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Examining the effects of authenticity fit and association fit: A digital human avatar endorsement model

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ABSTRACT

In recent years, the extensive use of digital human avatar (DHA) endorsement has emerged. DHA endorsement often entails the use of real products, e.g., wearing real clothes, which raises the issue of the fit between a "fake" virtual image and a real product. Whether consumers feel a positive attitude toward this kind of fit is the basis of whether DHA endorsement can be successful. Accordingly, based on cue consistency theory, we infer that consumers generate positive attitudes toward DHA endorsement when there is a fit between a DHA and a real product. We therefore developed a DHA endorsement model to explain the antecedents and consequences of avatar-product fit, decomposing fit type into authenticity fit and association fit. Two tests were used to verify this model. Their results show that authenticity fit and association fit have significant positive impacts on consumer attitudes toward DHA endorsement. Furthermore, the influences of these two paths vary by product. For hedonic products, authenticity fit has a greater impact on attitudes; for utilitarian products, association fit is a more influential factor.

1. Introduction

Digital human avatars (DHAs) are avatars with human-like imagery and behavior that are widely used for product endorsement (Silva and Bonetti, 2021; Miao et al., 2022). For example, Lil Miquela, a famous DHA, has over 3 million Instagram followers and has collaborated with brands such as Channel, Coach, Balenciaga and Prada (Klein, 2020; Arsenyan and Mirowska, 2021). Ling, a Chinese DHA, is active on various social platforms and has endorsed several well-known brands, such as Tesla, Estee Lauder, and Bulgari (Andy and Tian, 2021). DHAs are a new form of endorser, and consumers' positive attitudes toward DHA endorsement play a key role in the success of DHA endorsement. Previous studies (Till and Busler, 2000; Park and Lin, 2020; Belanche et al., 2021a) have shown that consumers prefer an endorsement only when they perceive a high level of fit between the endorser and the product, i.e., consumers have a positive attitude toward DHA endorsement only when there is a suitable fit between DHA and product. However, DHA endorsement may entail fit issues that do not occur in human endorsement. On the one hand, DHA endorsement displays virtual images of avatars using real products—for example, Lil Miquela wearing Diesel clothes—which leads to the issue of the fit between "fake" virtual images and real products. On the other hand, DHAs often have developed self-images; for example, Lil Miquela is a 19-year-old Brazilian-American model and musical artist. Thus, when she endorses a product that has a certain product association, the fit between her DHA image and the product's association is an issue that should be considered. Therefore, a valuable perspective for studying the success of DHA endorsement is to examine the mechanism of the fit between DHAs and products. Due to the novelty, controllability, high designability and low cost of DHA endorsers (de Brito Silva et al., 2022), DHA endorsements are becoming a common choice for brand endorsement and thus are changing the ecology of advertising. In addition, *due to the rapid growth of DHAs' fan base and their potential impact, many businesses across industries are considering or have already adopted DHA endorsement. For example, more than 60 brands partnered with Lil Miquela as their brand endorser in just six months (de Brito Silva et al., 2022). Therefore, an in-depth exploration of the mechanism of DHA endorsement is urgently needed.* However, DHA endorsement has been understudied by scholars; hence, its mechanism remains unknown.

Research on DHA endorsement can be conducted from the perspective of how a digital entity should match a physical entity. DHAs differ from cartoon characters in that they are highly developed digital entities with high form and behavioral realism that are powered by artificial intelligence (AI) with human-like abilities and emotions, similar to those

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of any human being (Silva and Bonetti, 2021; Miao et al., 2022). However, consumers can still clearly identify the nonhuman digital characteristics of DHAs (Karpinska-Krakowiak and Eisend, 2021). Since the fit between endorser and product is a key element of endorsement success (Stafford et al., 2002; Park and Lin, 2020; Fernandes et al., 2022), the problem that needs to be solved when using digital entities to endorse physical products is how to make consumers perceive a suitable fit between DHAs and physical products. This is the key not only to convincing consumers to be positive about DHA endorsement but also to determining a mass application of DHA endorsement to reduce corporate costs.

The purpose of this paper is therefore to investigate the mechanism by which consumers perceive fit when virtual DHAs endorse real products and to analyze the moderating influence of hedonic and utilitarian products in the context of DHA endorsement. *Although previous articles have proposed the concept of avatar marketing (de Brito Silva et al., 2022; Miao et al., 2022), no empirical studies have been conducted on the mechanism of DHA endorsement. This paper explicates the fit mechanism between virtual DHA endorsers and real products to reveal how consumers can develop positive attitudes toward DHA endorsers.* Specifically, we first use cue consistency theory to explain the DHA-product fit. Because DHA endorsement has two fit problems, i.e., the fit problem between "fake" virtual image and real product and the fit problem between DHA self-image and product association, we then adopt avatar theory and mind perception theory to investigate these two fit problems (Maheswaran and Chaiken, 1991; Gray et al., 2007; Miao et al., 2022). Cue consistency theory suggests that the fit between DHAs and products includes authenticity fit for extrinsic cues and association fit for intrinsic cues, which collectively promote attitudes toward DHA endorsement. Authenticity fit is the fit between the authenticity of a DHA and the authenticity of a product (i.e., the fit between the appearance of a DHA and the appearance of a product); association fit is the fit between the association of a DHA and the association of a product (i.e., the fit between the temperament of a DHA and the temperament of a product). Moreover, following avatar theory, we propose the antecedents of authenticity fit that determine whether virtual humans can be perceived as real. According to mind perception theory, the antecedents of association fit are proposed to drive consumers' associations between a DHA and a product. The results of this study also show that consumers place more emphasis on authenticity fit in hedonic consumption and more emphasis on association fit in utilitarian consumption.

The theoretical contributions of this paper are as follows. First, we explain how to achieve digital-physical fit in the context of DHA endorsement. Although digital AI agents have become more common in recent years (Silva and Bonetti, 2021; Ahn et al., 2022), previous studies have paid little attention to how a digital entity can match a physical entity. Second, we extend the theory of fit in endorsement. Previous studies have examined the impact of endorser-product fit but have usually treated fit as an overall variable (Park and Lin, 2020). In contrast, we divide fit into authenticity fit and association fit to expand the literature on this area. Third, this study contributes to the literature on hedonic and utilitarian consumption. While this has been addressed in previous research on AI recommendation (Longoni and Cian, 2022), the role of hedonic and utilitarian effects in DHA endorsement has not been considered. In this paper, we thus explore the role of product type in our study of digital-physical fit. Finally, we apply cue consistency theory to digital-physical fit research, dividing cues into two categories—external and internal—thereby enriching cue consistency theory and expanding the application scenarios of this theory.

Moreover, this paper offers the following practical contributions: First, our findings reveal which DHA endorsement mechanism can help companies better design their DHAs. When a DHA is used as an endorser, it should focus not only on authenticity fit, i.e., making the image and behavior of the DHA as real as possible, but also on association fit, i.e., the DHA needs to make consumers perceive its levels of competence and warmth according to the product's characteristics. Second, products with different attributes require different DHA endorsers. During endorsement of utilitarian products, more attention should be given to the association fit between DHA and product; during endorsement of hedonic products, it may be better to emphasize authenticity fit, which is important for corporate marketing decisions. In summary, this study provides actionable insights for managers who seek to use DHAs as endorsers to attract and increase the probability of successful transactions.

2. Literature review

2.1. Conception of DHA endorsement

The definition of a DHA varies among researchers. Holzwarth et al. (2006) considered DHAs graphic personifications realized through computer technology, such as a virtual guide for online shopping (Moore et al., 2022). Kang and Watt (2013) defined DHAs as digital models that look or act similarly to the persons being represented, such as visual representations of people during mobile communications. Rahill and Sebrechts (2021) identified DHAs as representations of and potential substitutes for human participants in virtual environments. In any case, DHAs provide users with realistic interactions in various environments by imitating their behavior. Sometimes, consumers also perceive DHAs as representative of themselves (Hollebeek et al., 2020), typically when they are virtual characters in gaming environments (Wu and Hsu, 2018). In addition, consumers occasionally identify DHAs as entities with live characteristics and souls (Karpinska-Krakowiak and Eisend, 2021). Overall, DHAs are thus digital entities with high realism in their form and behavior.

DHA endorsers also differ from other kinds of endorsers. In the past, such endorsers have included human or animated spokespersons (Stafford et al., 2002). DHAs differ from both human and animated characters. On the one hand, since DHAs are highly life-like and more realistic than animated figures (Silva and Bonetti, 2021), their authenticity can have a significant impact on consumer attitudes and intentions (Ilicic et al., 2017; Kennedy et al., 2021). However, as people are still able to recognize that DHAs are not real people, DHAs carry certain animistic cues that trigger different types of association and evaluation from those of human endorsers. DHAs are also able to show special advertising contexts when endorsing, which can induce animistic thinking, unlike human endorsers (Karpinska-Krakowiak and Eisend, 2021). In addition, DHA endorsement is not subject to unpredictable events. DHAs are therefore safer than humans as endorsers. In summary, DHA endorsement comprises a unique pattern of endorsement that is different from the previous forms of endorsement. In the following subsection, we adopt cue consistency theory to explain the mechanism of DHA endorsement.

2.2. Cue consistency theory

Cue consistency theory was first proposed by Anderson (1981) to explain how individuals integrate information and form cognitive attitudes. It suggest that consumers rely on multiple cues and assess the consistency of these cues to determine which attitudes to adopt (De Roeck and Farooq, 2018). Furthermore, when consumers evaluate multiple cues, if the information these cues provide is consistent, they positively influence consumers' attitude and intention (Maheswaran and Chaiken, 1991; Miyazaki et al., 2005; Jiménez and Mendoza, 2013). Thus, cue consistency theory can be used to explain the endorsement mechanism of DHAs; that is, the more the cues characterized by DHAs fit product cues, the greater the positive attitudes toward DHA endorsement.

Cues can be divided into two categories: external and internal. External cues are mainly cues such as the appearance and shape of an entity or situational factors (Puccinelli et al., 2015). Internal cues include cues such as the associations, thoughts, and feelings contained in

an entity that are perceived by a consumer (Keller, 1987). In endorsement contexts, external cues are reflected in the words and actions of an endorser and the appearance of a product (Dean, 1999), and internal cues are reflected in the associations produced by an endorser and the associations generated by a product (Bakamitsos, 2006). DHAs, as endorsers, include both external and internal cues; such external cues include the authenticity of a DHA's appearance and internal cues consists of a DHA's internal temperament and associations. Therefore, cue-matching between DHA endorser and product involves both external authenticity fit and internal association fit.

There are several reasons for using cue consistency theory to explain the fit between virtual DHAs and real products. First, in the context of endorsement, consumers acquire and evaluate multiple cues, including cues from the endorser (Dean, 1999) and cues from the product (Bakamitsos, 2006). Moreover, the fit between an endorser and a product is key for consumers to be positive about the endorsement (Till and Busler, 2000; Park and Lin, 2020). Therefore, as cue consistency between a DHA and the product is key to DHA endorsement, it is appropriate to use cue consistency theory to explain DHA endorsement. Second, cue consistency theory is suitable for explaining how to achieve a suitable fit between virtual DHAs and real products. Specifically, it explains how to achieve a suitable fit among multiple cues by ensuring the fit of external authenticity cues with internal association cues. In the following section, authenticity fit and association fit are discussed separately.

2.2.1. Authenticity fit in DHA endorsement

The authenticity fit between a DHA and product refers to cues such as the physical characteristics of the DHA being realistic and more human-like to ensure it can be matched to an authentic product in terms of extrinsic cues. Previous research has shown that the authenticity cues of an endorser can have a significant impact on consumer attitudes. Scholars have found that the presence of biological facial cues (e.g., freckles and moles) among endorsers allows consumers to perceive authenticity, which in turn has a positive impact on their attitudes and behavioral intentions (Ilicic et al., 2017). Research on avatars also illustrates the importance of authentic cues. Customers expect an authentic experience when interacting with avatars, whereby there is a negative impact if an online chat experience is not perceived as being provided by a real person (Luo et al., 2019). In avatar role-playing games, the authenticity of virtual characters has a positive impact on play intention and purchase intention (Wu and Hsu, 2018). Following previous studies, consumers demonstrate more positive attitudes toward DHA endorsers when they provide rich realistic cues. Although uncanny valley theory suggests that the more realistic a character is, the more likely consumers consider it creepy (Gray and Wegner, 2012), recent meta-analyses have shown that realistic cues result in more positive attitudes (Blut et al., 2021; Roesler et al., 2021).

Based on previous research, we infer that consumers are more receptive to DHA endorsement when they perceive a fit between the authenticity of a DHA and an actual product. For example, when a DHA is shown in an advertisement demonstrating how to use a product, consumers are more receptive to this endorsement if they perceive the demonstration to be similar to a real person's use of the product.

H1. The perceived authenticity fit between DHA endorsers and products has a positive effect on attitudes toward DHA endorsement.

2.2.2. Antecedents of DHA-product authenticity fit

We predict that a DHA's form realism and behavioral realism directly affect the perception of DHA-product authenticity fit. Hence, we adopt avatar theory to explain the antecedents of DHA-product authenticity fit. Avatar theory was first proposed by Miao et al. (2022) to explain how a virtual avatar can be real, which is also appropriate for revealing authenticity fit, as authenticity has been described as the sense that causes people to perceive things to be real (Wu and Hsu, 2018). In addition, avatar theory suggests that form realism and behavioral realism jointly contribute to the authenticity of a DHA. Since DHAs' form and behavior are in accordance with the definition of extrinsic authenticity cues in cue consistency theory, it is therefore appropriate to employ avatar theory to explain the antecedents of authenticity fit.

According to avatar theory, form realism is the extent to which an avatar appears to be human. Behavioral realism, on the other hand, measures the extent to which an avatar behaves like a human (Miao et al., 2022). High form realism means that a DHA has a highly life-like appearance and human characteristics, such as a gender, age, and name, while high behavioral realism entails that a DHA exhibits human-like behaviors, such as communication and expression (Kang and Watt, 2013). In terms of form realism, the judgment of realism is formed on multiple external cues. When a DHA is outwardly portrayed as a real person, consumers perceive that the DHA and its endorsed product are a reasonable fit; thus, the perception of authenticity fit between the two will be enhanced. In terms of behavioral realism, when DHAs behave like people, their use of real physical products in endorsement ads will be perceived as reasonable; hence, the perception of authenticity fit between the two is also enhanced. Based on the above inferences, we have derived the following hypotheses:

H2a. The form realism of DHA endorsers has a significant positive effect on the authenticity fit between DHA endorsers and products.

H2b. The behavioral realism of DHA endorsers has a significant positive effect on the authenticity fit between DHA endorsers and products.

2.2.3. Association fit of DHA endorsement

The association fit between DHAs and products depends on whether consumers perceive an association between the former and the latter. Research on avatars has shown that avatars can elicit consumer associations, thereby influencing their attitudes. For example, if an avatar in a game evokes certain associations and emotions, it can enhance a user's overall experience (Wu and Hsu, 2018). In addition, the personality traits of a DHA can cause consumers to make relevant associations and change their attitudes (Ahn et al., 2022). Research on endorsers suggests that since the fit between consumers' associations with endorsers and products is important (McCormick, 2016), the consistency of associations between endorsers and products allows consumers to generate associative learning that enhances their brand attitudes (Till and Busler, 2000).

Following previous studies, when consumers' associations of DHA endorsers fit those of products, their associative learning and formation of cue-consistent evaluations improves their attitude toward DHA endorsement. In other words, when consumers perceive that a certain temperament of a DHA is consistent with their product associations, they have a positive attitude toward the DHA endorsement. Therefore, the following hypothesis is proposed:

H3. The association fit between DHA endorsers and products has a positive effect on attitudes toward DHA endorsement.

2.2.4. Antecedents of DHA-product association fit

We predict that consumers' perceptions of a DHA's warmth and competence directly affect their perceptions of DHA-product association fit. We thus adopt mind perception theory to explain the antecedents of DHA-product association fit. Mind perception theory was first proposed by Gray et al. (2007) to reveal the dimensions of human perception and association concerning entities; hence, it is appropriate for revealing the association fit between DHAs and products because the theory suggests that people can assign associations to nonhuman physical or digital entities (Uysal et al., 2022). On the other hand, mind perception theory indicates that virtual DHAs can provide people with a relevant association of warmth and competence. Since perceptions of warmth and competence are internal association cues according to cue consistency theory, it is appropriate to employ mind perception theory to explain the antecedents of association fit.

According to mind perception theory, consumers' perceptions of DHAs can be divided into warmth or competence perception. Warmth perception comprises consumers' perception of a DHA's kindness and trustworthiness; competence perception comprises consumers' perception of a DHA's efficiency and intelligence (Aaker et al., 2010). Since perception affects the construction of association networks (John et al., 2016), consumers' perception of warmth and competence affects their association fit between DHAs and products. Therefore, perceived warmth and competence influence the perception of DHA-product association through their influence on the DHA association. Specifically, when consumers perceive that a DHA expresses sincere warmth, they have warmth-related associations with the DHA; this warmth perception also influences the DHA-product association fit in warmth-related association. When consumers perceive that a DHA is efficient, they have a competence-related association with the DHA; this competence perception also influences the DHA-product association fit in competence-related associations. Accordingly, the following hypotheses are derived:

H4a. The perceived warmth of DHA endorsers has a significant positive effect on the association fit between DHA endorsers and products.

H4b. The perceived competence of DHA endorsers has a significant positive effect on the association fit between DHA endorsers and products.

2.3. Moderating effect of product type

We predict that the influence of authenticity and association fit on DHA endorsement varies by product type (hedonic vs. utilitarian). Hedonic products are purchased and consumed to satisfy consumers' extrinsic symbolic needs (Ryu et al., 2006). When consumers pay more attention to the extrinsic symbolic attributes of a product, they thus prefer hedonic products to utilitarian products (Sela and Berger, 2012). Regarding advertising endorsement, consumers are more concerned with the fit between the external personalized representation of an endorser and the hedonic product; hence, consumers generate positive attitudes toward the DHA endorsement if it creates an authenticity fit between the DHA endorser and the hedonic product.

For utilitarian products, consumers tend to be more cognitively driven (Ryu et al., 2006); their evaluation of utilitarian products is more likely to be influenced by associative factors, such as intrinsic ability, than image factors. Previous research has also shown that consumers rely heavily on heuristic associative reasoning when evaluating more utilitarian products on social networking sites (Schulze et al., 2014). Research on DHA recommendations has shown that people make associations about DHAs regarding their capabilities and that such associations make consumers more likely to try utilitarian products recommended by AI (Longoni and Cian, 2022; Ahn et al., 2022). Regarding advertising endorsement of utilitarian products, consumers are more concerned with the intrinsic association between the endorser and the product rather than the authenticity fit in the hedonic context. Accordingly, we posit the following:

H5. The DHA-product authenticity fit of hedonic products has a greater impact on attitudes toward DHA endorsement than that of utilitarian products. The DHA-product association fit of utilitarian products also has a greater impact on attitudes toward DHA endorsement than that of hedonic products.

Based on the above theories and discussion, we propose the DHA endorsement model, which is illustrated in Fig. 1.

3. Research methods

To empirically test the validity and robustness of our DHA endorsement model, we selected two DHAs for separate tests. Using multiple sets of tests to test model robustness is common in the extant research (Huang et al., 2013). In both tests, we used different manipulations for hedonic and utilitarian products to demonstrate the applicability of the moderating effect of product type in multiple scenarios. Specifically, we first constructed a scale for the DHA endorsement model

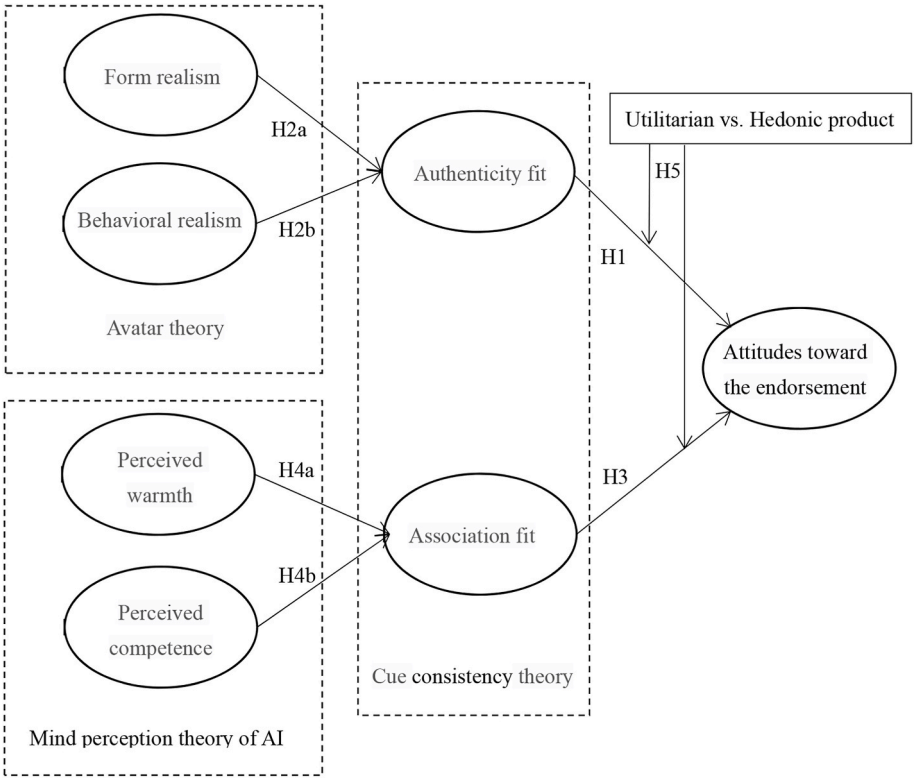

Fig. 1. Digital human avatar endorsement model.

based on the literature, completed two DHA tests to examine the reliability and validity of our scale, and then conducted separate multigroup analyses of the two tests to determine the role of product type in the DHA endorsement model.

3.1. Pretest

We selected the top nine DHAs on the popularity list of the China metahuman influence index report for a pretest to identify the DHA that is most compatible with the concept of this paper (CUC, 2022). In the pretest, using a within-group design, we sequentially showed 3 s of video clips for each of the nine avatars and then asked participants whether the DHA matched the definition of a DHA, including the following two questions about realistic image and realistic behavior: "I think the appearance/behavior of the virtual person looks no different from that of real people" (1 = strongly disagree, 7 = strongly agree). The videos of the nine DHAs were presented in a randomized order to eliminate within-group pretest effects.

Forty participants took the pretest in exchange for payment through Credamo (Mage = 30.15, SD = 6.43; 50.00% female), a questionnaire collection platform similar to Mturk where sample quality is guaranteed (Gong et al., 2020). The results showed that Liu Yexi was the DHA with the highest scores for most realistic image (Mean = 6.25, SD = 0.67) and behavior (Mean = 6.275, SD = 0.88), while Ling was the DHA with the second highest scores for most realistic image (Mean = 5.85, SD = 1.31) and behavior (Mean = 5.975, SD = 1.07). These results were in line with the popularity list of DHAs in the virtual digital human influence index, where Liu Yexi ranked first and Ling second, confirming the reasonableness of the virtual humans that we selected. Next, we used these two DHAs in our testing.

3.2. Measures

The items of the DHA questionnaire were derived from previous related studies, and we adapted and designed the question items to fit the context of this study. Specifically, the form realism and behavioral realism questions were designed based on the definition of DHA in Miao et al. (2022), in which form realism was defined as human-like appearance, lifelike features, and realism of facial expressions; behavioral realism was described as richness and realism of behavioral expressions, facial movements, and body language. The question of DHA authenticity fit was adapted from the studies of Spiggle et al. (2012) and Kamins (1990); it focuses on the consistence with the product, reflection of the product and the match of DHA characteristics with the product. The measurement of perceived warmth and competence of DHAs was mainly based on the studies of Aaker et al. (2010) and Belanche et al. (2021b); perceived warmth contains the three items of perceived warmth, kindness and good-natured, while perceived competence includes perceived intelligence, perceived skillful body language and competent facial expressions. The questions of DHA association fit was adapted from Keller's (1993) study, including the similarity of the intrinsic characteristics of DHA and products, association with product attributes, and image temperament fit. Attitude toward the endorsement was derived from Belanche et al. (2021a) study and included perceived delight, liking and positive opinion of the endorsement.

In addition to the design of the question items in the DHA endorsement model, we included gender and age as control variables in the test. To ensure the validity of the content, six undergraduate students familiar with DHAs were invited to examine the wording, legibility, and usability of the questionnaire. After investigating the clarity of the expression of the questionnaire's measurement items, a final agreement was reached on the content of the questionnaire, which is shown in Table 1.

Table 1
The DHA questionnaire with all of the final items.

Construct	Items		Supporting literature
Form Realism (FR)	FR1	Visually, the DHA is very human-like	Miao et al. (2022)
	FR2	Many of the features of the DHA's appearance (features, hair, etc.) are lifelike	
	FR3	Visually, the DHA's facial expression is very realistic	
Behavioral Realism (BR)	BR1	The DHA's facial movements and gestures are abundant	Miao et al. (2022)
	BR2	The DHA's body language is rich in expression	
	BR3	The DHA's behavior is not different from that of a human	
Authenticity Fit (AUF)	AUF1	The DHA's appearance is consistent with my image of the product	Spiggle et al. (2012); Kamins (1990)
	AUF2	The style of this endorser (behaviors and expressions) seems to reflect that of the product	
	AUF3	The human characteristics of the DHA match the product's characteristics	
Perceived Competence (PC)	PC1	The DHA is intelligent	Aaker et al. (2010); Belanche et al. (2021b)
	PC2	The DHA's body language is highly skillful	
	PC3	The DHA's facial expressions are highly competent	
Perceived Warmth (PW)	PW1	The DHA gives me a feeling of warmth	Aaker et al. (2010); Belanche et al. (2021b)
	PW2	The DHA gives me a feeling of kindness	
	PW3	The DHA is good-natured	
Association Fit (ASF)	ASF1	The DHA has similar intrinsic characteristics to the product	Keller (1993)
	ASF2	The DHA reminds me of some attributes of the product	
	ASF3	The DHA's personality matches the product's image ethos	
Attitudes toward the endorsements (AE)	AE1	The DHA's endorsement of the product is delightful	Belanche et al. (2021a)
	AE2	I like the fact that the DHA endorsed the product	
	AE3	I have a positive opinion of this DHA endorsement	

3.3. Data collection

As mentioned above, we selected two DHAs for separate tests, and pretesting was performed to ensure we conformed to the aim of this study when selecting the DHAs. We obtained two DHAs in the test, Liu Yexi and Ling. Liu Yexi is a DHA from ChuangYi technology, and Ling is a DHA from MoFa technology. They are the two most influential DHAs that we could identify. We designed two tests after obtaining their image license for application in academics. Test 1 used Liu Yexi as the DHA endorser, and the product type was manipulated with a hedonic product (cake) and a utilitarian product (ergonomic mouse) (Choi et al., 2020). Test 1 used different products (cake vs. ergonomic mouse) to manipulate the moderator. To enhance the validity of the moderating effect, we conducted test 2 with different primings of the same product (laptop for entertainment vs. laptop for office). Test 2 used Ling as the DHA endorser, and the product type was manipulated by showing the hedonic value (for entertainment) and the utilitarian value (for office) of the same product (laptop) with different descriptions (Wien and Peluso, 2021). The reason we chose cake and an ergonomic mouse is that these products have been demonstrated to be good stimuli in previous studies on hedonic/utilitarian attributes; such products can allow consumers to

easily perceive whether they are hedonic or utilitarian (Choi et al., 2020). Similarly, previous studies have shown that computers can allow participants to distinguish between hedonic or utilitarian attributes through different descriptions (Wien and Peluso, 2021). Through two tests, the changes in the DHAs were thus used to validate the robustness of the DHA endorsement model, and the changes in the product-type manipulation were used to validate the robustness of the product-type moderation, as described below.

3.3.1. Test 1

The avatar used for this test was Liu Yexi, and the test had a between-group design for product type (hedonic vs. utilitarian). A total of 628 participants took the test on the Credamo platform in exchange for monetary payment. Nine participants with identical responses for all items were excluded, leaving 619 valid questionnaires (M_{age} = 29.74, SD = 6.69; 63.00% female; $N_{Hedonic}$ = 307; $N_{Utilitarian}$ = 312). In test 1, we referenced the scenario of Choi et al. (2020), in which cake was used as a hedonic product and an ergonomic mouse were used as a utilitarian product, and participants were randomly assigned to either the hedonic or utilitarian group. Participants first read a description of the DHA to gain an initial understanding of the DHA, after which they watched a 30-s video of Liu Yexi's expressions and movements. We then showed a picture depicting the DHA-endorsed cake or ergonomic mouse. Next, participants completed the DHA questionnaire and participated in the between-group manipulation check and filled out the demographic information items.

The manipulation check for product type included two questions from Chen et al. (2017): "Buying this product represents pleasure-oriented consumption (e.g., people buy something to have fun or an experience)", and "Buying this product represents goal-oriented consumption (e.g., people buy something to perform a function or task)" (1 = strongly disagree, 7 = strongly agree). The results suggest that the manipulation of product type was valid, with the perceived hedonic value of the cake being greater than that of the mouse (M_{Cake} = 5.88, SD = 1.76; M_{Mouse} = 3.42, SD = 0.96; F(1, 617) = 463.38, p<.001), while the perceived utilitarian value of the mouse was greater than that of the cake (M_{Cake} = 3.42, SD = 1.78; M_{Mouse} = 5.93, SD = 1.08; F(1, 617) = 453.71, p<.001).

3.3.2. Test 2

The avatar used for this test was Ling, and the test used a between-groups design for product type (hedonic vs. utilitarian), with 628 participants taking the test through the Credamo platform in exchange for monetary payment. Eleven participants with identical responses on all items were excluded, yielding 617 valid questionnaires (M_{age} = 28.98, SD = 6.57; 59.97% female; $N_{Hedonic}$ = 309; $N_{Utilitarian}$ = 308). In test 2, we refer to the study by Wien and Peluso (2021) in which the hedonic product was described as a laptop for entertainment and the utilitarian product was described as a laptop for office use. As in Test 1, participants read the DHA instructions, watched a 30-s video of Ling's expressions and movements, saw the endorsement image depicting the laptop for entertainment or office use, filled out the DHA questionnaire and then completed the same control check options and demographic characteristics as in test 1.

The manipulation of product type for test 2 was also valid, with the perceived hedonic value of the hedonic descriptions being greater than that of the utilitarian descriptions ($M_{Hedonic}$ = 5.87, SD = 1.14; $M_{Utilitarian}$ = 3.11, SD = 1.69; F(1, 615) = 567.70, p<.001) and the perceived utilitarian value of the utilitarian descriptions being greater than that of the hedonic descriptions ($M_{Hedonic}$ = 3.77, SD = 1.84; $M_{Utilitarian}$ = 6.18, SD = 0.91; F(1, 615) = 421.03, p<.001).

Detailed information on the demographic characteristics of test 1 and test 2 can be found in Table 2. Links to videos and images are included in the appendix.

4. Data analysis and results

We adopted a partial least squares structural equation modeling (PLS-SEM) tool to evaluate the structural model measurements. Specifically, we employed SmartPLS software for data analysis. PLS-SEM can handle model complexity with fewer limitations than other methods and has been employed in previous multigroup analyses (Hair et al., 2019; AlNuaimi et al., 2022).

4.1. The measurement model

We assessed reliability and validity based on three criteria: (1) for reliability tests, composite reliability and Cronbach's alpha should be above 0.7 (Hu and Bentler, 1999); (2) all factor loadings for convergent validity tests should exceed 0.7, and the average variance extracted (AVE) should exceed 0.5 (Hair et al., 2019); and (3) the square root of each AVE in the discriminant validity test should be greater than the correlation coefficient between constructs (Bollen, 1989). We examined the samples of the two tests separately, and the relevant reliability and validity results are shown in Table 3 and Table 4. These results indicate the plausibility of the DHA endorsement model.

4.2. The structural model

We measured the covariance of the structural model using the variance inflation factor (VIF). Ideally, the VIF value should be less than 5 (Hair et al., 2019). These results showed that all the VIF values in the models constructed with different DHAs were below this threshold, indicating that there was no collinearity between the constructs. We also examined the adjusted R^2 values, which indicate the predictive power of a model by showing the variance in endogenous variables that can be explained by exogenous variables. The adjusted R^2 values of AE were all greater than 0.6 (Liu Yexi = 0.648; Ling = 0.663), indicating that the model explained most of the variance in AE, in line with most existing studies (AlNuaimi et al., 2022). In addition, we examined the Q^2 values to assess the predictive correlation values generated by the variables. The Q^2 values for AE (Liu Yexi = 0.498, Ling = 0.492), ASF (Liu Yexi =

Table 2
Demographic information.

Variable	Category	Liu Yexi(N = 619)		Ling(N = 617)		Full samples (N = 1236)	
		Numbers	Percentage	Numbers	Percentage	Numbers	Percentage
Gender	Male	229	37.00%	247	40.03%	476	38.51%
	Female	390	63.00%	370	59.97%	760	61.49%
Age	18–30	364	58.81%	384	62.27%	748	60.52%
	31–40	220	35.54%	205	33.23%	425	34.39%
	41–50	20	3.23%	17	2.76%	37	2.99%
	≥51	15	2.42%	11	1.78%	26	2.10%
Educational level	High school or below	32	5.17%	19	3.08%	51	4.13%
	Undergraduate or bachelor	510	82.39%	483	78.28%	993	80.34%
	Postgraduate	74	11.96%	106	17.18%	180	14.56%
	Doctor or above	3	0.48%	9	1.46%	12	0.97%

Table 3
Reliability and convergent validity analysis.

Construct	Item	Liu Yexi(N = 619)				Ling(N = 617)			
		Factor loading	AVE	Composite Reliability	Cronbach's Alpha	Factor loading	AVE	Composite Reliability	Cronbach's Alpha
Form Realism (FR)	FR1	0.754	0.649	0.847	0.731	0.781	0.627	0.834	0.705
	FR2	0.799				0.761			
	FR3	0.861				0.831			
Behavioral Realism (BR)	BR1	0.862	0.718	0.884	0.803	0.823	0.650	0.848	0.730
	BR2	0.868				0.823			
	BR3	0.811				0.771			
Authenticity Fit (AUF)	AUF1	0.873	0.735	0.893	0.819	0.814	0.647	0.846	0.728
	AUF2	0.820				0.779			
	AUF3	0.878				0.821			
Perceived Competence (PC)	PC1	0.707	0.653	0.848	0.730	0.720	0.628	0.835	0.702
	PC2	0.853				0.814			
	PC3	0.856				0.839			
Perceived Warmth (PW)	PW1	0.883	0.733	0.891	0.818	0.874	0.770	0.770	0.851
	PW2	0.875				0.893			
	PW3	0.808				0.866			
Association Fit (ASF)	ASF1	0.900	0.795	0.921	0.871	0.820	0.676	0.862	0.761
	ASF2	0.871				0.811			
	ASF3	0.903				0.836			
Attitude toward the Endorsement (AE)	AE1	0.833	0.777	0.913	0.856	0.854	0.749	0.900	0.833
	AE2	0.907				0.892			
	AE3	0.853				0.851			

Table 4
Discriminant validity analysis.

Construct	Liu Yexi(N = 619)							Ling(N = 617)						
	AE	ASF	AUF	BR	FR	PC	PW	AE	ASF	AUF	BR	FR	PC	PW
AE	**0.881**							**0.866**						
ASF	0.761	**0.892**						0.724	**0.822**					
AUF	0.774	0.819	**0.857**					0.782	0.741	**0.805**				
BR	0.593	0.582	0.694	**0.847**				0.559	0.432	0.606	**0.806**			
FR	0.595	0.535	0.639	0.661	**0.806**			0.566	0.462	0.578	0.636	**0.792**		
PC	0.618	0.608	0.709	0.793	0.636	**0.808**		0.596	0.498	0.597	0.725	0.646	**0.793**	
PW	0.726	0.582	0.685	0.633	0.617	0.604	**0.856**	0.668	0.505	0.597	0.595	0.501	0.566	**0.878**

Notes: Diagonal elements (in bold) are the square root of AVEs of constructs.

0.346, Ling = 0.211) and AUF (Liu Yexi = 0.387, Ling = 0.269) were above 0, implying that the model had predictive relevance (Chin, 2010). Finally, we calculated the standardized root mean square residual (SRMR) to determine the goodness of fit (Liu Yexi = 0.056, Ling = 0.062). SRMR values below 0.08 imply that data fit their model (Hu and Bentler, 1999). In summary, we found that our DHA endorsement model had a good fit. Thus, we proceeded to test our hypotheses.

4.3. Hypothesis testing

Table 5 shows the results of our estimated structural models, including the path coefficients and t values, for the two tests of the respective samples of Liu Yexi and Ling. These results showed that all the path coefficients in the proposed structural model were significant for the two tests. Therefore, H1-H4 were sufficiently supported by our analyses.

To test the effect of product type (hedonic vs. utilitarian) on attitudes toward the endorsement, we used multiple group analysis (MGA) with a bootstrap of 5000 trials. These results for the two DHAs are detailed in

Table 5
Hypothesis testing for DHA endorsement model of two tests: Liu Yexi(N = 619) and Ling(N = 617).

Hypothesis	Path	Avatar	Path coefficient (B)	T Statistics	Results
H1	AUF→AE	Liu Yexi	0.448***	8.671	Support
		Ling	0.526***	13.915	
H2a	FR→AUF	Liu Yexi	0.319***	7.726	Support
		Ling	0.324***	7.469	
H2b	BR→AUF	Liu Yexi	0.483***	11.332	Support
		Ling	0.399***	9.948	
H3	ASF→AE	Liu Yexi	0.385***	6.856	Support
		Ling	0.316***	7.972	
H4a	PC→ASF	Liu Yexi	0.405***	8.920	Support
		Ling	0.313***	6.698	
H4b	PW→ASF	Liu Yexi	0.337***	6.661	Support
		Ling	0.329***	7.418	

Notes:***p < 0.001, **p < 0.01, **p < 0.05.

Table 6
Hypothesis testing for moderation of product type for sub-sample of two tests: Liu-Yexi$_{Hedonic}$(N = 307); LiuYexi$_{Utilitarian}$(N = 312); Ling$_{Hedonic}$(N = 309); Ling$_{Utilitarian}$(N = 308).

H#	Path	Avatar	Path coefficient(B)		Path coefficients-diff	Result
			Hedonic	Utilitarian	(Hedonic vs. Utilitarian)	
H5	AUF→AE	Liu Yexi	0.596***	0.286***	0.310**	Support
		Ling	0.616***	0.444***	0.172*	
	ASF→AE	Liu Yexi	0.278***	0.509***	−0.231*	Support
		Ling	0.235***	0.392***	−0.157*	

Notes:***p < 0.001, **p < 0.01, *p < 0.05.

Table 6. These findings are consistent with H5.

The results support our proposed DHA endorsement model and reveal the antecedents and consequences of DHA-product fit. They show that the fit between a virtual DHA and real product can be divided into authenticity fit and association fit. Form realism and behavioral realism are the factors that promote the authenticity fit between DHA and product, while perceived competence and perceived warmth are the factors that promote the association fit between DHA and product. These two dimensions of fit jointly drive consumers' positive attitudes toward DHA endorsement. In addition, these results indicate that people place different emphases on perceptual fit across different types of products. Authenticity fit has a greater positive impact on consumer attitudes toward DHA endorsement when a DHA endorses a hedonic product, while association fit is more likely to promote positive attitudes toward DHA endorsement in a utilitarian context. These results thus provide some insights for marketers studying DHA endorsement and managers trying to adopt it.

5. General discussion

In this study, we have investigated the mechanism of DHA endorsement, revealing it to be the fit between virtual DHAs and real products, and we have found that DHA-product authenticity fit and association fit are important factors influencing consumers' attitudes toward DHA endorsement. In addition, this research has described what strategies DHAs should adopt for hedonic or utilitarian products.

The inspiration for this paper was twofold. First, DHAs, as endorsers, are a new phenomenon that has been adopted by companies and is gradually coming to the attention of consumers (Arsenyan and Mirowska, 2021), but it is not yet known how this novel endorsement model affects consumer attitudes. Second, DHA endorsement has become increasingly common in recent years (Miao et al., 2022), but it is not clear what strategies should be adopted for DHA endorsement for different products. In this context, our study provides new theoretical implications, managerial implications, and directions for future research, which we explore in the following sections.

5.1. Theoretical implications

Our study provides several important theoretical contributions, the first of which is our identification of the mechanism inherent to digital-physical fit in the context of DHA endorsement, a key point that has not been discussed in previous studies. *Previous research on virtual entities in marketing has focused mainly on consumers' particular attitudes (e.g. aversion or appreciation) (Castelo* et al., *2019*; *Logg* et al., *2019), consumers' interactions with DHAs and their impact on consumer experience (Silva and Bonetti, 2021*; *Moore* et al., *2022). In addition, recent emerging research on avatar marketing has focused only on the theoretical or qualitative level and has not revealed how avatars can be integrated into real life (de Brito Silva* et al., *2022*; *Miao* et al., *2022)*. Thus, the mechanism by which digital-physical fit is achieved has remained unknown. This study thus provides direction for how virtual entities can fit into real life. Our results show that to ensure consumers adopt virtual entities in real life, it is first necessary to consider how to enhance the latter's form realism and behavioral realism to achieve authenticity fit. Second, it is necessary to consider how to enhance the warmth perception and competence perception of virtual entities to achieve association fit. This paper thus extends the literature on this area by defining the digital-physical fit mechanism.

The second theoretical contribution of this paper is our discussion of how to achieve a suitable fit in the context of endorsement. Previous studies on fit in endorsement have often focused on the impact of endorser-product fit according to, e.g., *product attitude (Kamins, 1990), brand attitude (Till and Busler, 2000), endorser credibility (Park and Lin, 2020), and intentions (McCormick, 2016*; *Fernandes* et al., *2022). However, previous research has usually treated fit as an overall variable.* Few studies focus on the deep dimensions of endorser-product fit. In this paper, however, we start from the perspective of the fit of external cues and internal cues between endorser and product during endorsement and thereby divide endorser-product fit into authenticity fit and association fit. In addition, we have also shown how the impact of these two fit dimensions on consumers' attitudes toward endorsement varies by product attributes. Thus, marketers can further discuss endorsement with the perspective of these two fit dimensions.

The third theoretical contribution of this paper is our exploration of the types of products for which DHA endorsement is appropriate and our discovery of the moderating effect of hedonic/utilitarian products. *Previous research on avatars in hedonic/utilitarian consumption has focused only on AI recommenders (Longoni and Cian, 2022*; *Wien and Peluso, 2021*; *Ahn* et al., *2022) or virtual agents (Lunardo* et al., *2016) and has not addressed the field of endorsement. In addition, previous studies on product attributes in endorsement have focused on endorser ethnicity (Ryu* et al., *2006) or internet celebrities (Park and Lin, 2020) and have not addressed the field of DHA*. Therefore, how the hedonic-utilitarian trade-off affects attitudes toward DHA endorsement has thus far remained unknown. This paper, however, shows that while for hedonic products, the authenticity fit of DHAs with products has a greater impact on the attitudes toward DHA endorsement, for utilitarian products, the association fit of DHA with products has a greater influence. Hence, when DHAs are used to endorse hedonics, the fit between the external realism of the DHAs and products should be promoted more; when DHAs are used to endorse utilitarian products, the fit between the association of DHAs and products should be promoted more. This finding therefore expands both our understanding of DHA endorsement and the literature on hedonic/utilitarian products in the context of DHA endorsement.

Finally, this paper contributes to the literature on cue consistency theory. In this study we used cue consistency theory to explain DHA endorsement, extending the application scenario of cue consistency theory. *The theories previously used to explain the match in endorsement have primarily been social adoption theory (Kamins, 1990), associative learning theory (Till and Busler, 2000), and self-congruity theory (Park and Lin, 2020). Our findings show that cue consistency theory is suitable for explaining the mechanism of DHA-product fit. For multiple cues among DHA endorsers (Dean, 1999) and products (Bakamitsos, 2006), cue consistency has a large impact on consumer attitude (Maheswaran and Chaiken, 1991*; *Miyazaki* et al., *2005*; *Jiménez and Mendoza, 2013).* On the other hand, we divide cues into internal and external categories, enriching cue consistency theory. Previously, cues have mainly been used to emphasize the consistency of cues and without effectively distinguishing cue types (Maheswaran and Chaiken, 1991). Our results show not only that internal cue consistency and external cue consistency exist but also that both have significant effects on consumer attitudes. In addition to the theoretical implications mentioned above, our results have implications for management practice, which we elaborate below.

5.2. Managerial implications

Given the development and application of artificial intelligence and computer graphics in marketing, managers need to leverage these new technologies to optimize the customer experience. Hence, the findings in this paper have profound implications for managers considering the adoption of DHA endorsement.

First, our findings provide fruitful insights for how companies and public organizations can effectively adopt DHA endorsement. Brands such as Tesla and Estee Lauder have begun to adopt DHA endorsement, and our findings suggest that DHA-based endorsement is more effective when authenticity and association fit between a DHA and product is achieved. Thus, a company should choose a DHA endorser with both external authenticity and internal temperament. Our results can also help companies make strategic decisions. Due to the high plasticity of DHAs, marketers targeting DHA-based endorsement can adopt certain means to enhance the authenticity fit between their DHA and product,

for example, by changing the appearance of the DHA to make its image more consistent with the appearance of the product. For association fit, marketers could change the temperament of their DHA to ensure that consumers' perceptions of the DHA are consistent with their product associations. In addition, the fit mechanism of DHAs is applicable in many tactical decisions, such as marketing communication; for example, managers can emphasize the authenticity and association fit of their DHA with the products in their advertising campaigns.

Second, this study highlights the role of product type in DHA endorsement, which may be beneficial to operations in management practices. The results of our two tests reveal when the use of DHA authenticity fit is more effective (i.e., when the hedonic attributes of a product are more prominent, such as entertainment products) and when association fit is more effective (i.e., when utilitarian attributes are more prominent, such as office products). On the one hand, marketers can change the description in an advertisement depending on the type of DHA endorsers, similar to test 2, when the same product can be described in different ways to reflect hedonic or utilitarian value (Longoni and Cian, 2022; Choi et al., 2020). Thus, marketers can use an experiential positioning strategy (focusing on describing the hedonic value of their product) when DHA has a strong authenticity fit with the product and a functional positioning strategy (focusing on describing the utilitarian value of their product) when DHA has a significant association fit with the product. On the other hand, marketers can adjust their marketing strategies according to product type by emphasizing the authenticity fit (vs. association fit) between their DHA and product when hedonic attributes (vs. utilitarian attributes) are more important. Nevertheless, despite the useful implications of our findings, the limitations of our study provide some opportunities for future research, which we explore below.

5.3. Limitations and future research

First, we have investigated the mechanism of digital-physical fit in DHA endorsement and demonstrated the robustness of our DHA endorsement model through two different tests. However, we have not compared DHA endorsement with human endorsement or animated endorsement. As consumers have different responses to humans and AI (Luo et al., 2019; Longoni and Cian, 2022; Wien and Peluso, 2021) and endorser type affects consumer attitudes (Stafford et al., 2002), the differences between DHA endorsement, human endorsement, and animated endorsement could be further investigated to explore the unique roles of DHAs as endorsers to emphasize the most effective points of DHA endorsement.

Second, although this paper has explored the moderating role of product type in the regulation of DHA endorsement, more moderating variables could be evaluated in the future because purchases in service settings are complex. On the one hand, further research could examine the more personalized characteristics of DHA endorsers, such as their gender, age, or race; these have been shown in previous studies of human endorsers and DHA to influence consumer decisions (Ryu et al., 2006; Lunardo et al., 2016; Fernandes et al., 2022), and thus this influence may also be reflected in DHA endorsement. In addition, consumers' personal characteristics may be moderating variables that influence their attitudes toward DHA endorsement. For example, people with a higher need for uniqueness are more reluctant to try AI products (Granulo et al., 2021), while consumers' anxiety about AI itself may influence their attitudes toward DHAs (Li and Huang, 2020). Hence, the role of the personal factors of consumers in DHA endorsement could be further explored.

Finally, this study has only discussed the effect of digital-physical fit on attitudes toward DHA endorsement. Therefore, additional downstream results, such as product attitudes and purchase intentions, could be analyzed in the future. In addition, the attitudes toward DHAs in this paper were derived from participants' self-reports; a lab study could be applied in the future to explore the effects of DHA endorsement on individual behaviors and choices. Finally, given the rise of the use of biometric technology in marketing, methods such as electroencephalography (EEG) or eye movement could also be used to study DHA endorsement. Although there is less recent research in this area, it is important to examine the impact of DHA endorsement based on consumer behaviors and responses.

Data availability

Data will be made available on request.

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Appendix

Test 1

video links: https://www.bilibili.com/video/BV1bu411e7yn.
Images: Liu Yexi endorsement condition for the hedonic (cake) versus utilitarian (ergonomic mouse) product.

Test 2

video links: https://www.bilibili.com/video/BV1N3411p7o2.
Images: Ling endorsement condition for the hedonic (laptop for entertainment) versus utilitarian (laptop for office) product.

This new laptop has high performance and several new features that are very useful when working and doing analytical activities.

This new laptop has high performance and several new features that are very useful when working and doing analytical activities.

*The images and videos displaying the two DHAs were adopted from ChuangYi technology company and MoFa technology company, licensed.

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