Harder and Smoother on Touchscreens? How Interaction Mode Affects Consumer Product Judgment

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Abstract

Emerging technologies, such as touchscreen interaction and mid-air gesture-based interaction, are changing the ways we interact with products virtually. However, despite research on how these technologies can be leveraged to improve consumers' shopping experience, few studies have explored how they affect consumer product judgment. This study explores how two types of gesture-based human-device interaction modes (i.e., touchscreen interaction and mid-air interaction) influence consumers' judgment on product haptic attributes (i.e., softness and roughness). Results from a lab experiment reveal that interacting with a product via touchscreen, as compared via a mid-air gesture controller, leads to a lower perception of product softness and roughness. Furthermore, such effects are more salient among users with a higher level of need for touch. The results imply that people may mistakenly use the incidental haptic experience gained from interaction device (e.g., the solid and smooth haptic experience a user feels when interacting with touchscreen surface) in product judgment although such experience is not directly related to the product being evaluated. Theoretical contributions, practical implications, and future research are discussed.

1. Introduction

The past decade has seen fundamental changes in the devices people use to experience and purchase products online. Recent data shows that 44.5 percent of US e-commerce sales in 2019 is expected to be driven by consumers using their touchscreen devices, such as mobile phones and tablets [6]. Despite touchscreen, mid-air gesture-based interaction is also increasingly used by retailers and marketers. Mid-air gesture-based interaction, also termed as mid-air interaction, is a cutting-edge technology which involves touchless manipulations of digital content, based on sensor tracking of hand movements and gestures [13]. Innovative retailers have explored ways to engage customers with the digital experience enabled by mid-air gesture-based devices. For example, to promote their homeware, Marks & Spencer allows its customers to drag and drop items with mid-air gestures to create a digital living space displayed in virtual reality (VR) [5]. Timberland and Topshop have implemented virtual fitting applications in which consumers can see themselves try on different shoes and clothes displayed on a screen by waving their hands in the air [30].

Indeed, practitioners have endeavored to design hardware devices and software applications to support different types of gesture-based interaction (i.e., touchscreen interaction and mid-air interaction). Laptop and smartphone manufacturers, such as Microsoft and Apple, are contemplating incorporating mid-air gesture input into their new products [10, 22]. E-commerce giants, such as Amazon and Taobao, are providing tools and platforms for developers to create innovative digital experiences suitable for gesture-based input devices [11]. The prevalence of touchscreen interaction and the emerging use of mid-air interaction in e-commerce has driven a growing number of studies investigating how these gesture-based human-device interaction modes, as compared with the traditional mouse-based interaction, affect consumers' online shopping experience. In particular, a stream of literature has compared how consumers' shopping experience and behavior differ when they are using touch-based tablets and mouse-based PC. For example, it has been found that reaching out to touch a product on a touchscreen device can make the consumption experience more vivid in people's mind and thus lead to higher purchase intention as opposed to using a mouse to click on the product [32].

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Furthermore, touchscreens lead to more impulsive and diversity-seeking purchase behavior [35]. However, scant attention has been paid to mid-air interaction, which has shown great potential in the e-commerce context [13].

Both touchscreen interaction and mid-air interaction enable consumers to interact with products in a more natural way by using their hands [28]. However, they provide different sensory experience. Consumers may obtain tactile feedback provided by the surface of a touchscreen device while they will not get any tactile feedback from a mid-air gesture controller because they do not touch anything tangible object during interaction. Given the vital role of people's bodily sensation in influencing their judgment and behavior [14, 15], this study will deepen our knowledge about how to shape consumer product judgment, in particular, judgment on product haptic attributes, through gesture-based interaction modes (i.e., touchscreen interaction and mid-air interaction). Haptic information (e.g., texture and softness) is vital in product evaluation [12]. This is particularly true with regard to products that have important tactile properties (e.g., clothing, mattresses, and leather accessories). Barriers to touch can inhibit the access and use of haptic information and consequently increase uncertainty in product evaluations, resulting in frustration and dissatisfaction [9]. In online stores, the consumer is deprived of actual touch before making a purchase. Therefore, it is important to understand how consumers' haptic experience and judgment are shaped by digital technology. Because the hand is the primary haptic sensation input channel [17], interaction modes that provide different haptic experience may lead to different haptic perceptions in product judgment. In addition, because of the high development cost of mid-air interaction, understanding the difference between the two gesture-based interaction modes is vital to practitioners who need to make an informed decision on the choice of technology with limited time and financial budget. Therefore, this study focuses on the comparison between touchscreen interaction and mid-air interaction in the e-commerce context.

Specifically, we investigate how consumers' judgment on haptic attributes is influenced by the interaction mode they are applying. Although some studies have investigated how different interfaces affect mental imagery [32], thinking style [39], engagement and product choice [31], empirical research investigating their impacts on consumers' product judgment still lags. Prior research has revealed that people may mistakenly consider sensory experiences that are not directly related to the focal object they are evaluating. For example, when people carry a heavy bag (compared with a light bag), they tend to perceive a mountain in front of them to be steeper because they incidentally incorporate the sensorial fatigue triggered by carrying a heavy bag in their judgment of mountain slant [27]. In the online shopping context, the lack of haptic information about products has greatly impeded consumers' ability to obtain a comprehensive evaluation of their desired products. Thus, it is conceivable that they may incorporate incidental haptic cues into their product judgment. Because touchscreen interaction and mid-air interaction provide different haptic experience, it would be interesting to investigate whether such incidental haptic experience delivered by different digital interaction modes may influence consumers' haptic judgment on the products they are interested in.

To draw a more comprehensive understanding of the effect of interaction mode on product judgement, we examine need for touch as a relevant individual-difference factor. Need for touch is a key consumer trait that defines the individual differences in preference for touch information when they evaluate products [24]. Previous research has shown that need for touch affects how people process haptic information in various contexts [23, 25]. It may thus influence how haptic experience conveyed by different interaction modes is incorporated in consumers' product judgment.

The objective of this research is to explore the impacts of interaction mode (i.e., touchscreen interaction and mid-air interaction) on consumers' product judgment on product haptic characteristics (e.g., softness and roughness). Furthermore, we investigate how users' need for touch moderates such effects. Through exploring the impact of interaction on consumers' product judgment, this study presents an initial exploration into the differences between two types of gesture-based interaction and elucidates the need for further inquiries into consumers' biased product judgment caused by digital technology.

2. Related Literature

2.1. Grounded Cognition and Consumer Sensory Experience

In recent years, the role of sensory experiences in judgment and decision making has seen a surge of interest in consumer research. According to the theory of grounded cognition, all cognitive processes are grounded in bodily states, situated actions and mental simulations [2]. Specifically, bodily feelings obtained from vision, audition, haptics, smell and taste [14, 29], critically modulate an individual's judgments, decisions, and behaviors. On the one hand, sensory experience can provide diagnostic information needed

for product evaluation [14]. On the other hand, enjoyable sensory experience can also lead to positive emotions and thus increased persuasion [29].

The theory also suggests that our bodily sensations can serve as informational input to consumer judgment, even regardless of whether the bodily feelings are an integral part of the judgment task or arise from incidental factors that are irrelevant to the judgment task. Because the sensory experiences are often interlinked, sometimes people may not deliberately differentiate the source of the sensory experience and thus mistakenly use incidental sensory experience in judgment. For instance, the haptic information obtained by holding a cup of hot coffee (i.e., warmth) leads people to perceive others as socially warm [14]. Standing on a soft carpet (vs. a hard tile floor) can make consumers judge a product to be more comfortable [26]. In the preceding examples, sensory experience is induced by situational factors but misattributed to the target of judgment. Indeed, abundant evidence indicates that people often confuse their feelings about a stimulus that they are judging with the feelings that they are experiencing for something else and they use these feelings to judge the stimulus (a review see [34]).

Specifically, our haptic sensation provides us with information about the world, such as shape and weight of things, texture and temperature of materials, verticality and stability of the structure, and many other physical properties [19]. Many studies support the idea that touch is an important sensory modality for acquiring relevant product information and it is therefore highly effective in influencing product evaluation [29] and consumer decision-making [26]. In the subsequent section, we review literature on how digital technology affects consumers' haptic perception.

2.2. Haptic Perception and Digital Technology

Prior literature suggests that sensation and perception are different stages in the processing of the sensory information. [26]. Sensation is when the stimulus impinges upon the receptor cells of a sensory organ—it is biochemical (and neurological) in nature. Perception is the awareness or understanding of sensory information. Haptic perception can be constructed based on the haptic sensations derived from mechanoreceptors and thermoreceptors embedded in the skin ("tactile" inputs) together with mechanoreceptors embedded in muscles, tendons, and joints ("kinesthetic" inputs) [25]. It can also be facilitated by visual or textual information. For example, orienting the handle of a cup towards one's dominant hand on a printed ad [16] and vivid textual description of haptic experience [18] can facilitate people to simulate a touch experience in mind and thus enhance shopping satisfaction when actual haptic input is not accessible. Researchers have also explored the impacts of information technology on consumers' simulated haptic experience. For instance, Elder and Krishna [7] have employed interactive image technology which enables product images to change (e.g., stroke) in response to consumers' actions (e.g., dragging the mouse).

Recent studies have explored how human-device interaction modes, e.g., touchscreen interaction and mouse-based interaction, can affect consumers' online shopping experience. There is initial evidence showing that touchscreen interaction could affect consumers' elaboration on haptic information. For example, Brasel and Gips [23] find that compared with mouse-based interaction, touchscreen interaction leads to a higher sense of product ownership, which is typically established via physical touch. Further, they find that compared with mouse-based interaction, touchscreen interaction lead users to rely more on haptic attributes when evaluating products [21]. They argue that this is because on touchscreens, consumers can directly touch the product images, which simulates physical contact with a product. With mid-air interaction, consumers can sense the motions of their hands, which are often employed when they are touching and interacting with products in reality. However, they cannot obtain any tactile feedback because their gestures are perfromed in the air. Thus, the two interaction modes may differ in shaping consumers' haptic perception.

Haptic perception entails judgments on material properties related to texture, hardness, temperature, and weight, etc. Despite its critical role in the shopping context, touch is usually not feasible for online consumers. Specifically, the mediated nature of e-commerce inhibits consumers from directly touching their desired products prior to purchase, thereby raising difficulties in product judgment. In the past few years, some exciting work has revealed that incidental haptic experiences can have a significant impact on judgment processes in social cognition context. For example, holding a resume attached to a heavy clipboard leads people to think the job candidate as more important [4]. Incidental exposure to the haptic sensation of roughness (vs. smoothness) increases individuals' attention to the unfortunate others and promotes charitable behavior [35]. The current research seeks to add to this line of research by proposing that haptic experiences obtained from interacting with devices can affect consumers' haptic judgment on products displayed in the digital environment.

3. Hypothesis Development

In this study, we investigate how different gesture-based human-device interaction modes (i.e., touchscreen interaction and mid-air interaction) affect consumers' product haptic judgment. Specifically, we focus on two haptic attributes, i.e., material softness and texture roughness, which are essential in the evaluation of a variety of products (e.g., clothes, furnitures and handbags) [1]. As individuals differ in preference for sensory feedback from touch (i.e., need for touch) in the product evaluation process [33], we also explore how the effects of interaction mode on product haptic judgment stand among consumers with different levels of need for touch. The research model is presented in Figure 1.

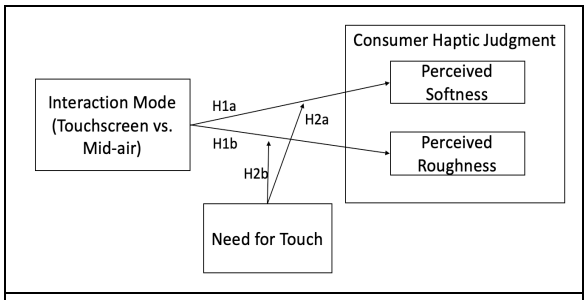

Figure 1. Research model

According to the theory of grounded cognition, consumers use their concurrent bodily experiences as a source of information in judgments and such information can be diagnostic or nondiagnostic [4, 31]. Whether incidental sensory information will be used in judgment often depends on whether consumers can easily differentiate it from genuine sensory experience [14, 29]. Thus, when actual haptic sensation is not available, touchscreen users and mid-air interaction users may unwittingly attribute the haptic characteristics of their interaction device to products being evaluated if the device can deliver a realitic haptic experience.

Specifically, touchscreen devices allow consumers to touch a tangible surface and provide hard and smooth haptic feedback. When exploring a product on touchscreen, consumers can directly touch the product images, which simulates physical contact with a product despite the contact being mediated via the touchscreen [18, 24]. It creates a vivid illusion of "touch". Therefore, people will be more likely to confuse the haptic attributes of a touchscreen with the haptic attributes of the focal product.

When using mid-air interaction, there a distance between consumers and the products. Prior study has found that compared with allowing physical contact in product evaluation, judging a product merely by seeing it at a distance, inhibits consumers' ability in constructing a vivid haptic imagery in mind [29, 38]. Therefore, they can easily distinguish the incidental haptic experience obtained from mid-air interaction from the actual haptic experience of interacting with the product physically. In this case, they will be more likely to make product judgment based on visual cues or textual product description. In other words, their product evaluation will be more rational.

Therefore, we posit that people using touchscreen are more likely to incorporate the incidental haptic experience obtained from the interaction device (i.e., hardness and smoothness) in product judgment than people using mid-air interaction. Therefore, we propose that

H1a: Compared with mid-air interaction, touchscreen interaction leads to lower perceived softness.

H1b: Compared with mid-air interaction, touchscreen interaction leads to lower perceived roughness.

Prior literature suggests that people differ in preference for haptic information when judging products [2]. People who are high in need for touch are more willing to gather information about a product to help them make judgments. Physical contact with products provides them with access to the relevant information they cannot gather through other means, such as reading descriptions of products or visually inspecting products. The inability to touch seems, therefore, to be a true limiting factor for high need-for-touch consumers in an online shopping context. Prior literature also suggests that consumers with a higher level of need for touch are more willing to incorporate haptic experience into consideration when judging a product [20]. When actual haptic sensations are missing, they may evaluate the product based on simulated haptic experience. Thus, they are more likely to be "misled" by the haptic experience created by the interaction mode. Indeed, prior study has revealed that they are more likely to compensate for lack of touch through spontaneous imagery, i.e., an illusionary touch experience, triggered by external stimuli [24]. Therefore, it is conceivable that consumers with a higher level of need for touch are prone to be influenced by incidental haptic experience.

On the contrary, consumers who have less haptic need may be content with an overall assessment of the product based on other information, such as visual and audio information provided on the website. Hence, they will be less likely to be influenced by incidental

haptic sensations gained from interaction mode. Thus, we propose that

H2a: The effect of interaction mode on product softness judgment is more salient among users with a higher level of need for touch than among users with a lower level of need for touch.

H2b: The effect of interaction mode on product roughness judgment is more salient among users with a higher level of need for touch than among users with a lower level of need for touch.

4. Experiment Design and Experimental Procedure

This study adopted a one-factor (interaction mode: (touchscreen interaction vs. mid-air interaction) between-subjects experimental design. The participants were randomly assigned to one of the two experimental conditions. They were required to complete a product evaluation task on a laptop using either the touchscreen of the laptop, or a mid-air gesture controller connected to the laptop (i.e., Leap Motion). Leap Motion controller is a device that facilitates user interaction with computers via mid-air gestures. It creates a virtual "touch" surface in the air, and recognizes users' gestures when they move hands over the device. We developed a website to display a lounge chair for evaluation. A lounge chair was selected as the focal product because haptic attributes (e.g., softness of the chair and texture of the cover material) are important factors that determine the performance of the product. Participants could interact with the chair and view it from different perspectives. Specifically, touchscreen users could place a finger on the chair and drag it by moving left and right to rotate the chair; and Leap Motion users could wave their hand left and right in the air to rotate the chair. We also provided a short description of the chair beside the product image to explain the material, size, components and other features.

A recruitment advertisement was posted on the online forum of a major university in Asia three weeks before the experiment. In the advertisement, we described the general purpose of the study and provided a registration link. Specifically, university students were invited to participate in an online shopping task and answer some questions about their shopping experience. During the registration, participants were asked to select a time slot and provide some demographic information, such as age, gender, prior mobile shopping experience, and our moderator, i.e., need for touch.

Upon arrival, they were randomly assigned to one of the two experimental conditions. The participants first underwent a training session in which we provided instructions on how to interact with products using the specific interaction mode. Subsequently, they were asked to imagine that they had just moved to a new apartment and needed to acquire some furniture. They were then asked to evaluate a lounge chair for potential purchase. The participants performed the product evaluation task on the same laptop using either the touchscreen of the laptop or Leap Motion. To ensure that the participants used the specific interaction mode as instructed and would not interfere with each other, we assigned only one participant to each session.

After completing the product evaluation task, the participants were asked to answer a post-experimental questionnaire that captured major constructs, i.e., perceived softness and perceived roughness. To make sure the participants' make judgments based on the same reference point, we asked them to indicate the extent to which they thought the chair displayed on the website was softer/rougher than the chair they were sitting on when completing the task. All the participants sat on the same type of chair during the experiment. They were then paid 5 dollars as reimbursement for their time and dismissed. On average, each session took approximately 15 minutes.

5. Data Analysis

One hundred twenty-six participants were randomly assigned to the two conditions, resulting in 63 participants in each condition. Among them, 54.8% were female. The age of the subjects ranged from 18 to 32 (M = 22.2). In general, the participants were experienced at online shopping (M = 5.26, SD = 1.55). There was no significant difference in terms of participants' demographic information across the experimental conditions.

Since we have two dependent variables (i.e., perceived softness and perceived roughness), we conducted a MANCOVA (multivariate analysis of covariance) test first to discover the general effect of interaction mode on both variables. Specifically, interaction mode was modeled as the fixed factor and need for touch as the covariate. We controlled users' past mobile shopping experience and perceived ease of use of the website in all the analysis. Since need for touch was a continuous variable, we centered this covariate and then created an interaction term (interaction mode and need for touch) based on the centered variable to avoid the multicollinearity issue. In all the subsequent analysis, we used the centered variable. The results showed that the effect of

interaction mode was significant (*Wilk's lambda* = 0.94, $p < 0.05$) and the interaction effect between interaction mode and need for touch was significant too (*Wilk's lambda* = 0.95, $p < 0.05$). Hence, ANCOVAs were further conducted on the two dependent variables separately.

We first investigated whether interaction mode influenced the participants' judgments on softness. Specifically, ANCOVA was conducted with the interaction mode (touchscreen interaction vs. mid-air interaction) as the independent variable and need for touch as a covariate. The results revealed a significant main effect of interaction mode on perceived softness with a medium effect size. As expected, touchscreen interaction led to lower perceived softness than mid-air interaction ($M_{touchscreen}$ = 5.06, SD = 1.63 vs. $M_{mid\text{-}air}$ = 5.49, SD = 1.33, $F(1, 120) = 5.27$, $p < 0.05$, Partial η^2 = 0.04). Moreover, the interaction effect between interaction mode and need for touch was significant ($F(1, 120) = 4.30$, $p < 0.05$, Partial η^2 = 0.04) with a medium effect size.

To elucidate the nature of this interaction effect, we performed a spotlight analysis [23, 36] at one standard deviation above (i.e., high need for touch) and one standard deviation below (i.e., low need for touch) the mean of need for touch. Specifically, we tested the simple main effects of interaction mode among subjects with a relatively high and low need for touch based on their global influence on perceived softness. For people with a high level of need for touch, touchscreen interaction led to lower perceived softness than mid-air interaction (*beta* = 1.07, $t = 2.89$, $p < 0.05$). By contrast, among the participants with a lower level of need for touch, the difference in softness judgment between the two conditions was not significant (*beta* = -0.16, $t = -0.36$, $p > 0.1$). A plot of the interaction effect on perceived softness is shown in Figure 2.

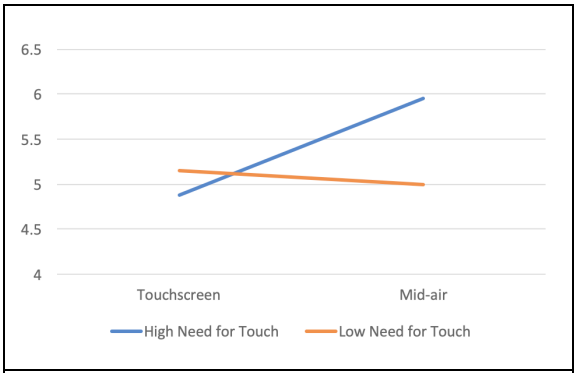

Figure 2. Interaction plot on perceived softness

Similarly, there was a significant main effect of interaction mode on participants' perceived roughness, ($F(1, 120) = 4.70$, $p < 0.05$, Partial η^2 = 0.04). Specifically, touchscreen users were more likely to judge the texture of the chair as less rough than mid-air users ($M_{touchscreen}$ = 5.27, SD = 1.31 vs. $M_{mid\text{-}air}$ = 5.56, SD = 1.22). Moreover, the interaction effect between interaction mode and need for touch was marginally significant ($F(1, 120) = 3.66$, $p = 0.058$, Partial η^2 = 0.03). We performed a spotlight analysis at one standard deviation above (i.e., high need for touch) and one standard deviation below (i.e., low need for touch) the mean of need for touch as well. Results show that among participants with high need for touch, touchscreen led to significantly lower perceived roughness than mid-air interaction (*beta* = 0.94, t = 2.70; $p < 0.05$) whereas among participants with low level of need for touch, touchscreen users and mid-air users did not differ in their judgment on roughness (*beta* = -0.11, $t = -0.30$; $p > 0.1$). A plot of the interaction effect on roughness is shown in Figure 3.

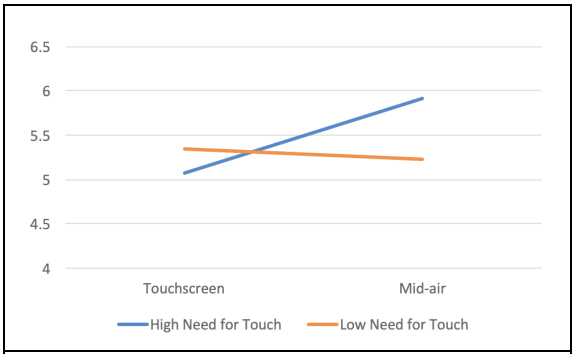

Figure 3. Interaction plot on perceived roughness

6. Discussion

Consistent with our predictions, the results revealed that compared with mid-air gesture, touchscreen interaction made a person feel a product being evaluated as less soft and less rough. In other words, using touchscreen leads people to perceive a product as harder and smoother as compared with using mid-air interaction. Touchscreen provides consumers glass-like haptic experience, which is hard and smooth. The two indicators of haptic judgment provide converging evidence implying that people tend to apply the incidental haptic experience obtained from interacting with input devices (e.g., touchscreens) in their product judgment. We also observed an interaction effect between interaction mode and need for touch on users' product judgment. Specifically, touchscreen interaction reduced perceived softness and roughness among users

who prefer to touch product in evaluation (high need for touch); however, such effect was not evident among users who are less likely to rely on haptic experience in product evaluation (low need for touch). Thus, it appears that users' who are more willing to use haptic information are more likely to be influenced by incidental haptic experience obtained from interaction mode although such experience is not directly related to product performance.

This paper extends the current literature in several ways. This research addresses the gap in human-computer interaction research by hypothesizing and testing the effects of touchscreen interaction and mid-air interaction on consumers' online shopping context. The use of touchscreen devices and mid-air interaction as shopping tools has become more and more popular in consumer markets, but this rapid growth has not been matched by research. While prior literature emphasizes the difference between touchscreen interaction and mouse-based interaction, our study provides an initial comparison between touchscreen interaction and the emerging mid-air interaction. In addition, unlike previous studies investigating the impacts of interaction mode on consumers' shopping experience and purchase behavior, our research focuses on product judgment. By showing that consumer judgment can be influenced by interaction mode, our study inspires future research to investigate product judgment in the interactive digital environment.

The current research also advances knowledge in the area of sensory marketing, especially haptic perception research. Traditional haptic experience research focuses on the functionality of touch and haptic information collected from the actual products directly. Our study shows that incidental haptic experience, e.g., the glass-like haptic experience gained from interacting with touchscreens, can influence consumers' product haptic judgment as well. It concurs with prior literature which highlights that physical experience induced by situational factors may be misattributed to the target of judgment. Indeed, prior literature suggests that haptic experience, e.g., weight, texture, and hardness, can nonconsciously influence social judgments and behaviors. For example, heavy objects made job candidates appear more important, rough objects made social interactions seem more difficult, and hard objects increased rigidity in negotiations [8]. We extend this stream of literature by highlighting the impacts of haptic experience delivered by digital technology on haptic judgment.

We also contribute to grounded cognition theory, which highlights the importance of bodily feelings on human judgment. Different from some studies which simply compare various types of interaction methods, our study takes consumers' need for touch into consideration and argues that the impacts of different types of gesture-based interaction is contingent upon consumers' difference in preference for touch in product evaluation. We develop a conceptual model regarding the perceptual transfer of haptic characteristics from interaction device (i.e., touchscreen and mid-air gesture controller) to judgments of the products themselves. This model further predicts that not all consumers are equally affected by such nondiagnostic haptic cues. Results from our studies show that consumers high in the need for touch are more affected by such nondiagnostic haptic cues compared to consumers low in need for touch.

Our findings offer several broad managerial insights. First, our study advances people's understanding of the conceptual differences between the two gesture-based interaction modes and provides clear managerial implications to practitioners regarding how to maximize the advantage of the different interaction technology. Specifically, our results reveal that mid-air interaction increases softness and roughness perceptions as compared with touchscreen interaction. Thus, products like sofas may benefit from mid-air interaction because softness is typically regarded as a good attribute for a sofa. A solid understanding of the effects of interaction mode is indispensable for implementing effective, successful marketing strategies. Retailers and marketers can manipulate product perceptions with the choice of marketing channel and encourage consumers to use a specific interaction mode. Our study also highlights that consumers need to be cautious that even when retailers do not have deception intent, their judgment might be influenced by the way they interact with products.

This research is not without its limitations, which in turn provides opportunities for future research. First, we only compare touchscreen interaction with mid-air interaction. We did not consider mouse and other interaction devices. This is because these two types of interaction are more comparable, both of which involve natural hand movements. Future research can consider mouse or mere visual information without interaction device as control conditions. In addition, we did not provide the actual product for comparison. Therefore, our results only reveal the relative effect between touchscreen and mid-air interaction. To show whether touchscreen interaction and mid-air interaction lead to bias in product judgment, we need a comparison between touchscreen interaction, mid-air interaction and physical product interaction.

Second, in our study, we only focus on the moderating effect of consumers' need for touch. However, the relationship between interaction mode

and product judgment may be influenced by other factors. Prior literature suggests that in arriving at product judgments, individuals will engage in a preliminary stage of automatic processing that is followed by a more deliberative, controlled processing stage if people have sufficient cognitive resources or are motivated to do so. In our context, an automatic judgment would first be formed in which the nondiagnostic haptic input (e.g., smoothness and hardness of the touchscreen) may affect product judgment (e.g., of the chair). Future study can investigate under what condition people will invest more cognitive effort and thus realize that the haptic input is nondiagnostic and should be discounted in product judgment. For example, we can examine whether the effect of interaction mode on product judgment will remain the same among different types of products.

Third, we only investigated simple mid-air and touchscreen gestures in our study. We focused on the fundamental differences between mid-air interaction and touchscreen interaction, i.e., whether they provide haptic feedback on one's skin, but did not consider the specific gestures supported by each interaction mode. The prior literature indicates that different gestures, e.g., moving the hand up and moving the hand down, might be associated with and trigger different mental representations and thus affect human judgment [37]. Thus, more effort is necessary to investigate the impacts of different gestures. In our study, we only examine two haptic attributes, i.e., softness and roughness. Future study can explore how interaction mode affects other haptic characteristics (e.g., stability, warmth, size, weight). We also did not consider how different visual product presentation technologies can influence product judgment. Prior literature suggests that the visual information also contributes to haptic perception. With advancements in interaction technology, more complex visual presentation formats can be afforded [3]. Thus, future research can explore how to leverage the power of different interaction modes with immersive output technology, such as head-mounted virtual reality and augmented reality.

7. Conclusion

Gesture-based interaction is increasingly used in new retail and marketing contexts. Complementing prior research that suggests digital interface affects consumers' shopping experience, this study represents one of the first attempts to investigate how interaction mode (touchscreen interaction vs. mid-air interaction) can affect users' product judgment. By showing touchscreen reduce perceived softness and roughness, we suggest that users may bias their product judgment towards device characteristics. Furthermore, we propose a framework that outlines how the effects of interaction mode on haptic judgments will differ according to the individual's need for touch and embark on a contingent view of grounded cognition. The findings of this study serve as a basis for future theoretical development on sensory marketing and interaction design, and provide valuable practical implications for marketers, retailers, and consumers.

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