Real versus virtual celebrity endorsement: presentation of online product information and consumer attitudes toward digital products

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Abstract
Purpose – This paper aims to reveal the influence of the presentation of online product information (POPI) on consumer attitudes in the context of online buying digital products.
Design/methodology/approach – Two main experimental designs are used to collect data. The ANOVA, t-test and Bootstrap methods are applied to check hypotheses.
Findings – Findings of Study 1 indicate that if the POPI is combined with different types of celebrity endorsement (CE) (real vs virtual), the self-brand connection will be changed and further influence consumer attitudes toward digital products. Study 2 verifies the diverse moderating effects of the type of virtual CE. The CRP (central-route presentation) online product information with SVCE (super-realistic-digital virtual CE) can decrease consumer attitudes, while the PRP (peripheral-route presentation) online product information with AVCE (anthropomorphic virtual CE) can enhance consumer attitudes.
Practical implications – E-commerce enterprises should optimize the current layout of POPI by considering diverse matchings between POPI and CE to increase consumer attitudes. Moreover, marketers could make various schemes of POPI considering (virtual) CE and self-brand connection.
Originality/value – Findings contribute to understanding the relationship between POPI and consumer attitudes considering the mediation of self-brand connection and the mediations of virtual/real CE. Additionally, this study bridges the gap between research on virtual CE and business practices.

Keywords Online product information, Celebrity endorsement, Self-brand connection, Consumer attitudes, Digital products

1. Introduction
Asia Pacific region has experienced high growth in e-commerce over the past decade (Liu et al., 2022). China is the leading international e-commerce country in the Asia Pacific, and Tmall is one of the largest e-commerce platforms in China. While searching for the keyword “smartwatch” on Tmall, products from the flagship online stores of Huawei and Apple will appear. The presentation of online product information (POPI) in the two online stores is quite different. The products of Huawei are presented with pictures and a small amount of text, but Apple has more text information. Meanwhile, the POPI of Huawei displays a celebrity endorsement (CE) but Apple does not display a celebrity because Apple does not invite a celebrity to business practice. According to the sales data of the two brands, the monthly sales volume of Huawei is higher than 40,000 and that of Apple is merely about 600. If other

Thanks to the editors and anonymous reviewers for their valuable comments and suggestions that improved the quality of the paper significantly. The authors also thank Dr Ruoxi Yao for her great work on proofreading and polishing.

This work was supported by the National Social Science Fund of China (No. 19BGL108).
factors, such as price, premium, brand awareness and order brushing, are excluded, we would ask why is the sales data of the two brands different seriously? Is it related to POPI or CE?

The above business phenomenon is related to consumer processing of online product information in marketing science. A prior study has verified that different webpage designs of online stores generate various consumer attitudes (Wu and Wang, 2019). The arrangement of interface elements (Altmajer et al., 2022), hedonism in the design of web pages (Barta et al., 2021) and the presentation of information order (Liu et al., 2017) significantly influence consumer experience and evaluation. However, it is not enough to explore the optimization of online store design and layout (Wu et al., 2014) because specific product information presented in online stores (Kripesh et al., 2020) is essential for consumers to make decisions. Therefore, most studies focus on the consumer responses to POPI including purchase intentions (Chen et al., 2022), perceived usefulness and customer engagement (Arghashi and Yuksel, 2022) to verify consumers’ processing of online product information. Existing research explores consumer processing of POPI (Niu et al., 2021) or ad information (Segev and Fernandes, 2023) based on the elaboration likelihood model (ELM). There are two patterns of processing online product information: peripheral route and central route. It is a heuristic peripheral processing mode and does not require consumers a greater cognitive effort under the peripheral route. On the contrary, processing under the central route requires consumers to allocate more mental resources and systematically think to judge the received online product information. The existing research focuses on exploring the impact of the characteristics of POPI on consumers. Many studies in recent years illustrate that the visual complexity of POPI (Lin and Lin, 2022), the layout of the online store (Porat and Tractinsky, 2011) and element complexity (Koh and Cui, 2022) affect consumer attention and shopping emotion. Overall, when consumers make online purchase decisions, the psychology and behavior of consumers can be explained through ELM.

Nevertheless, there are some gaps between research on POPI and consumer attitudes. Existing research focuses on the relationship between product information and buying behaviors (Zhao et al., 2021) and the correlation between online shopping and consumer attitudes (Chetioui et al., 2020). Whereas the first gap exists in understanding the link between online product information and consumer behaviors, the second gap exists in the connection between POPI and consumer attitudes in the context of buying digital products from the perspective of online product information. Therefore, this paper aims to address these gaps by establishing a novel relationship between POPI and consumer attitudes toward digital products.

It remains unclear whether different POPI can be identified by consumers based on the cues of ELM and can influence consumer attitudes when consumers process online information about digital products. Research on visual complexity, element complexity (Koh and Cui, 2022; Lin and Lin, 2022) and ELM reveal that consumers are more likely to process information in the way to CRP when facing complex information but process information in the way to PRP when facing uncomplicated information. In marketing, processing fluency is identified as the perceived ease or perceived difficulty when consumers process, identify or recognize information (Min, 2022). Processing fluency is negatively affected by information complexity (Orth and Wirtz, 2014); that is, more complex information decreases consumers’ processing fluency, and less complex information increases consumers’ processing fluency. In our disclosure, according to the logic of the above research on information complexity, processing fluency and ELM, POPI that is more complex, reducing consumers’ processing fluency, is defined as CRP online product information. Conversely, POPI that is simple and enhances consumers’ processing fluency is defined as PRP online product information.

Additionally, although previous research on CE is focused on ads (Gabor et al., 2020), influencer marketing (Abhishek and Srivastava, 2021) and social media influencers (Koay
et al., 2023), CE in POPI is ignored, there are still existing research gaps regarding CE within POPI. Prior research has classified the type of CE into real CE and virtual CE (Zhu et al., 2022). Through the insight into business practices, we find the various appearances of virtual CE. For instance, Colonel KI has obvious characteristics of animation, but Zoe looks more like a real person (see Figure 1). Therefore, we will provide a nuanced understanding of virtual CE by further subdividing the forms of appearance in the view of self-avatar (Wang et al., 2022).

In sum, it is necessary to explore consumer online shopping behavior (Li et al., 2020a,b) from the perspectives of POPI and CE to gain insights into consumer attitudes toward digital products. Consequently, we intend to address these gaps through our two research questions.

**RQ1.** How do different POPI (CRP vs PRP) affect consumer attitudes toward digital products? Is there a novel mediation mechanism to understand the relationship between POPI and consumer attitudes toward digital products?

**RQ2.** Whether the virtual CE can be further divided, and what is the effect of different types of virtual CE (SVCE vs AVCE) on consumer attitudes?

This paper contributes to the literature in several ways. First, this paper contributes to extending a novel application scope of ELM theory. We further focus on the cues of ELM to classify POPI to understand consumer attitudes rather than focusing on the consumers’ processing of online product information, which is different from previous research. Second, a novel conceptual model is built between POPI and consumer attitudes considering the

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**Figure 1.** Some virtual celebrities in business practice

**Source(s):** Author’s own creation
mediation of self-brand connection. Moreover, the type of CE and the type of virtual CE are progressively introduced to the conceptual model as boundaries, which further contributes to the literature on CE. Third, our findings provide crucial evidence for e-commerce enterprises to optimize online product information. The better matching schemes under different contexts considering POPI and CE are put forward through our study, which can better understand consumer attitudes while purchasing digital products online.

2. Literature review

2.1 The ELM theory
Petty and Cacioppo proposed the elaboration likelihood model (ELM) theory based on the dual processing theory (Petty and Cacioppo, 1986). The ELM theory suggests that consumers’ processing of information follows two patterns: peripheral route and central route (Lee et al., 2019). In marketing science, ELM can explain the impact of online reviews of products which is a kind of product information belonging to user-generated-contents on consumer decision-making (Chou et al., 2022). In marketing communication, ELM can also be applied to research on the persuasiveness of social media information for consumers/users (Shi et al., 2018), and is also applied to the research field of website design to guide enterprises in designing more persuasive and attractive shopping websites (Cyr et al., 2018). In this paper, we do not consider online reviews that are related to product information, but we take ELM as a theoretical basis to explore different presentations of online product information.

2.2 Presentation of online product information
Online product information including texts, pictures and videos acts as a fundamental IT artifact for facilitating consumers’ online shopping (Li et al., 2016). Based on previous research, the scope of the POPI is mainly focused on two streams. The first stream highlights that narrow POPI only covers attribute-based presentations on e-commerce platforms (Niu et al., 2021), such as appearance, material, brand, price and package on platforms like Amazon. The second stream highlights that the generalized conception of POPI includes various ways to present products online. For instance, presentations of AR (Augmented Reality) technology (Kowalczuk et al., 2021; Yim and Park, 2019) have become increasingly acceptable in recent years.

However, we argue that whether POPI is narrow or generalized depends on different carriers for presenting online product information. In this regard, it is more meaningful to understand consumers’ process of product information (Sun et al., 2020). Therefore, we categorize POPI into peripheral-route presentation (PRP) and central-route presentation (CRP) based on complexity, information processing fluency and ELM theory.

2.3 Celebrity endorsement
CE is an effective strategy in marketing practice to shape brand image and enhance brand awareness. McCracken pointed out that CE refers to a person who displays and describes the attributes or functions of a product or brand to consumers in commercial activities based on their social influence and reputation (McCracken, 1989). Existing research on CE mainly focuses on its aftereffects on consumer purchase intention (Khan et al., 2019), brand memory (Liu and Liu, 2020), brand loyalty, brand attachment (Özer et al., 2022) and preference for TV ads (Gabor et al., 2020).

From the perspective of types of CE, although previous literature has classified CE into real and virtual (Zhu et al., 2022), there are few works on the division of virtual CE. In fact, there have been a lot of virtual CEs in business practices. For instance (see Figure 1), Chenxi Qu serves as a virtual CE of Watsons, Colonel KI functions as a virtual product
recommendation officer of KFC, Zoe operates as a virtual CE of Nestle, and AYAYI represents a super-realistic-digital virtual celebrity of Bose. However, it is not clear how these different virtual CEs influence consumer attitudes. In this paper, we will not only investigate the effect of real CE but also testify to different types of virtual CE on consumer attitudes.

3. Hypotheses development

3.1 The type of CE, self-brand connection and consumer attitudes

Previous studies verify that real CE represents idealized role models for some consumers who are willing to learn and pursue a lifestyle like that of celebrities (McCutcheon et al., 2002). The attractiveness of real CE can lead to consumers’ positive attitudes, promoting their trustworthiness (Wang and Liu, 2022) of brands or products due to the acceptance of the real CE. In this sense, real CE can significantly affect consumers’ brand evaluation (Li et al., 2020a, b), brand attitude (Tong and Su, 2021) and purchasing behavior (Calvo Porral et al., 2021). Furthermore, the social influence of real CE positively affects individuals’ purchase intention, attitude, celebrity attachment and perceived celebrity credibility (Purohit and Arora, 2022), thereby enhancing marketing communication with consumers. Similar to real CE, virtual CE can also do some business activities on social media platforms (e.g. posting photos, creating relatable content and serving as ambassadors of sponsor brands) to shape brand image (Arsenyan and Mirowska, 2021). Moreover, virtual CE can also increase consumers’ attachment to products and purchase intention (Chiu and Ho, 2023). Consequently, we can deduce that virtual CE may also influence consumer attitudes like real CE in general. Furthermore, digital products are often distinguished by their continuous enhancement and innovation in cutting-edge technology, as exemplified by successive iterations of the Apple iPhone (Zhu et al., 2022). Analogously, virtual CE is the production of computer AI high technology and machine learning (Sands et al., 2022). In this sense, virtual CE may align more closely with digital products due to the common features of the two on innovation and technological advancement.

Self-brand connection (Fournier, 1998) conveys important identity, tasks or themes through a brand, thereby expressing consumer self-image in various aspects. The self-brand connection can affect consumers’ brand love, and consumers’ self-concept can also affect the relationship between self-brand connection and brand love (Palazon et al., 2019). There are also studies indicating that the effectiveness of CE, whether they are real or virtual, can be evaluated through the strength of the lifelong relationship established between CE and products/brands (Tom et al., 1992).

Based on the previous literature review, it can be concluded that self-concept often affects consumers’ self-image building. Therefore, we infer that regardless of the type of CE, it may affect consumers’ self-brand connection, thereby affecting consumer attitudes. Stated formally, we propose the following hypothesis.

\[ H1. \] Compared to a real CE, a virtual CE has a more positive effect on consumer attitudes toward digital products (H1a), and self-brand connection plays a mediating role in the above-mentioned influencing relationships (H1b).

3.2 POPI and the type of CE

In addition to introducing product attributes, POPI on some e-commerce platforms often contains poster images and text information about real CE. Research on ads also verifies the vital role of real CE (Liu and Liu, 2019). A high degree of matching between brand personality and the traits of CE will make consumers have a positive attitude toward the brand (Min et al., 2019). That is, the level of celebrity-brand congruence (e.g. the matching of attractiveness and CE-product) is positively correlated with consumer attitudes (Tseng and Wang, 2023) and purchase intentions (Liu et al., 2010).
From the perspective of information complexity (Phillips-Wren and Adya, 2020), it is obvious that CRP online product information contains more information and is more complex. In addition, in situations where ad information is highly complex (e.g. information overload), consumers prefer to focus their attention on the most familiar elements, celebrities rather than information on products/brands to avoid the stress of purchase decisions (Phillips-Wren and Adya, 2020). Afterward, real CE is more authentic and intimate (Nunn and Biressi, 2010), which will make consumers trust real CE more. Nevertheless, given virtual CE is computer-generated (Mrad et al., 2022), virtual, and novel, consumers have a low level of trustworthiness for virtual CE (Chiu and Ho, 2023). Accordingly, it can be inferred that consumer attitudes will be promoted by the matching of real CE and CRP online product information rather than virtual CE and CRP online product information.

In the real world, consumers can see virtual CE who endorse a product or a brand and can experience the vividness and humanoid attributes of the virtual CE (Jiang and Feng, 2020). This mapping between the virtual and the real world leads to consumers’ unique experiences and positive emotions, shifting to the perceived value of the product/brand. Moreover, PRP online product information has a smaller amount of information, which makes consumers less information processing pressure. At this moment, the virtual CE is more attractive to consumers due to the features of computer-generated graphics (Liang and Yang, 2022) and novelty compared to traditional real CE. Therefore, when a virtual CE appears in online product information with PRP, the virtual CE can make consumers feel inconsistency with a real CE, which can transfer the vivid perception of the virtual CE to the brand/product (McCracken, 1989) and strengthen consumer attitudes. Based on the above analysis, the second hypothesis is proposed.

H2. The type of CE moderates the relationship between POPI and consumer attitudes toward digital products. Specifically, under the situation of CRP online product information, a real CE (vs a virtual CE) can improve consumer attitudes (H2a); under the situation of PRP online product information, a virtual CE (vs a real CE) can improve consumer attitudes (H2b).

3.3 POPI and the type of virtual CE

This paper aims to further refine the division of virtual CE and explore the relationship between virtual CE and consumer attitudes in the era of digital consumption. The theory of self-avatar asserts that a self-avatar is a theoretical concept that can explain how users psychologically feel the sense of being themselves, especially when they use an avatar as their representational or anthropomorphic agent in a virtual space (Seo et al., 2017). One of the most essential features of a self-avatar is an anthropomorphic agent (Wang et al., 2022). In this regard, a virtual CE has the characteristics of a virtual space and agent; therefore, we divide virtual CE into two types: anthropomorphic virtual CE (AVCE) and super-realistic-digital virtual CE (SVCE) based on the self-avatar concept. We argue that AVCE has a low level of anthropomorphism which means the appearance of AVCE is a little close to humans (e.g. Figure 1(a) and (d)), but SVCE is very close to humans, even like true humans (e.g. Figure 1(b) and (c)).

AVCE can evoke feelings of warmth, competence, cuteness and coolness (Li et al., 2022). The previous study suggests that products with anthropomorphic designs can increase consumers’ willingness to pay and usage tendency (Du et al., 2022). SVCE is even closer to the characteristics of humans compared to AVCE. AVCE is more likely to enhance consumers’ perceived authenticity (Zhou et al., 2018), mental perception (Jiang and Feng, 2020) and perceptual vividness. Moreover, SVCE can increase consumers’ credibility by transferring consumers’ cognition from reality to the virtual digital world to shape brand attachment in social interactions (Zhou et al., 2018). Consequently, the following hypothesis is proposed, and the research framework of this paper is presented in Figure 2.
The type of virtual CE moderates the relationship between POPI and consumer attitudes toward digital products. In specific, (H3a) when AVCE appears in CRP or PRP online product information, consumer attitudes can be improved. (H3b) However, only when SVCE appears in PRP (vs CRP) online product information, consumer attitudes can be improved.

4. Study 1
Study 1 aims to test H1 and H2 through experimental design, examining (1) the moderating effect of type of CE (real CE vs virtual CE) and (2) the mediating effect of self-brand connection on the relationship between POPI and consumer attitudes.

4.1 Pretest
4.1.1 Stimuli. Study 1 requires four different experimental stimuli (see Figure 3). In the process of designing stimuli, the following key points are primarily considered. First, we need to confirm characters of real CE and virtual CE by focus group including twenty-one young consumers and two marketing professors. A famous Chinese film star named Yuanyuan Gao is selected as a real CE, and Tianyi Luo who is a female virtual singer and idol produced based on virtual IT technology is selected as a virtual CE. Second, in terms of product and product selections, an Asus laptop is chosen as the stimulus. The reason for choosing the laptop of Asus is that both men and women can use laptops in their daily lives, and Asus has higher brand awareness in Chinese markets. Third, visual complexity serves as a core cue to control and distinguish between CRP online product information and PRP online product information (Walia et al., 2016). Fourth, in the visual design of the two types of CE, the interference of the eye gaze direction of CE is eliminated. Given that the prior study reveals that compared to the direct gaze of CE, the averted gaze of CE can directly affect attractiveness to consumers and advertising effectiveness (To and Patrick, 2021). Consequently, we make the visual perception of CE face subjects head-on with a straight and flat sight rather than averted gaze to eliminate the interference of eye gaze. Finally, the background, size and resolution ratio of stimuli are controlled to keep a serious consistency.

4.1.2 Manipulation check. In total, 120 participants were recruited on the Credamo [1] online platform, including 55 males (45.83%) and 65 females (54.17%), with an average age of 28.90 years old. First, we randomly divided the participants into two groups, with one group only viewing Figure 3 (a) and (c), and another group only viewing Figure 3 (b) and (d). Second, participants are asked if they can distinguish between the real CE and virtual CE, the item is, “Can you distinguish which of the two celebrity endorsements in the picture is a virtual

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celebrity endorsement (real celebrity endorsement)" (1 = completely not a virtual celebrity endorsement (real celebrity endorsement), 7 = completely a virtual celebrity endorsement (real celebrity endorsement). Third, the measurement of visual complexity (Cronbach’s
α = 0.81) is finished including 5 items (Pieters et al., 2010). These items are: (1) Overall, how complex do you think the product information presented to you is? (2) How clear do you think the boundaries of the product information presentation are? (3) How large is the amount of information you see in the product information presentation? (4) How well do you understand the content displayed in the product information? (5) How cluttered do you think the product information presented is? Finally, participants are required to finish the answer of brand familiarity (Are you familiar with the brand Asus, 1 = very unfamiliar, 7 = very familiar).

The results of the independent sample t-test indicate that both groups of participants can successfully distinguish between virtual CE and real CE (Virtual CE: MCRP = 5.56, SD = 0.68, MPRP = 6.55, SD = 0.60, t = 1.06, p = 0.30 > 0.05; Real CE: MCRP = 5.61, SD = 0.58, MPRP = 5.89, SD = 0.62, t = 1.24, p = 0.41 > 0.05), which means there is a significant differentiation between the two types of CE. In terms of visual complexity, there is also a significant difference between the two groups of data, and the mean value of CRP is higher than that of PRP (MCRP = 5.44, SD = 0.76, MPRP = 2.34, SD = 0.37, F (1, 238) = 45.16, t = 28.51, p < 0.001). In addition, the results of one-way ANOVA demonstrate that there is no significant difference between males and females in distinguishing between virtual CE and real CE (Mmale = 5.20, SD = 0.28, Mfemale = 5.11, SD = 0.30, p = 0.78 > 0.05). Simultaneously, no remarkable diversity exists in visual complexity in the dimension of gender (Mmale = 4.42, SD = 0.31, Mfemale = 4.37, SD = 0.26, p = 0.28 > 0.05). Then, results of the independent sample t-test indicate that both groups have no significant difference (MCRP = 4.01, SD = 0.35, MPRP = 4.07, SD = 0.33, t = 1.13, p = 0.26 > 0.05) on brand familiarity. It means that the potential effects of the gender of participants and brand familiarity have been eliminated. Overall, the manipulations of CE and POPI are successful, and the stimuli can be used in the formal experiment of Study 1.

4.2 Procedure

A total of 328 valid subjects are recruited on the Credamo online platform, including 192 males (58.54%) and 136 females (41.46%), with an average age of 34.26 years old. First, all participants are randomly divided into four groups, and each group is required to observe Figure 3(a)–(d) separately at least 60s, each group of participants is asked to observe one picture exclusively.

Second, we re-measure the manipulation variables in the pretest. Furthermore, the items of self-brand connection (Moliner et al., 2018; Nadeem et al., 2021) and consumer attitudes are measured as well. The scale of self-brand connection includes four items: (1) I agree with the Asus brand endorsed by this celebrity, (2) I think paying attention to the Asus brand endorsed by this celebrity can help shape my identity, (3) The Asus brand endorsed by this celebrity can reflect who I am and (4) I feel that the Asus brand endorsed by this celebrity has a personal connection with me (Cronbach’s α = 0.88). The scale of consumer attitudes (Gardner, 1985; Shimp, 1981) consists of four items: (1) I don’t like the brand and product, (2) I think the brand and product are bad, (3) I think the brand and product make me unpleasant and (4) I think the brand and product is worthless. A seven-point Likert scale is used, with 1 = very disagree, 7 = very agree (Cronbach’s α = 0.80).

4.3 Results

The result of manipulation suggests that both groups of participants can distinguish between real CE and virtual CE correctly (Virtual CE: MCRP = 5.28, SD = 1.01, MPRP = 5.16, SD = 1.21, F (1, 162) = 1.71, t = 1.32, p = 0.18 > 0.05; Real CE: MCRP = 6.07, SD = 0.31, MPRP = 6.00, SD = 0.40, F (1, 162) = 1.53, t = 1.46, p = 0.12 > 0.05). Moreover, in terms of visual complexity, the mean value of CRP is significantly higher than that of PRP (MCRP = 5.82, SD = 0.57, MPRP = 2.48, SD = 0.83, F (1, 326) = 15.89, t = 20.91, p = 0.002 < 0.01). In summary, the
rationality of the stimuli designed in the pretest is once again verified in the formal experiment of Study 1, and the relevant variables are successfully manipulated. Additionally, the results of descriptive statistics, reliability, validity, and correlation analysis in Study 1 are visible in Tables S1, S2, S3, and S4 of Supplementary Materials.

The Bootstrap process in IBM SPSS 26.0 is used to check the mediation of self-brand connection (Hayes, 2017). As demonstrated in Table 1, the direct effect of the type of CE on consumer attitudes is significant ($c = 0.39$, SE = 0.08, 95% Boot CI: [LLCI = 0.2252, ULCI = 0.5566] not including 0), and the indirect effect is also remarkable ($c' = -0.20$, SE = 0.03, 95% Boot CI: [LLCI = -0.2613, ULCI = -0.1271] not including 0). Therefore, it verifies that self-brand connection plays a mediating role in the effect of the type of CE on consumer attitudes, and H1 (b) is supported. In addition, the results of one-way ANOVA display that virtual CE can enhance consumer attitudes more compared to real CE ($M_{real CE} = 4.14$, SD = 0.83, $M_{virtual CE} = 5.11$, SD = 0.91, $p < 0.001$); thus, H1a is confirmed. Therefore, H1 including H1a and H1b is supported.

Results of the Bootstrap demonstrate that (see Table 2) there is a significant moderating effect of the type of CE on the relationship between POPI and consumer attitudes ($c' = -0.22$, SE = 0.08, 95% Boot CI: [LLCI = -0.3744, ULCI = -0.0732] not including 0). Afterwards, the results of one-way ANOVA indicate that the interaction of the type of CE and POPI is significant ($F (3, 324) = 22.83$, $p < 0.001$).

Finally, LSD multiple comparisons after ANOVA are conducted (see Figure 4). Results reveal that when online product information is displayed with CRP, compared to virtual CE, real CE is more likely to promote consumer attitudes ($M_{real CE} = 5.01$, SD = 0.79, $M_{virtual CE} = 2.61$, SD = 1.06, $p < 0.001$). As a consequence, H2b is supported. When online product information is displayed with PRP, compared to real CE, virtual CE is more likely to improve consumer attitudes ($M_{real CE} = 2.87$, SD = 1.23, $M_{virtual CE} = 5.32$, SD = 1.14, $p = 0.02 < 0.05$). Eventually, H2 including H2a and H2b is supported.

### 4.4 Discussion

We verify the main effect of POPI (PRP vs CRP) on consumer attitudes considering the moderation of the type of CE and the mediation of self-brand connection; that is, H1 and H2 are fully supported. Findings demonstrate that different types of CE (real CE vs virtual CE) will

<table>
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<th>Influence path</th>
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<th>95% Boot LLCI</th>
<th>95% Boot ULCI</th>
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<td>$-0.51$</td>
<td>$0.12$</td>
<td>$-4.20$</td>
<td>$-0.7567$</td>
<td>$-0.2716$</td>
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<tr>
<td>Self-brand connection → Consumer attitudes</td>
<td>$0.38$</td>
<td>$0.06$</td>
<td>$6.46$</td>
<td>$0.2634$</td>
<td>$0.4966$</td>
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<tr>
<td>Direct effect</td>
<td>$0.39$</td>
<td>$0.08$</td>
<td>$4.67$</td>
<td>$0.2252$</td>
<td>$0.5566$</td>
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<td>Indirect effect</td>
<td>$-0.20$</td>
<td>$0.03$</td>
<td>$-2.94$</td>
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**Source(s):** Author’s own creation

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<th>Influence path</th>
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<tr>
<td>POPI → Consumer attitudes</td>
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<td>$0.09$</td>
<td>$4.40$</td>
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<td>Type of CE → Consumer attitudes</td>
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<td>$0.08$</td>
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<td>$-0.3744$</td>
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**Source(s):** Author’s own creation
have diverse effects on consumer attitudes. We argue that when different types of CE appear in online product information, it will change consumer self-brand connection and further influence consumer attitudes toward digital products. Moreover, the alternative explanation of cuteness is checked because the virtual CE has a cute visual perception (Li et al., 2022). Although participants rate high on cuteness ($M_{CRP} = 5.16$, $M_{PRP} = 5.09$), cuteness does not significantly influence self-brand connection (95% Boot CI: [LLCI = $-0.0923$, ULCI = 1.1088] including 0) and consumer attitudes (95% Boot CI: [LLCI = $-0.8726$, ULCI = 0.9304] including 0).

The results of Study 1 are consistent with research on ads, CE (Gabor et al., 2020), and consumer attitudes (Handriana and Wisandiko, 2017). However, it is still unclear whether different types of virtual CE influence consumer self-brand connection and consumer attitudes. Consequently, we will further explore the moderation of the type of virtual CE in Study 2 to discover more valuable conclusions by considering AVCE and SVCE.

5. Study 2

Study 1 has revealed the effect of POPI on consumer attitudes by analyzing the moderation of the type of CE rather than the type of virtual CE. Nevertheless, will the proposed conceptual framework be still supported when a virtual CE is combined with different online product information (CRP vs PRP)? To answer this question, we will verify the moderating effect of the type of virtual CE (SVCE vs AVCE) in Study 2 based on the findings of Study 1.

5.1 Pretest

5.1.1 Stimuli. In the pretest of Study 2, four different stimuli (see Figure 5) need to be designed as well. It is a matching result of the type of virtual CE and POPI. In the process of creating texts and pictures of stimuli, the following factors are mainly considered.

First, a virtual CE need to be determined. Given Tianyi Luo who exists in real business practice with high fame has been used in Study 1, we decided to create two novel virtual CEs that are completely unfamiliar to consumers to make results of experiments with high robustness and generalizability. Therefore, Study 2 uses a professional virtual character design platform, MetaHuman Animator to design SVCE. MetaHuman Animator is a 3D engine technology application platform launched by American company Epic in 2023, which can meet the needs of users to design super-realistic-digital meta human images. The AVCE is AI...
generated based on the SVCE which has been generated through MetaHuman Animator. Second, a product with high digital technology should be selected as the stimulus. Given high technology products (Seyyedamiri and Tajrobehkar, 2019) can be matched with SVCE that is generated by advanced AI and digital technology; thus, a high-tech sound therapy day bed is chosen, and the brand is virtually named H-tec. Third, as in the pretest of Study 1, we manipulate the POPI through the visual complexity of online product information, and we make the visual perception of CE face subjects head-on with a straight and flat sight. In the end, we ensure the background, size and resolution ratio of stimuli are equal.

Source(s): Author’s own creation
5.1.2 Manipulation check. The subjects required for the manipulation test of stimuli are recruited online through the Credamo platform, with a total of 136 participants, including 69 males (50.74%) and 67 females (49.26%), with an average age of 32.18 years. Participants are randomly assigned to two groups to observe different stimuli. One group is asked to browse Figure 5 (a) and (c), while another group is only asked to browse Figure 5 (b) and (d).

First, participants are required to finish the familiarity with virtual CE (Are you familiar with the SVCE (AVCE), 1 = very unfamiliar, 7 = very familiar). Second, the familiarity with the virtual brand H-tech (Are you familiar with the brand H-tech, 1 = very unfamiliar, 7 = very familiar) is measured. Subsequently, the participants are asked about the perceived difference between the two different virtual CEs. The item is “Can you distinguish which of the two virtual CE is an SVCE (AVCE)?” 1 = completely not SVCE (AVCE), 7 = completely an SVCE (AVCE). Finally, we complete the measurement of visual complexity, 1 = very uncomplicated, 7 = very complex. The above questions use the Likert seven-point scoring method.

The results indicate that participants are not familiar with SVCE (MCRP = 1.89, SD = 0.45, MPFP = 1.90, SD = 0.41, F (1, 134) = 1.75, t = 0.08, p = 0.19 > 0.05) and AVCE (MCRP = 1.78, SD = 0.34, MPFP = 1.73, SD = 0.40, F (1, 134) = 2.60, t = 1.83, p = 0.11 > 0.05). Moreover, participants are not familiar with brand H-tec (MCRP = 1.83, SD = 0.49, MPFP = 1.94, SD = 0.53, F (3, 132) = 0.26, t = 0.02, p = 0.60 > 0.05). Furthermore, there is a significant difference in visual complexity (MCRP = 5.11, SD = 0.83, MPFP = 2.63, SD = 0.79, F (1, 270) = 19.19, t = 16.73, p < 0.001). In the end, participants can distinguish the appearance of SVCE and AVCE correctly (SVCE: MCRP = 5.50, SD = 0.84, MPFP = 5.42, SD = 0.79, F (1, 134) = 0.13, t = 0.63, p = 0.66 > 0.05; AVCE: MCRP = 5.74, SD = 0.91, MPFP = 5.80, SD = 0.82, F (1, 134) = 1.17, t = 1.63, p = 0.69 > 0.05). The above results verify successful manipulation, and the stimuli can be used in the formal experiment of Study 2.

5.2 Procedure
A total of 304 valid subjects were recruited through Credamo, including 181 males (59.54%) and 123 females (40.46%), with an average age of 34.26 years old. First, we design purchase scenarios and basic information about virtual CE (see Table 3). Moreover, we set a virtual name Aseel for SVCE, and a virtual name Bernice for AVCE. Second, all subjects are randomly divided into four groups after they finish reading the purchase scenario. Two groups of participants are requested to read basic information for SVCE, and then observe Figure 5(a) or (b). The other two groups of participants are asked to read basic information for

<table>
<thead>
<tr>
<th>Basic information for SVCE</th>
<th>I am Aseel, a super-realistic-digital virtual human living in the metaverse world. I am a professional singer. Of course, I love life even more. I enjoy a healthy lifestyle and always look forward to beauty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic information for AVCE</td>
<td>My name is Bernice, a professional singer. My dream is to become a virtual singer who conveys happiness and emotion. I hope to always sing the songs in everyone's hearts. Of course, I also love life. I enjoy a healthy lifestyle and always look forward to beauty</td>
</tr>
<tr>
<td>Purchase scenario in the context of SVCE or AVCE</td>
<td>If your current company is far from your home and you have a habit of noon breaks. The company allows employees to bring their chairs or beds to the designated space for a nap. There is now a High-tech sound therapy day bed endorsed by Aseel/Bernice online, which can ensure the quality of rest at noon. If you have a sufficient budget, please read the following information about the product below and complete your answers</td>
</tr>
</tbody>
</table>

**Table 3.**
Brief introduction of virtual CE and purchase scenario settings

**Source(s):** Author’s own creation
AVCE, and then observe Figure 5(c) or (d). The purpose of the above operation is for each group of participants to only observe one type of experimental stimulus material. Finally, the manipulation variables in the pretest are re-measured, including the familiarity of the virtual CE, the familiarity and visual complexity of the brand H-tech and the dependent variable consumer attitudes.

5.3 Results
The results of the manipulation check of the formal experiment in Study 2 indicate that participants are not familiar with SVCE (MCRP = 1.71, SD = 0.43, MPRP = 1.82, SD = 0.42, F (1, 150) = 0.05, t = 1.51, p = 0.94 > 0.05), AVCE (MCRP = 1.97, SD = 0.55, MPRP = 2.00, SD = 0.62, F (1, 150) = 0.07, t = 0.45, p = 0.27 > 0.05) and brand H-tech (MCRP = 2.15, SD = 0.63, MPRP = 2.21, SD = 0.67, F (3, 300) = 1.11, t = 0.58, p = 0.29 > 0.05). Moreover, there is a significant difference in visual complexity (MCRP = 5.61, SD = 0.39, MPRP = 5.72, SD = 1.44, F (1, 302) = 5.05, t = 7.17, p = 0.02 < 0.05). At last, participants can distinguish the two virtual CEs (SVCE: MCRP = 5.61, SD = 0.39, MPRP = 5.72, SD = 1.44, F (1, 150) = 1.02, t = 1.75, p = 0.74 > 0.05; AVCE: MCRP = 5.59, SD = 0.42, MPRP = 5.68, SD = 1.02, F (1, 150) = 1.13, t = 1.84, p = 0.70 > 0.05). Overall, the successful manipulation of experimental stimuli in Study 2 is once again tested. Additionally, the results of descriptive statistics, reliability, validity and correlation analysis in Study 2 are given in Tables S5, S6, S7, and S8 of Supplementary Materials.

The Bootstrap regression results are displayed in Table 4. When consumer attitudes are set as the dependent variable for Bootstrap regression, the type of virtual CE significantly moderates the effect of POPI on consumer attitudes ($c'$ = -0.65, SE = 0.45, 95% Boot CI: [LLCI = -0.5383, ULCI = -0.0654] not including 0).

The specific moderating effect can be determined through one-way ANOVA analysis and LSD multiple comparisons after ANOVA. First, the results of ANOVA indicate that there is a significant interaction effect between the type of virtual CE and POPI (F (3, 300) = 21.26, p < 0.001). Second, the results of LSD multiple comparisons after ANOVA present (see Figure 6) that when AVCE appears in online product information, both CRP and PRP can increase consumer attitudes (M CRP = 6.17, SD = 0.28, M PRP = 6.21, SD = 0.77, p = 0.53 > 0.05). Thus, H3a is supported. When SVCE appears in online product information, online product information with PRP (vs CRP) can increase consumer attitudes more (M CRP = 4.28, SD = 0.97, M PRP = 6.09, SD = 0.83, p = 0.02 < 0.05). Consequently, H3b, H3a and H3 are supported.

Further simple slope analysis results are presented in Figure 7. We consider the mean of the score of the type of virtual CE as the reference point and, respectively, take M-1SD and M+1SD as the low-level and high-level values. Under the condition of AVCE (see Figure 7(a)), both CRP (simple slope = 0.48, t = 10.34, p < 0.001) and PRR (simple slope = 0.39, t = 7.90, p < 0.001) online product information can increase consumer attitudes. Under the condition of SVCE (see Figure 7(b)), PRP online product information (simple slope = 0.29, t = 8.47, p < 0.001) promotes consumer attitudes remarkably rather than that of CRP (simple slope = -0.13, t = 11.29, p < 0.05). Thus, H3 is supported once more.

<table>
<thead>
<tr>
<th>Influence path</th>
<th>Effect</th>
<th>SE/Boot SE</th>
<th>t</th>
<th>95% BootLLCI</th>
<th>95% BootULCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>POPI → Consumer attitudes</td>
<td>1.16</td>
<td>0.72</td>
<td>4.60</td>
<td>1.8877</td>
<td>4.7242</td>
</tr>
<tr>
<td>Type of virtual CE → Consumer attitudes</td>
<td>0.61</td>
<td>1.91</td>
<td>2.41</td>
<td>0.8344</td>
<td>1.3877</td>
</tr>
<tr>
<td>Moderating effect Int_2</td>
<td>-0.65</td>
<td>0.45</td>
<td>-8.13</td>
<td>-0.5383</td>
<td>-0.0654</td>
</tr>
</tbody>
</table>

**Source(s):** Author’s own creation

| Table 4. Bootstrap test results of the moderating effect of type of virtual CE |
5.4 Discussion
Study 2 validates the H3 and further explores the moderating effect of virtual CE on POPI and consumer attitudes. The results manifest that the moderating effect is equally significant when dividing the type of virtual CE into SVCE and AVCE. Whether CRP or PRP online product information, if combined with AVCE, it can improve consumer attitudes. However, under the condition of SVCE, there will be positive and negative effects. The CRP online product information with SVCE will weaken consumer attitudes, while PRP online product information with SVCE can enhance consumer attitudes. In addition, we also exclude the alternative explanation of cuteness due to the high rate of cute perception of AVCE (M_{CRP} = 4.92, M_{PRP} = 5.13). However, cute perception has no significant effect on self-brand connection (95% Boot CI: [LLCI = −0.1076, ULCI = 0.0344] including 0) and consumer attitudes (95% Boot CI: [LLCI = −0.0016, ULCI = 0.1983] including 0). In summary, the conclusion of Study 2 expands the boundary of Study 1, which states that different influence mechanisms occur under the condition of virtual CE. Thus, the conclusion of Study 1 has been further and deeply extended.

6. General discussion
This paper focuses on the effect of POPI on consumer attitudes toward digital products through two longitudinal experimental studies. The findings of Study 1 reveal that virtual CE has a stronger effect on consumer attitudes compared to real CE, without considering the
other boundary conditions. In other words, real CE and virtual CE have different effects on consumer attitudes, which are partially consistent with research on advertisement, CE (Gabor et al., 2020), and consumer attitudes (Handriana and Wisandiko, 2017). Additionally, our findings provide evidence for the mediating mechanism by exploring the role of self-brand connection. In specific, when different types of CE appear in online product information, they change consumer self-brand connection and further influence consumer attitudes toward digital products. It is a new conclusion compared to previous research.

Furthermore, we not only verify the effect of the type of CE (real CE vs virtual CE) but also further imply the moderation of the type of virtual CE (SVCE vs AVCE). Our results indicate that online product information with CRP or PRP has a positive impact on consumer attitudes. However, this positive impact is altered in the context of virtual CE. Specifically, PRP online product information with SVCE or AVCE can promote consumer attitudes, but CRP online product information with SVCE negatively weakens consumer attitudes. The above results are novel findings on virtual CE compared to the existing literature (Zhou et al., 2018). The cause of these novel findings is that we further divided the type of virtual CE, and the matching between the virtual CE and POPI leads to diverse conclusions. On the contrary, if the type of virtual CE is not considered, unspecific and vague conclusions are likely to be obtained because it is unclear how the matching impacts consumer attitudes before our research.

6.1 Theoretical contributions
This paper contributes to research on POPI, CE and consumer attitudes in several noteworthy ways. First, our findings contribute to extending the application scope of the ELM theory. We focus on cues (peripheral route and central route) of ELM, information complexity, and processing fluency to classify POPI for the first time, and the results of our two studies reveal the rationality of our attempt. Furthermore, the relationship between POPI and consumer attitudes is proposed through theoretical deduction and verified by two experiments. Hence, our research offers an understanding of the connection between POPI and consumer attitudes in the context of purchasing digital products on e-commerce platforms.

Second, our research contributes to providing a clear distinction between virtual CE and promoting the research on virtual CE under the background of AI technology development. In this paper, the concept of self-avatar is used to categorize virtual CE appearing in business practices. Although both SVCE and AVCE are computer-generated graphics, they have different appearance characteristics. Consequently, this paper successfully manipulates the anthropomorphic characteristics or the super-realistic-digital characteristics of virtual CE, and our data provides compelling evidence for the aftereffect of virtual CE. Fortunately, our findings not only provide a novel understanding of the type of virtual CE but also illustrate different results, which contributes to understanding the diverse effects of virtual CE under different boundaries.

Third, our conclusions contribute to understanding the relationship between POPI and consumer attitudes by revealing the roles of self-brand connection and the type of (virtual) CE. The self-brand connection serves as the mediating factor to explain the connection between different types of CE and consumer attitudes. Moreover, the type of CE and the type of virtual CE are set as boundary conditions, in turn, to further comprehend the connection between POPI and consumer attitudes. Notably, by matching the type of CE (real vs virtual) and POPI (CRP vs PRP), or the type of virtual CE (SVCE vs AVCE) and POPI, we provide different perspectives of insight into consumer attitudes toward digital products in the context of online shopping.

6.2 Managerial implications
With the fast-growing e-commerce market, online behaviors and the way of online shopping are essential factors affecting the digital economy (Cheba et al., 2021). When consumers purchase online, the design of web pages of shopping websites (Barta et al., 2021) and POPI
directly influence consumer experience and attitudes. Thus, it is worthwhile to understand
the detailed relationship between POPI and consumer attitudes. Based on the conclusions of
this paper, we have the following several practical suggestions.

First, we provide theoretical guidance for e-commerce enterprises on POPI solutions by
considering pictures and text information online. For instance, Amazon China has more text
presentations for products, but Tmall displays more pictures. We propose that e-commerce
enterprises could investigate consumer preference for POPI to present product information
using a suitable layout. Especially for the third-party enterprises of e-commerce platforms, it
is necessary to design CRP or PRP online product information to attract consumer attention.
For marketers, a preliminary market survey could help them gain insights into consumers’
processing capabilities and preferences for online product information, which would benefit
to make schemes of various POPI.

Second, the self-brand connection should be strengthened to promote consumer attitudes
toward digital products, as our conclusions have verified the role of self-brand connection in
Study 1. Enterprises could build virtual CE to reinforce ties between fan consumers and
brands for virtual CE can accelerate self-brand connection and consumer attitudes (Study 1).
For example, Lil Miquela is a famous virtual CE generated by AI technology who was once
published in Wonderland, New York Magazine and Vogue. Several brands, including
Outdoor Voices, Supreme, Chanel and Burberry, have collaborated with Lil Miquela to
cultivate their brand image and engage with her fan base (Huang et al., 2022).

Third, from the perspective of CE, whether inviting a CE, whether choosing a real CE or
virtual CE, whether choosing an SVCE or an AVCE and whether presenting CE in online
product information, are practical business issues that enterprises need to consider. Based on
our conclusions, if enterprises determine to integrate CE with online product information, we
could advise that “CRP online product information + real CE” and “PRP online product
information + virtual CE” are the best matching schemes to increase consumer attitudes. For
instance, IU, a singer from the Republic of Korea, serves as a real CE for Sony earphones, and
Hatsune Miku who is a virtual singer in Japan once is the CE of Redmi (a famous smartphone
brand in China) smartphone. However, we could not suggest a selection of SVCE due to its
negative effect if enterprises determine to present online product information and virtual CE
together. Furthermore, “PRP online product information + SVCE” is a better selection for
enterprises to promote consumer attitudes. For example, Ling is an SVCE for Centaine
(a famous Chinese brand of shampoo), and large monthly sales occur because her image
appears in Centaine product information of Tmall with a simple text description.

6.3 Limitations and future directions
While this paper has testified the moderating effects of the type of CE and the type of virtual
CE in the mechanism of POPI and consumer attitudes, as well as the mediation of self-brand
connection, it is not without limitations. First, the type of virtual CE is classified by the
concept of self-avatar through the appearance characteristics of virtual celebrities. However,
whether there are any other perspectives of classifying is necessary to further discover in
future research. For instance, virtual CE is generated with not only AI graphics but also the
technology of AI voice. In future research, care could be taken to explore the voice
characteristics of virtual CE to re-understand the type of virtual CE and consumers’
responses. Second, given the role of information overload in the online shopping process
(Appiah Kusi et al., 2022), we encourage researchers to identify different conclusions in the
context of information overload. Third, we explore consumer attitudes toward digital
products, it is not clear that our conclusion of POPI and CE could be suitable for other
products, such as food and clothing. Consequently, the product category could be taken as a
key perspective to enrich the conclusions of current research.
1. Credamo is an international smart research platform that provides data collection for professional surveys and scenario experiments by screening high-quality and representative samples. Researchers can recruit participants to conduct their studies via this tool by paying subjects a certain fee, and researchers can use this tool by accessing the following URL link: https://www.credamo.world/#/

References


**Supplementary materials**

1 The results of descriptive statistics, reliability, validity and correlation analysis in Study 1

Results of descriptive statistics are shown in Table S1 including the mean, standard deviation, maximum value and minimum value of variables. Then, we test the reliability and validity of the scales (see Table S2). For each variable, the results of EFA show that Cronbach’s α > 0.70, KMO>0.80 and p < 0.05 (Bartlett’s sphericity test), which means each variable has a high internal consistency reliability. Results of CFA demonstrate that factor loading coefficients of 13 items are all higher than 0.60, AVE>0.50, and CR > 0.7, which implies good convergent validity of scales. Furthermore, the results of discriminant validity (see Table S3) indicate that the three-factor model has the highest degree of fit (χ²/df = 2.412, CFI = 0.920, TLI = 0.901, RMSEA = 0.048) compared to the other two models, and the measurement scale of Study 1 has good discriminant validity. Two methods are used to check the common method bias effect. First, the result of Harman’s single-factor test manifests that the variance explained by the first factor is 24.27% which is lower than the critical value of 40.00%, and the total variance explanation is 68.84%. Second, results of an unmeasured latent common method factor (ULCMF) indicate that although the measured model with ULCMF on the fitting degree (χ²/df = 2.403, CFI = 0.961, TLI = 0.936, RMSEA = 0.041) is better than that of three-factor model, the promotion of fitting degree is not significant because of very small variations (Δχ²/df = 0.009 < 0.05, ΔRMSEA = 0.007 < 0.05, ΔCFI = 0.041 < 0.1, ΔTLI = 0.035 < 0.1). Overall, the above two methods reveal that there is no serious common method bias in the measurement of Study 1, and our measurement confirms the high quality of reliability and validity. Moreover, the correlation analysis result among variables is reported in Table S4. There is a significant correlation among key variables at different levels of significance (p < 0.05 or p < 0.01).

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>POPI</td>
<td>4.73</td>
<td>1.80</td>
<td>6.68</td>
<td>1.29</td>
</tr>
<tr>
<td>Self-brand connection</td>
<td>4.12</td>
<td>1.26</td>
<td>6.09</td>
<td>1.04</td>
</tr>
<tr>
<td>Consumer attitudes</td>
<td>3.91</td>
<td>1.04</td>
<td>6.24</td>
<td>2.06</td>
</tr>
<tr>
<td>Differentiation (Virtual CE and real CE)</td>
<td>6.06</td>
<td>0.30</td>
<td>6.80</td>
<td>4.62</td>
</tr>
</tbody>
</table>

**Source(s):** Author’s own creation

Table S1. Descriptive statistics of variables in Study 1
The results of descriptive statistics, reliability, validity and correlation analysis in Study 2

Table S5 indicates the results of descriptive statistics in Study 2. Then, we test the reliability and validity of the scales. Results of EFA (see Table S6) indicate that Cronbach’s $\alpha > 0.80$, KMO>0.80 and $p < 0.01$ (Bartlett’s sphericity test), which means each variable has a high internal consistency reliability. Results of CFA demonstrate that factor loading coefficients>0.70, AVE>0.50 and CR > 0.7, which implies good convergent validity of scales. The result of Harman’s single-factor test shows that the amount of the variance explained by the first principal component is 21.85% with a total variance explanation of 68.19%. This value is significantly less than the 40.00% benchmark, suggesting no serious problem with common method bias. Moreover, results of discriminant validity (see Table S7) indicate that the fit of two-factor model ($\chi^2$/df = 2.248, CFI = 0.917, TLI = 0.913, RMSEA = 0.045) is significantly better than that of the single-factor model, and the fit indices of the two-factor model do not differ from those of the measurement model with ULCMF ($\chi^2$/df = 2.244, CFI = 0.929, TLI = 0.934, RMSEA = 0.039) because of very small variations ($|\Delta\chi^2$/df| = 0.004 < 0.05, $|\Delta$RMSEA| = 0.006 < 0.05.

Table S2.
Reliability and validity tests of measurement scales in Study 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Item</th>
<th>Loading</th>
<th>KMO</th>
<th>Cronbach’s $\alpha$</th>
<th>Bartlett’s sphericity test</th>
<th>AVE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>POPI</td>
<td>I1</td>
<td>0.76</td>
<td>0.91</td>
<td>0.81</td>
<td>0.001</td>
<td>0.88</td>
<td>0.81</td>
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<td></td>
<td>I2</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I3</td>
<td>0.66</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>I4</td>
<td>0.70</td>
<td></td>
<td></td>
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<td></td>
<td>I5</td>
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<td>Self-brand connection</td>
<td>I1</td>
<td>0.66</td>
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<td>0.002</td>
<td>0.79</td>
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<td></td>
<td>I3</td>
<td>0.71</td>
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<td></td>
<td>I4</td>
<td>0.73</td>
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<td>Consumer attitudes</td>
<td>I1</td>
<td>0.83</td>
<td>0.87</td>
<td>0.80</td>
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<td>0.84</td>
<td>0.82</td>
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<td></td>
<td>I2</td>
<td>0.82</td>
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<tr>
<td></td>
<td>I3</td>
<td>0.82</td>
<td></td>
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<tr>
<td></td>
<td>I4</td>
<td>0.73</td>
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<table>
<thead>
<tr>
<th>Variable</th>
<th>POPI</th>
<th>Self-brand connection</th>
<th>Consumer attitudes</th>
<th>Type of CE</th>
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<td>0.45**</td>
<td>–</td>
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<tr>
<td>Self-brand connection</td>
<td>0.45**</td>
<td>–</td>
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<td>–</td>
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<tr>
<td>Consumer attitudes</td>
<td>0.33**</td>
<td>0.40**</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Type of CE</td>
<td>0.02*</td>
<td>–0.55**</td>
<td>0.20*</td>
<td>–</td>
</tr>
</tbody>
</table>

Note(s): *$p < 0.05$, **$p < 0.01$

Source(s): Author’s own creation

Table S3.
Results of common method bias in study 1

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$/df</th>
<th>CFI</th>
<th>TLI</th>
<th>RMSEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-factor model</td>
<td>2.412</td>
<td>0.920</td>
<td>0.901</td>
<td>0.048</td>
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<tr>
<td>Two-factor model</td>
<td>5.078</td>
<td>0.714</td>
<td>0.701</td>
<td>0.109</td>
</tr>
<tr>
<td>Single-factor model</td>
<td>8.120</td>
<td>0.541</td>
<td>0.498</td>
<td>0.151</td>
</tr>
</tbody>
</table>

Note(s): Given the measure of the type of CE is a single item in Study 1; thus, a three-factor model that includes POPI, self-brand connection and consumer attitudes is analyzed

Source(s): Author’s own creation

Table S4.
Results of correlation analysis among variables in study 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>POPI</th>
<th>Self-brand connection</th>
<th>Consumer attitudes</th>
<th>Type of CE</th>
</tr>
</thead>
<tbody>
<tr>
<td>POPI</td>
<td>–</td>
<td>–</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>Self-brand connection</td>
<td>0.45**</td>
<td>–</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>Consumer attitudes</td>
<td>0.33**</td>
<td>0.40**</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Type of CE</td>
<td>0.02*</td>
<td>–0.55**</td>
<td>0.20*</td>
<td>–</td>
</tr>
</tbody>
</table>

Note(s): *$p < 0.05$, **$p < 0.01$

Source(s): Author’s own creation

2 The results of descriptive statistics, reliability, validity and correlation analysis in Study 2

Table S5 indicates the results of descriptive statistics in Study 2. Then, we test the reliability and validity of the scales. Results of EFA (see Table S6) indicate that Cronbach’s $\alpha > 0.80$, KMO>0.80 and $p < 0.01$ (Bartlett’s sphericity test), which means each variable has a high internal consistency reliability. Results of CFA demonstrate that factor loading coefficients>0.70, AVE>0.50 and CR > 0.7, which implies good convergent validity of scales. The result of Harman’s single-factor test shows that the amount of the variance explained by the first principal component is 21.85% with a total variance explanation of 68.19%. This value is significantly less than the 40.00% benchmark, suggesting no serious problem with common method bias. Moreover, results of discriminant validity (see Table S7) indicate that the fit of two-factor model ($\chi^2$/df = 2.248, CFI = 0.917, TLI = 0.913, RMSEA = 0.045) is significantly better than that of the single-factor model, and the fit indices of the two-factor model do not differ from those of the measurement model with ULCMF ($\chi^2$/df = 2.244, CFI = 0.929, TLI = 0.934, RMSEA = 0.039) because of very small variations ($|\Delta\chi^2$/df| = 0.004 < 0.05, $|\Delta$RMSEA| = 0.006 < 0.05.
ΔCFI = 0.012 < 0.1, ΔTLI = 0.021 < 0.1). Therefore, the results indicate that the common method bias of the measure is minimal. In summary, our measurement confirms the high quality of reliability and validity. Furthermore, the correlation analysis result among variables is reported in Table S8.

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>POPI</td>
<td>5.67</td>
<td>1.56</td>
<td>6.70</td>
<td>1.11</td>
</tr>
<tr>
<td>Consumer attitudes</td>
<td>4.09</td>
<td>1.07</td>
<td>6.03</td>
<td>2.11</td>
</tr>
<tr>
<td>Familiarity of SVCE</td>
<td>1.76</td>
<td>0.43</td>
<td>2.53</td>
<td>1.29</td>
</tr>
<tr>
<td>Familiarity of AVCE</td>
<td>1.99</td>
<td>0.65</td>
<td>3.04</td>
<td>1.01</td>
</tr>
<tr>
<td>Familiarity of brand H-tec</td>
<td>2.18</td>
<td>0.41</td>
<td>3.33</td>
<td>1.47</td>
</tr>
<tr>
<td>Differentiation (SVCE and AVCE)</td>
<td>5.64</td>
<td>1.04</td>
<td>6.44</td>
<td>4.93</td>
</tr>
</tbody>
</table>

Source(s): Author’s own creation

Table S5. Descriptive statistics of variables in Study 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Item</th>
<th>Loading</th>
<th>KMO</th>
<th>Cronbach’s α</th>
<th>Bartlett’s sphericity test</th>
<th>AVE</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>POPI</td>
<td>I1</td>
<td>0.70</td>
<td>0.86</td>
<td>0.80</td>
<td>0.001</td>
<td>0.87</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>I2</td>
<td>0.72</td>
<td>0.86</td>
<td>0.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I3</td>
<td>0.79</td>
<td>0.80</td>
<td>0.79</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I4</td>
<td>0.78</td>
<td>0.83</td>
<td>0.90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I5</td>
<td>0.82</td>
<td>0.88</td>
<td>0.84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer attitudes</td>
<td>I1</td>
<td>0.71</td>
<td>0.88</td>
<td>0.89</td>
<td>0.004</td>
<td>0.81</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>I2</td>
<td>0.82</td>
<td>0.83</td>
<td>0.82</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I3</td>
<td>0.84</td>
<td>0.83</td>
<td>0.90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I4</td>
<td>0.83</td>
<td>0.83</td>
<td>0.90</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source(s): Author’s own creation

Table S6. Reliability and validity tests of measurement scales in study 2

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$/df</th>
<th>CFI</th>
<th>TLI</th>
<th>RMSEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two-factor model</td>
<td>2.248</td>
<td>0.917</td>
<td>0.913</td>
<td>0.045</td>
</tr>
<tr>
<td>Single-factor model</td>
<td>5.491</td>
<td>0.683</td>
<td>0.632</td>
<td>0.105</td>
</tr>
</tbody>
</table>

Note(s): Given the measure of the type of virtual CE is a single item in Study 2; thus, a two-factor model that includes POPI, self-brand connection and consumer attitudes is analyzed

Source(s): Author’s own creation

Table S7. Results of common method bias in study 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>POPI</th>
<th>Consumer attitudes</th>
<th>Type of virtual CE</th>
</tr>
</thead>
<tbody>
<tr>
<td>POPI</td>
<td>–</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer attitudes</td>
<td>0.16*</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Type of virtual CE</td>
<td>0.48**</td>
<td>0.35**</td>
<td>–</td>
</tr>
</tbody>
</table>

Note(s): *p < 0.05, **p < 0.01

Source(s): Author’s own creation

Table S8. Results of correlation analysis among variables in Study 2
About the authors
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Yafeng Nan, Ph.D., his main research fields are consumer behavior and psychology, he has published three SSCI papers and four papers at the Annual Conference of JMS China Marketing Science and Chinese Marketing Association of Universities. Yafeng Nan is the corresponding author and can be contacted at: 18642936612@163.com

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