0.90, except for one item (SES8) with a lower loading of 0.60, which still falls within an acceptable range. All loadings are statistically significant.

The average variance extracted (AVE) values further supporting convergent validity. All factors exceed the commonly recommended threshold of 0.50 (Fornell & Larcker, 1981), with AVE values ranging from 0.66 to 0.84, indicating that a substantial proportion of variance is explained by the latent constructs. Factor 1 (0.84), Factor 2 (0.79), and Factor 3 (0.83) exhibit particularly strong AVE values, confirming that these constructs capture a high degree of variance from their indicators. Factor 4 (Self-esteem) has an AVE of 0.66, which is still well above the threshold, supporting the reliability of the scale.

Table 3
Factor loadings obtained from the confirmatory factor analysis. Est. = Estimates, SE = Standard error.

Factor	Item	Est.	SE	z-value	*p*
Interactivity	INT1	.93	.02	52.02	<.001
	INT2	.90	.02	52.02	<.001
Engagement	ENG1	.87	.01	75.48	<.001
	ENG2	.90	<.01	92.88	<.001
	ENG3	.87	.01	68.99	<.001
	ENG4	.94	<.01	99.18	<.001
	ENG5	.84	.01	67.53	<.001
	ENG6	.93	<.01	95.38	<.001
Enticement	ENT1	.92	.01	89.13	<.001
	ENT2	.94	<.01	95.94	<.001
	ENT3	.95	<.01	95.45	<.001
	ENT4	.83	.01	68.80	<.001
Self-Esteem	SES1	.81	.02	49.57	<.001
	SES2	.85	.02	50.87	<.001
	SES3	.89	.01	60.27	<.001
	SES4	.77	.02	41.55	<.001
	SES5	.79	.02	51.53	<.001
	SES6	.83	.02	52.05	<.001
	SES7	.82	.02	53.19	<.001
	SES8	.60	.02	32.92	<.001
	SES9	.82	.02	54.28	<.001
	SES10	.90	.01	61.81	<.001

Table 4
Generalized linear model. Main effects and interaction effects on user engagement. Est=Estimate, SE= Standard error, Int=Interactivity, SES=Self-esteem, Gnd=Gender (m=male, f=female); reference categories: Int(no), Gnd(f). Model fit was assessed using deviance statistics: Null deviance $D = 339.72$ ($df = 263$), Residual deviance (main effect model) $D = 306.44$ ($df = 259$), $\chi^2 = 33.27$, $p < .001$; Residual deviance (interaction effects model) $D = 297.84$ ($df = 256$), $\chi^2 = 41.87$, $p < .001$.

	Main effects model				Interaction effects model			
	Est.	SE	*t*	*p*	Est.	SE	*t*	*p*
Int (low)	.139	.165	.841	.401	1.945	.781	2.491	.013
Int (high)	.496	.163	3.044	.003	2.324	.836	2.780	.006
SES	.449	.106	4.243	<.001	.829	.209	3.960	<.001
Gnd(m)	.177	.135	1.317	.189	.339	.679	.499	.618
SES×Int (low)					−.577	.247	−2.341	.020
SES×Int (high)					−.579	.263	−2.206	.028
SES×Gnd (m)					−.051	.215	−.238	.812
(Intercept)	3.845	.367	10.490	<.001	2.626	.679	3.866	<.001

4.2. Manipulation check

The manipulation check revealed a significant effect of the experimental manipulation of the presentation format's interactivity on the scores of the Interactivity scale, F(2, 262)= 6.79, $p = .001$. In particular, participants in the high interactivity condition ($M = 5.89, SD = 1.08$) reported significantly higher interactivity scores than those in the low interactivity condition ($M = 5.48$, $SD = 1.28$, $p = .048$) and the control condition ($M = 5.17$, $SD = 1.51$, $p < .001$). Please note that we used Holm correction to adjust the p-values for alpha-error inflation for the post-hoc tests of the ANOVA.

4.3. Hypothesis testing

We report the results of our hypothesis tests separately for the Engagement and the Enticement variables below. A results summary of all hypotheses is highlighted in Table 6. To control for a potential impact of particular demographic variables (i.e., Age, Education, Income) or specific control variables (i.e., Online-shopping frequency, Spectacle-wearer, Colorblindness), we exploratory conducted one ordinal linear regression analysis for each dependent variable (Engagement and Enticement) including the demographics and control variable mentioned above. The models did not significantly explain variance in the dependent variables Engagement, F(4, 260)= 1.772, $p = .135$, and Enticement, F(4, 260)= 1.563, $p = .185$. Therefore, we assume that these variables have no impact on the dependent variables of the current study and we thus do not consider them further in the following analysis.

4.3.1. Engagement

With respect to our first hypothesis (H1), the analysis of the main effects (Table 4, main effects model) shows that participants who were assigned to the high AR condition of the Interactivity variable indicated a significantly higher engagement ($M = 5.82$, $SD = 1.04$) than those assigned to the control condition (no AR; $M = 5.40$, $SD = 1.20$). Engagement in the low AR Interactivity condition ($M = 5.42$, $SD = 1.13$) was not statistically different to the control condition.

Moreover, with respect to the individual self-esteem of the participants, we found that (1) there is a significant positive effect of the participants' self-esteem on their perceived engagement across all Interactivity conditions (supporting H3), i.e., the user engagement increased with increasing self-esteem of participants. (2) The statistically significant interaction effect of self-esteem by interactivity on the engagement variable as shown in Table 4 (interaction effects model), suggests that the effect of interactivity in VTOs on user engagement depends on the participant's individual self-esteem (supporting H6a). In particular, as illustrated in Fig. 3, the observed effect of increasing user engagement with increasing individual self-esteem is stronger in the control AR Interactivity condition than in the other conditions (low AR and high AR). However, the user engagement of participants with higher self-esteem seems to remain relatively stable across the three interactivity conditions. As self-esteem decreases, engagement also decreases in the control condition, but not in the low and high interactivity conditions. In other words, the lower the self-esteem, the stronger the effect of Interactivity on Engagement. Based on our analysis, we found no indications of a relationship between the variables of Gender, Self-esteem, and Engagement (H5a).

Table 5
Generalized linear model. Main effects and interaction effects on product enticement. Est=Estimate, SE= Standard error, Int=Interactivity, SES=Self-esteem, Gnd=Gender; reference categories: Int(no), Gnd(f). Model fit was assessed using deviance statistics: Null deviance $D = 339.72$ ($df = 263$), Residual deviance (main effect model) $D = 306.44$ ($df = 259$), $\chi^2 = 33.27$, $p < .001$; Residual deviance (interaction effects model) $D = 297.84$ ($df = 256$), $\chi^2 = 41.87$, $p < .001$.

	Main effects model				Interaction effects model			
	Est.	SE	*t*	*p*	Est.	SE	*t*	*p*
Int(low)	−.004	.216	−.018	.986	1.226	1.027	1.194	.234
Int(high)	.432	.213	2.029	.043	2.146	1.1	1.951	.052
SES	.474	.138	3.427	<.001	.579	.275	2.104	.036
Gnd(m)	.399	.176	2.267	.024	−.453	.893	−.507	.612
SES×Int (low)					−.391	.324	−1.206	.229
SES×Int (high)					−.549	.345	−1.590	.113
SES×Gnd (m)					.277	.283	.980	.328
(Intercept)	3.245	.479	6.777	<.001	2.886	.893	3.230	.001

4.3.2. Enticement

With respect to our second hypothesis (H2), the results of the GLM analysis of the main effects (Table 5, main effects model) showed that participants indicated a significantly higher product enticement in the high AR condition ($M = 5.35, SD = 1.37$) than in the other Interactivity conditions (low AR: $M = 4.86, SD = 1.51$; control: $M = 5.01, SD = 1.50$). There were no differences in product enticement between the low AR and the control condition of Interactivity. Moreover, the values of the Enticement variable increased with increasing values of Self-esteem (supporting H4) and it was higher for men ($M = 5.25, SD = 1.43$) than for women ($M = 4.85, SD = 1.50$). However, according to the GLM analysis, none of the expected interaction effects, i.e., Self-esteem by Interaction, and Self-esteem by Gender (Table 5, interaction effects model), showed a significant impact on product enticement (H5a, H6a).

5. Discussion

This study examined how self-esteem and gender influence the effect of interactivity in virtual product presentation formats on two central determinants of VPE, i.e., user engagement and product enticement. Building on prior research highlighting the relevance of

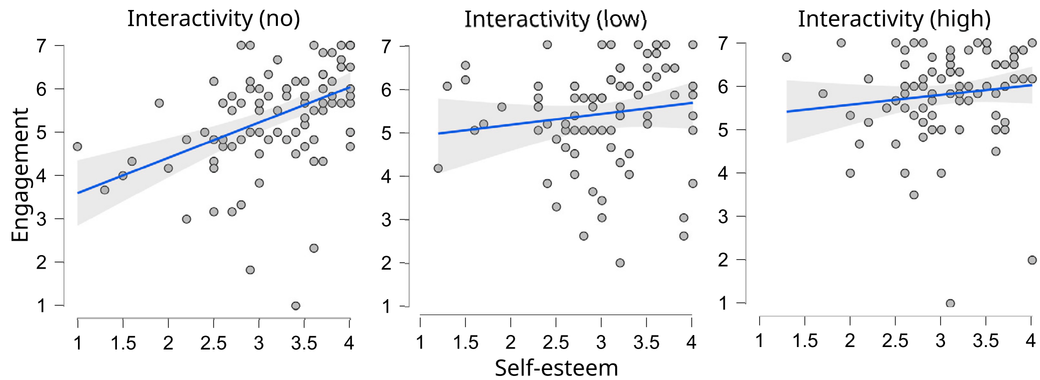

Fig. 3. The interaction effect between Interactivity and Self-esteem on Engagement.

Table 6
Summary of hypotheses and results.

Hyp.	Result	Explanation
H1	Partly supported	Engagement sig. higher in high AR; low AR not sig. different from control.
H2	Partly supported	Enticement sig. higher in high AR; low AR not sig. different from control.
H3	Supported	Engagement increased sig. with self-esteem across all conditions.
H4	Supported	Enticement increased sig. with self-esteem across all conditions.
H5a	Not supported	No sig. interaction of gender and self-esteem on engagement.
H5b	Not supported	No sig. interaction of gender and self-esteem on enticement.
H6a	Supported	Sig. interaction: interactivity boosted engagement mainly for lower self-esteem; stable for higher self-esteem.
H6b	Not supported	No sig. interaction of interactivity and self-esteem on enticement; only main effects observed.

interactivity-enhancing technologies such as AR-based VTOs for improving the individual VPE, the study adapted existing frameworks (Yi et al., 2015) and expands them by incorporating context-relevant psychological characteristics. In particular, while previous work investigating the effect of interactivity on VPE has largely focused on technological features, the current study considered self-esteem as a individual characteristic particularly relevant in self-evaluative settings such as VTOs. By bringing previous work examining the role of interactivity in VTOs (Yi et al., 2015) together with findings on the interrelationship between self-esteem, gender, and user experience (Cai et al., 2017; Chen et al., 2024), the study contributes to a more comprehensive understanding of how diverse consumers experience user engagement and product enticement in interactive virtual product presentations.

To empirically examine these relationships, we conducted an online experiment using a between-subjects design with three interactivity conditions: no AR (control), low AR interactivity, and high AR interactivity. Participants (n = 265) were randomly assigned to one of the conditions. Each participant evaluated three different eyeglass products and provided information about the perceived VPE.

We hypothesized that user engagement (H1) and product enticement (H2) are positively related to the interactivity level of the virtual product presentation. The results of our study partly support these hypotheses. The participants perceived significantly higher engagement and enticement in the high AR interactivity condition than in the control condition. However, the low AR interactivity manipulation has not significantly increased the levels of engagement and enticement. One possible explanation is that the low level of AR interactivity might not have involved participants at a sufficient depth to elicit an intrinsic enjoyment of the interaction (Agarwal & Karahanna, 2000; Csikszentmihalyi & Csikzentmihaly, 1990). Moreover, the photo-based VTO function used in the low interactivity condition may have caused some irritation due to the more static (less interactive) visualization. Although previous research suggests that interactivity has great potential to improve consumers' perceptions in AR environments, this effect can be diminished if the AR experience is perceived as irritating (Yim et al., 2017; Yim & Park, 2019). For instance, inconsistencies between virtual product overlays and the consumer's real facial proportions, as well as unfavorable viewing angles required to assess one's own appearance, can undermine the intended benefits of interactivity. The photo-based VTO did not offer the option to change the perspectives and viewing angles, which participants may have found irritating, negating the expected positive effects on user engagement and product enticement.

With regard to hypotheses H3 and H4, the results support the assumption that self-esteem positively influences both user engagement and product enticement in virtual product presentations. Across all interactivity conditions, engagement and enticement increased with increasing self-esteem suggesting that a better VPE is associated with higher self-esteem. This finding aligns with previous research indicating that self-esteem enhances enjoyment and curiosity in digital environments (e.g., Birk et al., 2015; Graves et al., 2012; Ha et al., 2024). It also corroborates theoretical perspectives that conceptualize self-esteem as a motivational resource that influences consumer behavior and facilitates user experience (Geng & Guo, 2022; Khare & Sadachar, 2014; Rucker et al., 2012).

As several previous studies suggest gender differences in self-esteem and technology use (Cai et al., 2017; Kim & Kim, 2022; Kling et al., 1999), with men usually tending to report higher self-esteem and more frequent technology use, we also expected gender differences in the relationship between self-esteem and VPE, i.e., user engagement (H5a) and product enticement (H5b). However, the current study does not support these two hypotheses in any way. The analysis of the data showed no significant interaction effects of self-esteem by gender on user engagement or product enticement. Nevertheless, for the regression analysis, we adjusted the main effect models for a potential main effect of the Gender variable on user engagement and product enticement. The results suggest that male participants experience stronger product enticement than female participants regardless of the individual level of self-esteem and the different conditions of virtual product presentation interactivity. This finding suggests that gender differences also play a role in individual VPE, which complements previous research indicating the influence of gender on technology use (Cai et al., 2017).

In addition, this paper examined the moderating effect of self-esteem on the relationship between interactivity and VPE. We hypothesized that the positive effect of interactivity on user engagement decreases with increasing self-esteem (H6a), and similarly, that the positive effect of interactivity on product enticement diminishes with increasing self-esteem (H6b). The results provide empirical support for H6a: we found that user engagement increases with increasing self-esteem particularly when the virtual product presentation includes no interactivity features. However, the positive relationship between self-esteem and user engagement becomes weaker when interactivity features are included in the virtual product presentation. As illustrated in Fig. 3, user engagement seems to remain relatively stable across the interactivity conditions among consumers with higher self-esteem. In contrast, among those with lower self-esteem, user engagement is more pronounced for low and high interactive virtual product presentation than for the control condition. These findings corroborate previous research suggesting that specifically individuals with lower self-esteem experience increased enjoyment in interactive play environments (Birk et al., 2015), and studies showing that self-esteem influences the way users experience interactivity and engagement with AR technology (De Laere et al., 1998; Javornik et al., 2021).

Moreover, while we found positive main effects of self-esteem and interactivity on product enticement, their interaction effect was not significant according to our analysis. That is to say, the individual product enticement increases with increasing self-esteem regardless of the interactivity level. Consequently, the data does not support hypothesis H6b. In other words, although we expected self-esteem to moderate the effect of interactivity on product enticement, the analysis revealed no such moderation. Both self-esteem and interactivity has positive main effects on enticement, but their interaction was statistically insignificant. Both the level of interactivity of the virtual product presentation and the individual's self-esteem influence the extent to which the virtual product presentation evokes curiosity and the desire for further product exploration in an offline "real-life" setting. Thus, contrary to our theoretical expectation, there is no evidence of an interrelationship between the influence of self-esteem and interactivity on enticement.

A possible explanation for the lack of support for this hypothesis could be found in the conceptualization of enticement. As the interrelationship between interactivity, self-esteem, and enticement has not been investigated so far, we have drawn on related concepts for the development of the hypotheses, in particular curiosity. Although previous work suggests that self-esteem has a positive effect on curiosity (Ha et al., 2024), enticement also reflects a consumer's desire to explore the product offline in a real-world setting. However, previous work has shown that individuals with lower self-esteem tend to prefer digital over real-world environments (Kiani & Laroche, 2019; Wai-Yu Lee & Mei-Kwan Cheung, 2014). Thus, people with lower self-esteem may perceive a greater curiosity with increasing interactivity. On the contrary, they may not feel a more pronounced desire to interact with the product in a real-world situation compared to people with higher self-esteem, thereby neutralizing the interaction effect of interactivity by self-esteem on enticement. Therefore, this study intends to encourage future research investigating the interrelationship between self-esteem, interactivity, and enticement to analyze these two components of enticement separately in this context to verify the proposed explanation approach.

5.1. Implications for theory and practice

The findings of this study extend the theoretical understanding of how interactivity-enhancing technology design elements affect VPE in the context of VTO systems. Adapting and advancing the framework proposed by Yi et al. (2015), our study incorporates self-esteem as an individual characteristic that influences the relationship between interactivity and two core determinants of VPE: user engagement and product enticement.

Our findings revealed that self-esteem not only directly influences user engagement and product enticement, but also moderates the impact of interactivity on user engagement. In particular, individuals with lower self-esteem have been shown to benefit more from high interactive virtual product presentation, i.e., their engagement increases with interactivity more strongly compared to consumers with higher levels of self-esteem. These findings offer a more differentiated and user-centered perspective on VPE than previous frameworks that predominantly focused on technical factors influencing the individual VPE. Furthermore, while we found no significant moderation effects of gender, the observation that male participants reported higher levels of product enticement across conditions corroborates previous research emphasizing gender-based differences in human-technology interactions.

Moreover, the study provides practical implications for online retailers, UX designers, and developers of AR-based VTO systems. The results suggests that VTO systems should be designed with a diverse user base in mind, considering differences in psychological characteristics, such as self-esteem, to optimize the individual VPE. High interactivity features, such as real-time AR overlays, particularly seem to encourage user engagement among consumers with lower self-esteem. As previous research has shown that individuals with lower self-esteem often prefer digital solutions over conventional "face-to-face" interactions (Kiani & Laroche, 2019; Wai-Yu Lee & Mei-Kwan Cheung, 2014), online retailers would benefit from creating an appealing environment for this specific consumer group.

Overall, the study contributes to a better, more personalized understanding of how diverse consumers engage with AR-based virtual product presentations and lays the foundation for more inclusive, comfortable, and user-centered strategies to design VTO systems.

5.2. Limitations

While this study offers important insights into how self-esteem moderates the effect of AR-based interactivity on user engagement and product enticement when using VTO systems, several limitations should be acknowledged. Firstly, the experiment was conducted online, with participants using their own devices to access the virtual product presentations. Although we were able to roughly evaluate the quality of their display based on the screenshots that the participants had to take, there was no fully reliable control over hardware characteristics such as webcam quality, screen resolution, or processing speed. Such technical differences may have influenced the quality and consistency of the AR experience across participants. Future research could address this limitation by conducting the study in a more controlled environment, such as a laboratory setting with uniform equipment, to isolate the effects of interactivity even more rigorously.

Secondly, the participants were recruited via the online platform Prolific. Although crowd-sourcing platforms allow access to large and diverse participant pools, they are subject to self-selection bias, as individuals who voluntarily participate in online studies may differ systematically from the general population in terms of motivation, digital literacy, and familiarity with technology. In this context, recent research has raised concerns regarding data quality and participant eligibility, especially for Amazon MTurk (Aguinis et al., 2021; Chmielewski & Kucker, 2020). Although Prolific is superior to MTurk with respect to the data quality (Adams et al., 2020; Albert & Smilek, 2023), it is not possible to eliminate all noise in the responses or completely eliminate selection bias, despite the implementation of attention checks and data validation procedures. Furthermore, cultural diversity may be limited, as most Prolific users are based in Western countries, especially the UK and the US. Thus, certain demographic groups may be underrepresented, which limits the generalizability of the findings. Future research should consider combining crowd-sourced sampling with additional recruitment strategies to ensure broader demographic representation and increase the robustness of the results across different user segments.

Finally, the scope of this study was limited to AR-based VTO applications for eyewear. While this context provides a compelling setting to examine self-evaluative product experiences, it does not fully cover the broader potential of AR interactivity in other domains. Previous work has emphasized that user responses to immersive technologies can vary substantially depending on the product category and application context (Zanger et al., 2022). Future studies should therefore investigate whether the patterns observed also apply to other domains, such as the clothing or cosmetics industry.

6. Conclusion

In conclusion, this study demonstrates that the consumer's self-esteem plays an important role in the relationship between interactivity of VTO systems and the individual VPE. The results show that interactive VTO features are not universally experienced in the same way by diverse consumers. In particular, those with lower levels of self-esteem reported significantly higher engagement levels in the interactivity conditions compared to the non-interactive control condition, whereas engagement among individuals with higher self-esteem remained relatively stable across all conditions. We interpret this finding as an indication that consumers with lower self-esteem can benefit most from interactive product presentations. In self-evaluative settings such as AR-based VTOs, where users engage with visual representations of themselves, interactive features can help to improve the individual VPE making the shopping experience more comfortable, particularly for consumers with lower self-esteem. Thus, taking consumer diversity into account when designing VTO systems can help to establish an inclusive and user-centered virtual product experience.

CRediT authorship contribution statement

Marc Wyszynski: Writing – review & editing, Writing – original draft, Visualization, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sebastian Weber:** Writing – review & editing, Writing – original draft, Validation, Project administration, Investigation. **Björn Niehaves:** Writing – review & editing, Supervision, Funding acquisition.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT-4o to support writing and editing tasks, such as wording suggestions and table formatting. After using these tools and services, the authors reviewed and edited the content as required and take full responsibility for the content of the publication.

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Declaration of competing interest

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None.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.chbr.2025.100772.

Data availability

The raw data required to reproduce the above findings are available to download from the Open Science Framework (https://osf.io/z3xep/).

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