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Abstract

Research on diverging device conditions remains scarce, particularly in relation to how they affect online shoppers' product assessments. This research investigates the effects of online shoppers' device type on the accuracy of their product size evaluations and reveals, for the first time, the complex mechanisms behind these effects by examining the role of confidence about product size, product familiarity, and shopping motivations. The findings from four experimental studies show that using a PC (vs. a smartphone) to view products results in greater size-estimation errors than do smartphones. Moderated-mediation analyses suggest that viewing products on a PC (vs. a smartphone) leads to overconfidence about product sizes, which then results in greater size-estimation errors, and this mediation effect is stronger for unfamiliar products. However, the mediation effect is reversed with utilitarian motivations—PC users become more accurate in estimating product sizes. Overall, the findings encourage online retailers to consider their customers' device type as one of the factors influencing size-related returns; thus, optimizing their product showcases by carefully monitoring customers' device information, which is easily identifiable through websites, is important in improving the accuracy of product assessment.

Keywords: confidence, e-commerce, information processing, familiarity, shopping motivation, size evaluation, device type, visual field

Introduction

Product size issues are the main reason behind online shopping returns across product categories, from furniture and home appliances to clothes and shoes, and the average online returns are about 10% to 30% higher than the average offline returns depending on the categories (Gilsenan, 2018; Reagan, 2019). As the types of devices used by online shoppers vary from PCs to smartphones, accurately presenting product size information has become more challenging for online retailers because the size of product images on websites are often proportioned according to users' device type. Even when size information is provided on a product webpage, a recent study suggests that it is still more difficult to accurately assess product sizes online compared to when examining the physical version of the products at a store. (Berg & Lindström, 2021). Thus, gaining more insights about potential device effects on accurate product size estimations is critical in improving the quality of online retailers' product showcases, which will eventually contribute to reducing size-related complaints and returns.

Research on device-related effects on consumers remains underexplored (Kannan & Li, 2017), particularly regarding product size estimations. To date, most research on device-related effects has focused on individual device *features* such as screen size or input mode, and the accuracy of product size estimations has not been directly measured in relation to device-related effects. The studies on screen size have shown that larger displays have positive effects on consumers' emotional responses toward *non-e-commerce* content such as TV clips (Lombard, Reich, Gabe, Bracken, & Ditton, 2000; Reeves, Lang, Kim, & Tatar, 1999), news stories (Naylor & Sanchez, 2018), and advertisements (Kim & Sundar, 2016; Xie, Zhao, & Xie, 2013). The effects of input modes have been examined with a focus on the effects of touchscreens and mouse devices, on online shoppers' perceived ownership (Brasel & Gips, 2014), information processing styles (Coulter, 2016; Kaatz, Brock, & Figura, 2019), engagement with shopping and purchase intentions (Chung, Kramer, & Wong, 2018), product choices (Shen, Zhang, & Krishna, 2016), and product returns (Seeger, Kemper, & Brettel, 2019).

Despite the importance, none of these previous studies have examined *cross-device effects* on the accuracy of product size estimations by comparing different device *types* such as PCs and smartphones rather than comparing individual device *features*. In order to fill this gap, we examine, via four experiments, whether and how online shoppers' diversified device types influence their size-estimation errors (i.e., the accuracy of their size estimations). Our findings indicate that using a PC leads to stronger confidence about product sizes, which then results in greater size-estimation errors. This mediation effect is likely to be stronger when consumers review unfamiliar (vs. familiar) products or when they have a hedonic (vs. utilitarian) shopping motivation.

Overall, our study is the first to view the type of device as a factor that influences the accuracy of product size estimations and captures complex mechanisms behind the effects of devices. As such, it has provided insights into the literature on device-related effects and product size evaluations. In addition, its findings afford a foundation for future research to explore additional device effects in greater depth. The findings also have important managerial implications, including that the type of device that consumers use to view product information online may influence the accuracy of their product size estimation, which may contribute to the number of size-related product returns. The results additionally encourage online retailers to consider their customers' device type as a factor influencing size-related returns and to carefully monitor device type using embedded codes in order to optimize their websites and improve the accuracy of product size assessments.

This article proceeds by providing the theoretical background of the study and presenting and justifying its hypotheses. Next, four experimental studies are presented and discussed in detail, before a concluding section outlines the study's theoretical contributions, managerial implications, and limitations as well as directions for future research.

Theoretical Background and Hypotheses Development

Device Effects on Consumers

Broadly, previous literature exploring device effects on consumer behavior tends to adopt one of two approaches, investigating either the effects of individual device features such as *screen sizes* (i.e., large vs. small screens) and *input mode*s (i.e., touchscreens vs. mouse devices) or the effects of device types (e.g., PCs vs. mobile phones) on consumers (see Appendix A). The screen size literature shows that users' screen size positively influences their emotional state toward non-e-commerce or TV content displayed on their screen (Kim & Sundar, 2014, 2016; Lombard et al., 2000; Lombard, Ditton, Gabe, & Reich, 1997; Naylor & Sanchez, 2018; Reeves et al., 1999; Xie et al., 2013), task performance (Chae & Kim, 2004), and purchase-related decision quality (Seeger et al., 2019). Using smaller screens such as mobile phones tends to negatively influence perceived visual complexity and satisfaction (Sohn, Seegebarth, & Moritz, 2017), and mobile device usage is positively associated with product returns and decision accuracy in e-commerce settings (Seeger et al., 2019). On the other hand, research on input modes reports that using a touchscreen (vs. a mouse) to view product information leads to higher perceived ownership of the product (Brasel & Gips, 2014), higher engagement with shopping, higher purchase intentions (Chung et al., 2018), and a higher likelihood of choosing hedonic options (Shen et al., 2016).

However, previous screen-size studies controlled for input modes (e.g., using a touchscreen smartphone only) or did not require any input element such as a mouse (e.g., watching TV). Similarly, in most input mode studies, screen sizes were controlled across input modes (Brasel & Gips, 2014; Chung et al., 2018) or within each input mode condition (Shen et al., 2016). Thus, when both screen size and input mode vary, it is unclear on which research stream we should rely on to predict the effects on consumer behavior. For example, if device types such as PCs and smartphones are compared, PCs may or may not produce more positive emotional responses because of their larger screen size as their input modes vary (e.g., touchscreen vs. keyboard/mouse).

It is possible that these device effects are more closely aligned with the findings in the screen size literature. According to a recent study on device type (Zhou, Tian, Mo, & Fei, 2020), consumers on a PC tend to write product reviews more positively than those on a smartphone, suggesting that the effects are more aligned with the screen size effects than the input mode effects, at least in regard to emotional responses. However, as shown in Appendix A, it still remains unclear whether users have similar responses, and none of the existing studies on device type (Cozzarin & Dimitrov, 2016; Kaatz, Brock, & Figura, 2019; Seeger et al., 2019; Wang, Malthouse, Krishnamurthi, 2015; Zhou et al., 2020) have tested whether and how device types (whereby both screen size and input mode vary) affect the accuracy of product size estimations. In the next section, we discuss related research including the device studies and hypothesize the potential effects of device type on product size estimations.

Size Estimations

According to visual field theories (Künnapas, 1955; Künnapas, 1959), the size of a visual frame (e.g., a rectangle) that surrounds an object influences the perceived size of that object. For example, a square-shaped frame greatly influences the perceived length of the object in the frame as well as the thickness of its line; the larger the square frame, the shorter and thinner the perceived line of the object (Künnapas, 1955). The effects are similar for an oval-shaped frame (Künnapas, 1959).

The horizontal-vertical illusion (HVI) theory and the figure-ground theory suggest similar associations between visual surroundings and perceived object size (Higashiyama, 1996). If people can clearly perceive the boundary of a visual field, the visual illusion tends to increase compared to when the frame is not clearly visible (Künnapas, 1957; Prinzmetal & Gettleman, 1993; Verrillo & Irvin, 1979), and people perceive the vertical length of an object within the field to be longer than its horizontal length (Higashiyama, 1996).

Overall, the literature suggests that having a visible frame around an object affects perceived object size. In an e-commerce setting, the screen of a shopper's device may also work as a visual frame as it surrounds the object displayed (e.g., content or product photos), and thus influences the shopper's evaluations of product sizes. However, although visual frame theories suggest that larger visual frames lead to *underestimation* of object sizes (Künnapas, 1955), particularly when estimating the objects' vertical length (Künnapas, 1959), we propose that the effects of larger frames in computer-mediated environments may be the opposite, leading to *overestimation* of sizes. Because most websites are designed to proportion the size of product images on a webpage automatically, the apparent sizes of product images are larger on a PC, the display size of which is significantly larger than that of a smartphone. Thus, when viewing objects (e.g., product images) on a PC, consumers are more likely to perceive their sizes to be *larger* than the actual size than when viewing the same objects on a smartphone, estimating the sizes less accurately:

H1. Consumers on a PC are likely to estimate the size of the objects *less* accurately (i.e., greater size-estimation errors) than consumers on a smartphone.

In the following sections, we consider the potential mechanisms behind the effects of device type on the accuracy of product size estimations. We draw from existing research to support our hypotheses that the effect may be influenced by different factors, specifically product familiarity, shopping motivations, and consumer confidence regarding product size estimations.

Product Familiarity

Product familiarity is defined as "the number of product-related experiences that have been accumulated by the consumer" (Alba & Hutchison, 1987, p. 411). Familiarity improves one's performance in accurately retrieving information from memory (Benjamin, Bjork, & Schwartz, 1998; Benjamin, Bjork, & Hirshman, 1998). Consumers who are familiar with products also tend to better recall product information (Alba & Hutchison, 1987; Krishen, Agarwal, & Kachroo, 2016), better differentiate unique product features from others (Zhou & Nakamoto, 2007), and recognize product attributes more accurately (Krishen et al., 2016). Overall, consumers who are familiar with a product are assumed to know more about the particular product (Alba & Hutchison, 1987; Shunurr, Brunner-Sperdin, Stokburger-Sauer, 2017), which we believe will help them accurately assess its size. Thus, we propose:

H2. PC (vs. smartphone) users are likely to estimate product sizes less accurately (i.e., greater size-estimation errors), and this effect will be stronger when reviewing unfamiliar products.

Shopping Motivation (Hedonic vs. Utilitarian)

As discussed earlier, inaccurate size estimations may be associated with the emotional effects of device size. Larger devices have a positive influence on users' emotions more than do smaller devices (e.g., Lombard et al., 2000; Reeves et al., 1999; Naylor & Sanchez, 2018); thus, compared to smartphones, PCs, which are significantly larger, may trigger affect-driven evaluation of products online. Holistic and affective information processing leads consumers to pay less attention to product-relevant details (Homburg, Koschate, & Hoyer, 2006; Klein & Melnyk, 2016; Petty & Cacioppo, 1986; Shiv & Fedorikhin, 1999; Viglia, Tassiello, Gordon-Wilson, & Grazzini 2019) and focus more on promotion-focused information (Aaker & Lee, 2001). Therefore, PC users may end up evaluating product sizes *less carefully*, resulting in less accurate size estimations. Moreover, this effect may be more apparent with hedonic shopping motivations because consumers with hedonic motivations tend to rely more on affective attributes that are less directly related to products such as how pleasant their shopping experience was or how nice the store design was (Barbin, Dardin, & Griffin, 1994). Utilitarian shopping motivations, on the other hand, lead consumers to more carefully evaluate product-related information such as product features or prices to make final purchase-related decisions (Barbin et al.,1994).

Thus, PC users' potential tendency to inaccurately estimate sizes may be attenuated in combination with utilitarian shopping motivations than with hedonic shopping motivations because utilitarian motivations control for affective information processing and help consumers focus more on the efficiency of overall shopping experiences (Scarpi, Pizzi, & Visentin, 2014).

Thus, we hypothesize:

H3. PC (vs. smartphone) users are likely to estimate product sizes less accurately (i.e., greater size-estimation errors), and this effect will be weaker with utilitarian shopping motivations.

Confidence

Existing literature confirms that consumers' confidence usually precedes final product evaluations in both offline (Laroche, Kim, & Zhou, 1996) and online retail environments (Weathers, Sharma, &Wood, 2007). If consumers feel confident in their product decisions, their confidence is likely to increase their satisfaction with their decisions (Chan & Wang, 2018). However, being confident does not necessarily guarantee accurate judgment (Mahajan, 1992) because confidence is relatively emotional and subjective (Luce, Jia, & Fischer, 2003). Consumers often miscalibrate their knowledge and overestimate its actual validity, which frequently leads to inaccurate product-related evaluations (Alba & Hutchinson, 2000). Therefore, online shoppers' confidence about products may also be overestimated, which may lead to inaccurate product size assessments. In other words, the level of consumers' confidence in estimating the size of a product that they view online may adversely mediate the device effects on the accuracy of their product size estimations.

Furthermore, this mediation process may be influenced by product familiarity. As brand or product familiarity is generally known to improve consumers' confidence (Laroche et al., 1996; Tsai & McGill, 2011) and product choices (Saini & Lynch, 2016), prior knowledge of a product would undoubtedly help consumers more accurately estimate its size online without in-person viewing. Thus, high product familiarity will help consumers reduce size-estimation errors while low product familiarity will increase errors, widening the gap between PC and smartphone users' size-estimation errors. Therefore, we propose the following moderated-mediation effect of product familiarity:

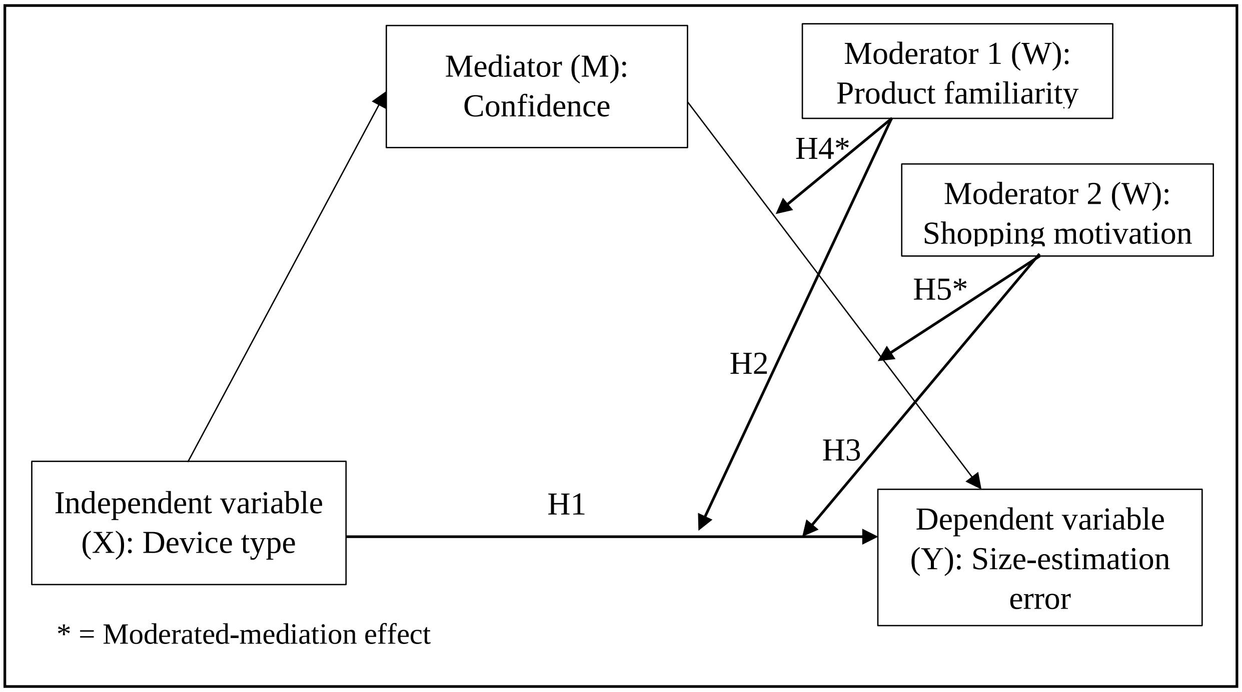
H4. Confidence about product size is likely to positively mediate the relationship between device type and size-estimation errors such that PCs (vs. smartphones) lead to *stronger* confidence, resulting in *greater* size-estimation errors, and this mediation effect is *stronger* for *unfamiliar* products.

Finally, the positive emotional effects induced by PCs, which we discussed earlier, may excessively increase consumers' confidence in judgments regarding product size. These overly confident consumers shopping on PCs may finalize their product size estimations without a careful assessment, resulting in less accurate estimations. Indeed, previous literature (Arnold & Reynolds, 2003; Babin et al., 1994) suggests that shopping motivations may also be involved in product evaluation processes. Hedonic motivations may even further emotionally overexcite PC users and amplify their already stronger confidence and greater size-estimation errors, while utilitarian motivations may control the emotional process and improve the accuracy of product size estimations. Thus, we propose the following moderated-mediation effect of shopping motivation:

H5. Confidence about product size is likely to positively mediate the relationship between device type and size-estimation errors such that PCs (vs. smartphones) lead to *stronger* confidence, resulting in *greater* size-estimation errors, and this mediation effect is *reversed* with *utilitarian* (vs. hedonic) shopping motivations.

Overall, in this research, we investigate how online shoppers' device type affects the accuracy of their product size estimations. We also examine whether their confidence positively mediates the device-type effect on product size estimation errors and whether this mediation effect varies by shopping motivations and product familiarity (Figure 1).

Figure 1. Conceptual framework



In the following empirical sections, we tested the aforementioned hypotheses via four experimental studies. A pilot study was designed to determine whether device effects on product size estimation would be likely to stem from the screen size attribute of a device while controlling for input mode. Experiment 1 then tested the proposed device effects by varying both screen size and input mode to determine whether the results found in Experiment 1 would be consistent. In Experiments 2 and 3, we included the moderators shown in Figure 1 and tested the moderated-mediation effects of product familiarity and shopping motivation, respectively.

Pilot Study: Screen Size Effects on Basic Size Estimation

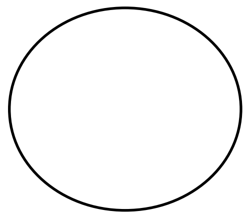
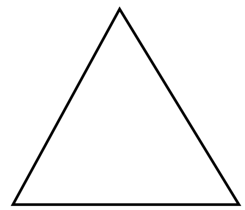
Method

The purpose of this experiment was to examine the baseline effects of screen size on size estimations. We used a one-way (screen size: large vs. small) between-subjects design and varied screen size only by its screen size while keeping the input modes consistent (i.e., use a mouse and a keyboard).

A total of 94 individuals (50% women) participated in the experiment at a university lab in the U.S. (age 18–24: 83%; 25–34: 15%; 35+: 2%). The participants were randomly assigned to either a large-screen (22" screen) or a small-screen (14" screen) condition, in which they used either an identical desktop or an identical laptop computer in the lab. The input mode of both conditions used a keyboard and a mouse, and no touchscreen functions were activated for either device.

In both screen size conditions, participants viewed an identical set of shapes and product images displayed in random order. The shapes involved plain black lines to avoid distractions from visual attributes (e.g., color) that are not directly related to size estimation (Table 1). The products were a black smartphone (iPhone 7) and a stainless-steel round trashcan with a black plastic lid and a black plastic pedal. Participants did not have information about the size of these stimuli (Table 1) and were not allowed to use any measuring tools. While viewing the items, the participants completed a survey regarding: (1) approximate size estimation of the actual height (vertical length) of the visual stimuli in inches (shapes: how tall do you think the actual height (vertical length) of the object is if printed; products: how tall do you think the actual height (vertical length) of the product is if you examine the physical product at a store?) and (2) demographic information.

Table 1. Experiment 1 Stimuli

Stimuli	**Basic Shapes**	
	Oval	**Triangle**
Actual height (vertical length)	3″ when printed in 100% proportion	3″ when printed in 100% proportion
Sample images		
Stimuli	**Products**	
	Smartphone	**Trashcan**
Actual height (vertical length)	5.44″when examined physically	26″when examined physically

Results

Manipulation check. All participants in the large-screen (*n* = 45) and the small-screen conditions (*n* = 49) reported the device type they used for the study correctly, confirming that the device type manipulation was implemented successfully.

Size-estimation error. We calculated difference between the participants' size estimations and the original height of the shapes and the products (Table 1) to assess the difference relative to the actual size; thus, the higher the difference, the greater the size-estimation errors. As expected, the ANOVA results showed that large-screen users led to greater errors in size estimation than small-screen users ($p < .05$) except for the smartphone image ($p = .14$), suggesting less accurate size estimations, supporting H1 (Table 2).

Table 2. Size-estimation error

		Screen size (*df* =1)		*F*	*p*
		Large	Small		
Shapes	Oval	*M* = 1.82" *SD* = 1.47	*M* = .75" *SD* = .86	19.07	< .001*
	Triangle	*M* = 1.88" *SD* = 1.47	*M* = .80" *SD* = 1.10	16.54	< .001*
Products	Smartphone	*M* = 1.06" *SD* = .71	*M* = 1.29" *SD* = .73	2.22	*.14*
	Trash can	*M* = 8.44" *SD* = 6.33	*M* = 5.38" *SD* = 3.65	8.45	*.01**

*Statistically significant at $p < .05$

Discussion

When participants used a large (vs. small) screen, their size-estimation errors regarding the shapes and products were greater (i.e., less accurate) except for the smartphone image. The results suggest that screen size differences may have a significant impact on consumers' size-estimation errors when the visual stimuli were kept neutral, as in the oval and triangular shapes. However, it is unclear why the screen size effects were inconsistent across the product images. It may be due to product familiarity, as most people are aware of the size of popular smartphones (e.g., iPhone). In the next experiment, we examined these effects further.

Experiment 1: PC vs. Smartphone

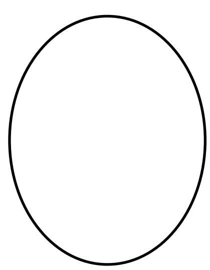
Method

In this experiment, we tested whether Pilot Study results would be consistent when both screen size and input mode varied by comparing PCs to smartphones. The study involved a one-way (device type: PC vs. smartphone) between-subjects design.

One hundred and four U.S. residents from Qualtrics' paid online panel participated in the study (32% women; age 18–24: 3.8%; 25–34: 41.3%; 35–44: 26.9%; 45–54: 14.4%; 55+: 13.6%). The participants were randomly invited to either a PC or a smartphone condition, in which the quota feature in Qualtrics maintained the number of participants in each condition similar. Additionally, we embedded device identification codes in our Qualtrics survey to identify device types and screen sizes based on User Agent (UA) strings in HTTP headers. The device data from the UA strings were also compared with the participants' self-reported device information, and both records matched. The screen sizes ranged from 19″ to 22″ for the PC condition and from 4″ to 6.5″ for the smartphone condition.

After the device/screen size validation process, similar to Pilot Study, participants reviewed an oval shape (height: 4″) and a black polyester backpack (height: 19″) displayed in random order (Table 3). Then, they completed a questionnaire, which was designed to measure (1) their size estimations using the same questions from Pilot Study and (2) demographic information.

Table 3. Experiment 1 stimuli

Stimuli	**Oval**	**Backpack**
Actual height (vertical length)	4″when printed in 100% proportion	19″when examined physically
Sample images		

Results

Manipulation check. The UA data show that participants were similarly assigned to either PC (n = 50) or smartphone (n = 54), and all of their self-reported device information also matched their assigned device type condition.

Size-estimation error. Similar to Pilot Study, our ANOVA results revealed that PCs (*M* = 3.33, *SD* = 1.88) led to higher estimation error in estimating the oval shape than smartphones (*M* = 2.45, *SD* = 1.85; $F(1, 102) = 5.72$, $p = .02$), suggesting a significant main effect. For the backpack, the main effect was also consistent with the smartphone result in Pilot Study; size-estimation errors did not significantly differ between PCs (*M* = 5.54, *SD* = 4.92) and smartphones (*M* = 4.85, *SD* = 3.64; $F(1, 102) = .66$, $p = .42$). Thus, for the line shape (oval), H1 is supported as in Pilot Study.

Discussion

The screen-size effects found in Pilot Study were consistent in this experiment when both screen size and input mode varied. PCs (larger screens) led to higher size-estimation error (less accurate estimation) when evaluating a line oval shape. Size estimation of a product (backpack) also did not significantly differ by device type, which may be due to product familiarity as in the smartphone image used in Pilot Study. The next experiment further examines whether these effects are indeed associated with product familiarity.

Experiment 2: Product Familiarity

Method

The purpose of this experiment was to examine whether the effects found in Experiment 1 would remain consistent when product familiarity varies, using a 2 (device type: PC vs. smartphone) × 2 (product familiarity: familiar vs. unfamiliar) between-subjects design.

A total of 150 U.S. residents from Qualtrics' paid research panels participated in the online experiment (42% women; age 18–24: 19%; 25–34: 37%; 35–44: 15%; 45–54: 25%; 55+: 4%). The same UA strings used in Experiment 1 were implemented in the Qualtrics survey for device type and screen size identification, and the data matched participants' self-reported device information. The range of screen size for PC and smartphone condition was kept the same as that of Experiment 1.

After participants' device assignment was done, participants were randomly assigned to either the familiar condition in which they reviewed the same black polyester backpack (height: 19″) tested in Experiment 1 or the unfamiliar condition in which they reviewed a black plastic poster tube (height: 30″; Table 4). Then, they answered a set of questions regarding; (1) confidence about the product size (α = .70) by averaging two questions such as 1. how confident and 2. how certain participants were about the product's size (1 = not so sure, 7 = very confident); (2) size estimation in inches using the same question from Experiment 1; (3) product familiarity (how familiar are you with the product category?, 1 = very unfamiliar, 7 = very familiar); and (4) demographic information.

Table 4. Experiment 2 stimuli

Condition	**Familiar**	**Unfamiliar**
Stimuli	**Backpack**	**Poster tube**
Actual height (vertical length)	19″when examined physically	30″when examined physically
Sample images		

Results

Manipulation check. The product familiarity manipulation was successful; participants in the familiar product condition perceived the product to be more familiar (M = 4.40, SD = 1.76) than those in the unfamiliar product condition (M = 3.37, SD = 1.87, p < .001). The number of participants were similarly distributed to a PC with the familiar (unfamiliar) product condition (n = 35 (32)) and a smartphone with the familiar (unfamiliar) condition (n = 42 (41)), and the device information from our UA data also matched the self-reported device type.

Size-estimation error. As in the first two studies, we calculated the difference between the size estimations and the actual product height to assess the difference from the actual size; thus, the higher the difference, the greater the size estimation errors.

The factorial ANOVA results showed that device type had a significant interaction effect with product familiarity level (F(1, 146) = 6.28, p = .01). As shown in Figures 2 and 3, our simple effect analysis revealed that PC users (M = 17.63, SD = 8.20) made less accurate size estimations than smartphone users (M = 11.89, SD = 6.60) in the unfamiliar condition (p < .001) while showing no significant differences between device types in the familiar condition (p = .92), supporting H2. The main effect of device type was significant on participants' size-estimation errors (F(1, 146) = 6.97, p = .01); PC users estimated the product size (M = 12.34, SD = 8.77) less accurately than smartphone users (M = 9.60, SD = 6.81, p = .01).

Figure 2. Size-estimation error (Experiment 2)

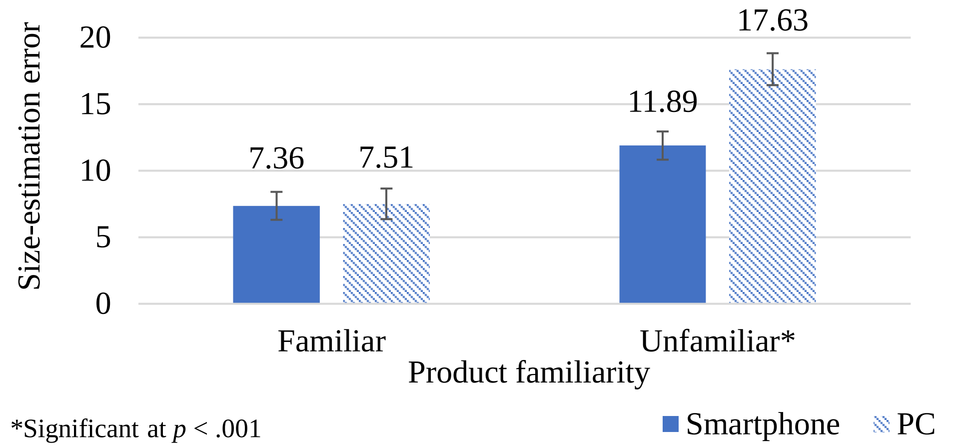
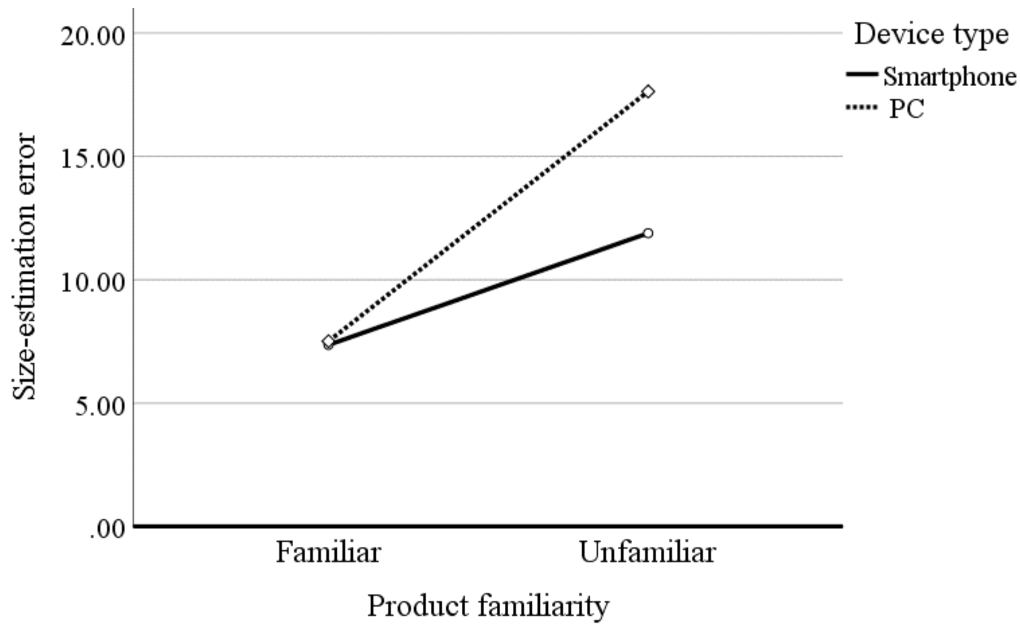


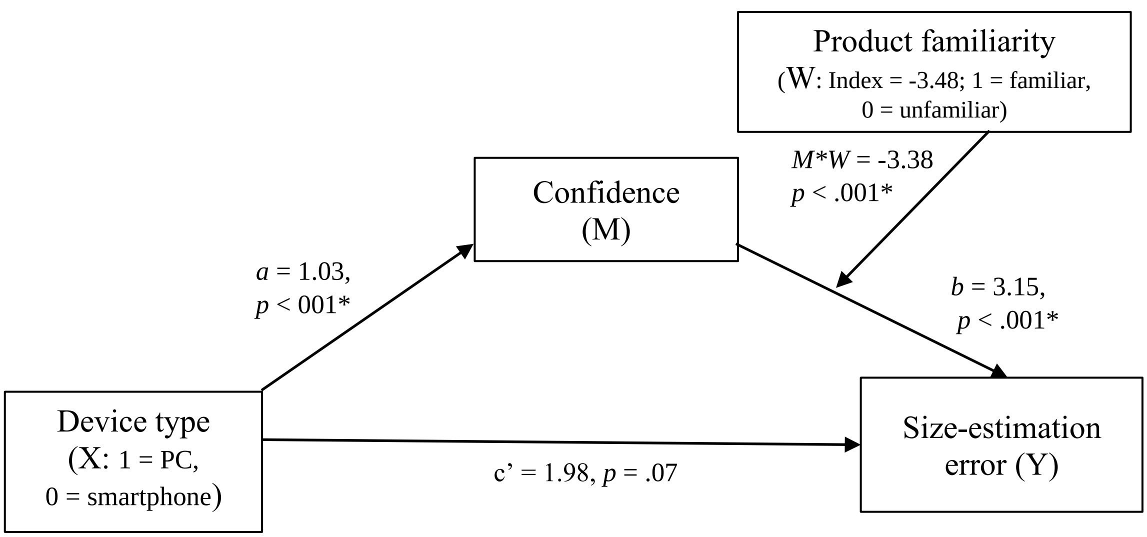
Figure 3. Interaction effect of device type and product familiarity



Moderated-mediation effect. We examined the proposed moderated-mediation effect of confidence about product size (M) and product familiarity (W) on the relationship between device type (X) and size-estimation error (Y), using Model 14 in PROCESS macros (version 3.5 released on May 1, 2020) with 50,000 bootstrap samples (Hayes, 2018).

The results indicated that the indirect effect of device type on size-estimation error was significant through confidence among participants who were *unfamiliar* with the given product (Figure 4). Among those who were familiar with the product, the indirect effect was not significantly different from zero. As proposed, the moderated-mediation index was significant such that product familiarity negatively moderated the indirect effect of device type on size-estimation errors. In other words, the strength of the mediation effect of confidence differed with the level of product familiarity; thus, PC users' stronger confidence was more likely to result in greater size estimation error with an unfamiliar product.

Figure 4. Moderated-mediation effect (Experiment 2)



Product familiarity (W)	**Indirect effect**	**Direct effect (c')**
Familiar (1)	*b* = -.23, *SE* = .54, 95% CI [-1.38, .79]	*b* = 1.98, *SE* = 1.07, *t*(145) = 1.84, *p* = .07
Unfamiliar (0)	*b* = 3.25, *SE* = .87, 95% CI [1.68, 5.07][i]	
Moderated-mediation effect Product familiarity (W): Index = -3.48, *SE* = 1.06, 95% CI [-5.75, -1.60][ii]		

i and ii. The effect is different from zero and is statistically significant.
* Statistically significant at $p < .001$

When controlling for confidence, device type did not have a significant direct effect on size-estimation errors, suggesting that the moderated-mediation model in Figure 4 better explains the process between device type and size-estimation errors than the direct effect. Thus, H4 is supported.

Discussion

The findings significantly enhanced our understanding of the mechanisms behind the influence of device type on accurate product size estimations. First of all, product familiarity, which we questioned in Experiment 1, indeed had a significant moderating effect; when evaluating product sizes, size-estimation errors were greater among PC users, and this difference was stronger with unfamiliar products, supporting H2. The moderated-mediation model (H4) was also fully supported; using a PC (vs. smartphone) device in online shopping increased confidence, which in turn increased size-estimation errors, if the products were unfamiliar.

Experiment 3: Shopping Motivations

Method

The purpose of this experiment was to test device-type effects when consumers' shopping motivations differed, while controlling for product size and category. We used a 2 (device type: PC vs. smartphone) × 2 (shopping motivations: hedonic vs. utilitarian) between-subjects design. A total of 169 U.S. residents (53% women) from Qualtrics' paid research panels participated in the online experiment (age: 18–24: 1%; 25–34: 14%; 35–44: 48%; 45–54: 32%; 55+: 5%).

The procedure, including the device type and validation process, was the same as that in Experiment 2 except for scenarios and product categories. After participants were randomly assigned to a device type that was validated by the UA strings, they were then randomly asked to read either a hedonic or utilitarian scenario in Appendix B and complete a few questions to ensure that they understood the information in the scenario. The hedonic scenario asked them to imagine shopping for decorative pillows to decorate their home before a house-warming party with best friends while the utilitarian scenario was about shopping for decorative pillows for a work space. Then, regardless of the conditions, participants reviewed an identical set of three 18″×18″ decorative pillows that were similar in style; all of them had similar asymmetrical patterns on a white background as shown in Table 5(product 1: navy/white pattern; product 2: gold/white pattern; product 3: dark yellow/beige pattern).

Unlike Experiment 2, we did not vary product categories: both hedonic and utilitarian conditions reviewed the same-size decorative pillows, but participants were not informed of the size (18″×18″). For each pillow, they completed the same scales and questions used in Experiment 2 concerning (1) confidence about the product size (α = .89; 1 = not so sure, 7 = very confident) and (2) size estimation in inches. Then, participants were asked to provide (3) an evaluation of the shopping task (how fun was the shopping task?; 1 = very boring, 7 = very fun) and (4) demographic information.

Table 5. Experiment 3 stimuli

Condition	**Hedonic**	**Utilitarian**
Stimuli	**Decorative pillows**	
Actual height (vertical length)	18″when examined physically	
Sample image		

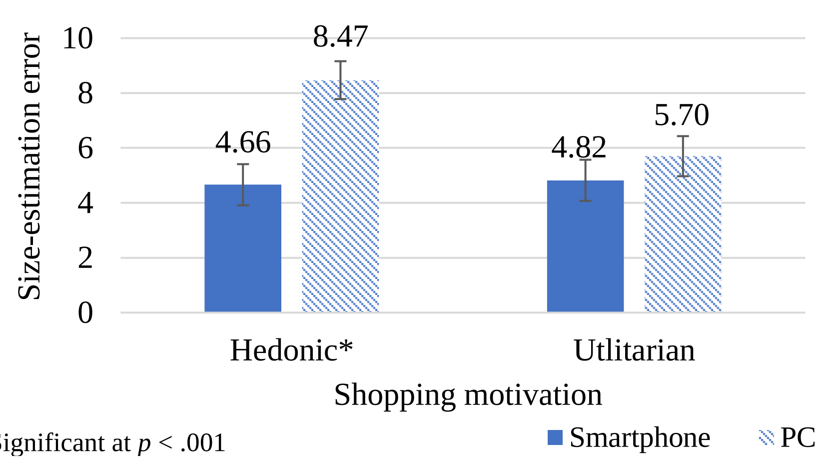
Results

Manipulation check. The manipulation was successful; our ANOVA results indicated that participants in the hedonic condition found the shopping task more fun (M = 6.11, SD = 1.03) than did those in the utilitarian condition (M = 5.46, SD = 1.98; F(1, 167) = 7.31, p = .01). The number of participants were similarly distributed into each condition (PC-hedonic (utilitarian) = 47 (42); smartphone-hedonic (utilitarian) = 40 (40)), and the UA device data matched participants' self-reported device type.

Size-estimation error. The results from a factorial ANOVA and simple effect analyses showed that device type and shopping motivation had a significant interaction effect on size-estimation error ($F(1, 165) = 4.04$, p =.046).

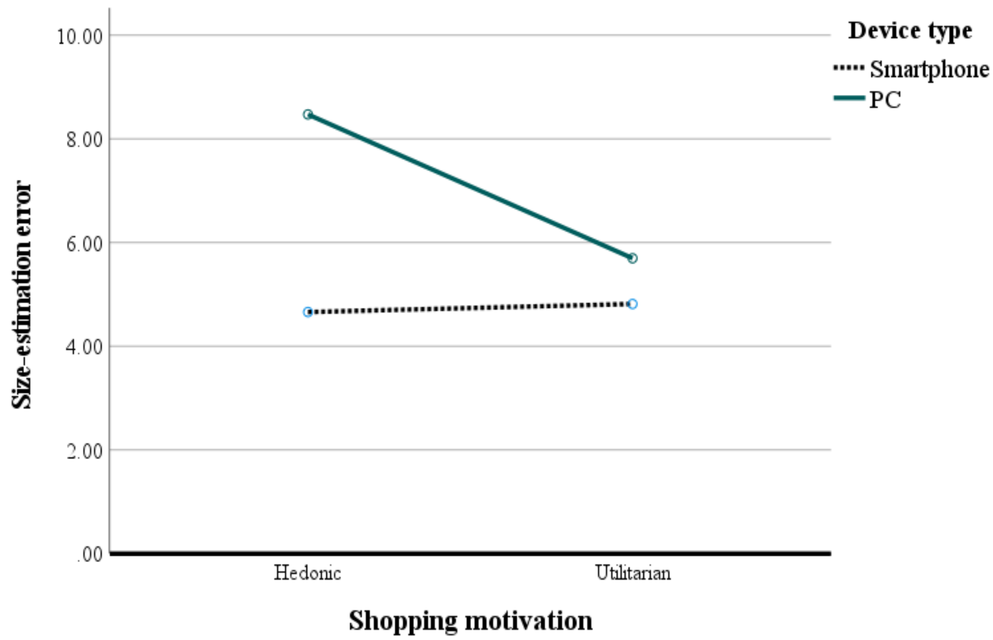
As shown in Figures 5 and 6, size-estimation errors on a PC (vs. smartphone) were significantly greater in the hedonic condition (M_{PC} = 8.47, SD_{PC} = 6.14; $M_{smartphone}$ = 4.66, $SD_{smartphone}$ = 3.55; $p < .001$) and were not significant in the utilitarian condition (p = .40), supporting H3. The main effect of device type was significant ($F(1, 165) = 10.37$, p = .002) such that PC users (M = 7.16, SD = 5.45) estimated the sizes less accurately than smartphone users (M = 4.74, SD = 3.97).

Figure 5. Size-estimation error (Experiment 3)



*Significant at $p < .001$

Figure 6. Interaction effect of device type and shopping motivation

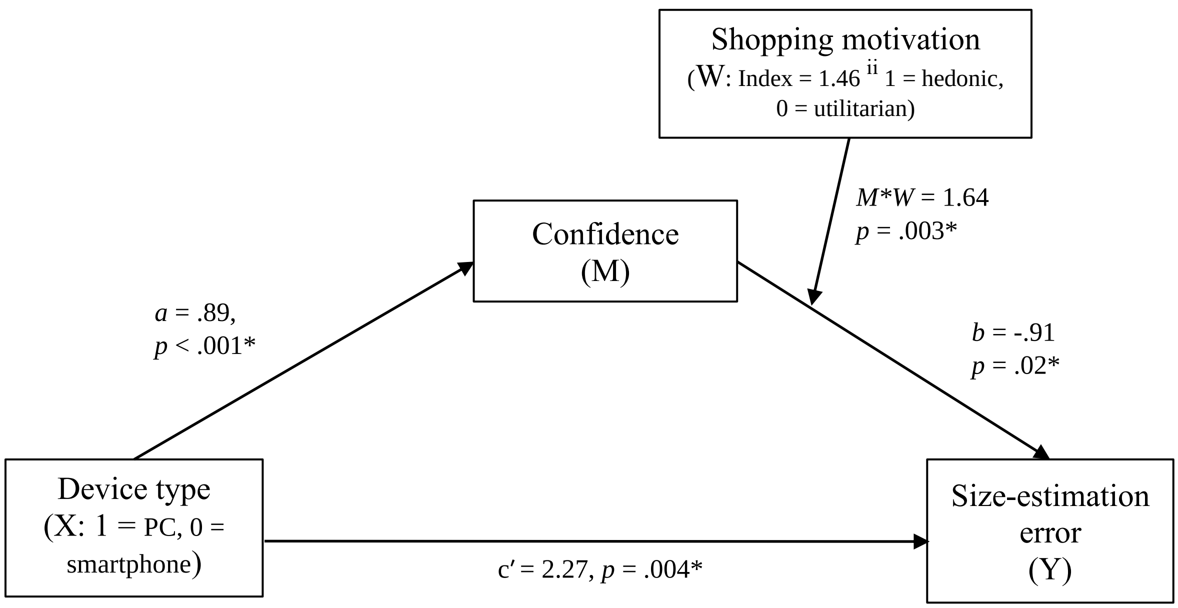


Moderated-mediation effect. We employed Model 14 in PROCESS macros (version 3.5: released on May 1, 2020) with 50,000 bootstrap samples (Hayes, 2018) to analyze the proposed moderated-mediation effect of confidence about product size (M) and shopping motivations (W), between device types (X) and size-estimation errors (Y).

As proposed, the moderated-mediation index (Figure 7) showed that shopping motivation positively moderated the mediation process. Controlling for confidence, the direct effect of device type on size-estimation errors was positive, increasing size-estimation errors. When confidence was included, the indirect effect was significant with utilitarian motivations; PC users led to stronger confidence, which led to lower size-estimation errors with utilitarian motivations. With hedonic motivations, the indirect effect was not significant, although it was positive (b = .65), suggesting a potential ceiling effect in which hedonic motivations strengthened the effect of confidence among both PC and smartphone users, resulting in similarly inaccurate size estimations.

Utilitarian motivations helped PC users prevent them from being carried away by their excessive confidence and allowed them to carefully assess product sizes, improving the accuracy of their size estimations, which supports H5. These results also imply that when product size and category are controlled, PC users' confidence level may accurately predict the level of size-estimation error (stronger confidence → higher accuracy) particularly with utilitarian motivations.

Figure 7. Moderated-mediation effect (Experiment 3)



Shopping motivation (W)	**Indirect effect**	**Direct effect (c′)**
Hedonic (1)	*b* = .65, *SE* = .43, 95% CI [-.09, 1.60]	*b* = 2.27, *SE* = .77, *t*(164) = 2.96, *p* = .004*
Utilitarian (0)	*b* = -.81, *SE* = .34, 95% CI [-1.53 -.20][i]	
Moderated-mediation effect Shopping motivation (W): Index = 1.46, *SE* = .58, 95% CI [.46, 2.72] [ii]		

i and ii. The effect is different from zero and is statistically significant.
*Statistically significant at $p < .05$

Discussion

The findings provide additional insights into device-type effects when shopping motivations vary while controlling for product size and category. The moderated-mediation effect (H5) was significant and suggested different roles for hedonic and utilitarian shopping motivations. Utilitarian motivations may have helped the participants more accurately estimate product sizes by making them focus on a careful size assessment. Hedonic motivations, on the other hand, likely ended up amplifying the positive effects of confidence regardless of device type; thus, differences in size-estimation errors attenuated and became *similarly inaccurate* in both the PC and smartphone conditions.

General Discussion

In our study, we examined the effects of PCs and smartphones on the accuracy of consumers' product size estimations. Four experimental studies revealed that consumers were likely to estimate product sizes less accurately when they evaluated products on a PC than on a smartphone. Using a PC (vs. a smartphone) made them more confident about product sizes, and the over-confidence led them to estimate product sizes less accurately. Our moderated-mediation analyses revealed that the adverse mediation effect of confidence was stronger with unfamiliar products but attenuated with utilitarian shopping motivations. The findings thus contribute to theory and practice in several ways, with the implications discussed separately below.

Theoretical contributions

First, to our knowledge, this research is the first to examine the effect of device type on the accuracy of consumers' product size estimations in e-commerce contexts. Our results suggest that online shoppers who use a PC to view products are likely to be overly confident about product size, which lead them to assess product size *less accurately* than those using a smartphone.

Second, this study introduces, for the first time, two critical mechanisms behind device-type effects on product size estimations online: (1) the mediating effect of confidence between device type and size-estimation errors; and (2) the moderating role of product familiarity and shopping motivation in this mediation process (moderated-mediation effects). Using a PC to review products is likely to increase consumers' confidence, which will then make them estimate product sizes less accurately particularly when viewing *unfamiliar* products. Interestingly, PC users' stronger confidence may also improve the accuracy of size estimations, lowering size estimation errors if consumers have *utilitarian* shopping motivations. This implies that with utilitarian motivations, PC users' confidence may be driven by careful cognitive judgment rather than by emotional state, resulting in more accurate size estimations.

Third, the findings of the research expand the scope of literature on device effects. As discussed, previous studies on device effects focused primarily on individual device *features*, comparing screen sizes or input modes (i.e., touchscreen and mouse), and little research was done on cross-device effects of device *types*. Thus, whether and how PCs and smartphones, whose screen size and input mode vary, might influence online shoppers' product size estimations had remained largely unknown before our study was able to address that gap. As expected, the findings are more closely aligned with those found in literature on screen size; devices with larger screens, regardless of input modality, achieved stronger emotional responses, which we predicted would increase size estimation errors. In particular, participants on PCs, which have larger screen sizes than smartphones, were more confident than those using smartphones, which resulted in less accurate size estimations regardless of input mode. It is possible that a specific device feature (e.g., screen size or input modality) predominantly drove those effects; however, further research is required to confirm whether the effects of the individual device features played a significant role.

Fourth, our study builds a meaningful foundation for future research on cross-device effects and product size evaluations. The results suggest that consumers' device types used for online shopping need to be considered as a factor influencing their product size assessment. As further research is needed to verify more specific effects, the study introduces a broad range of areas for future research, as explained further below.

Managerial implications

Because size-related concerns and complaints rank among the most common reasons why consumers return products to online retailers (Gilsenan, 2018; Reagan, 2019), improving the accuracy of customers' product size estimations is critical for online retailers. High product return rates require online retailers to invest personnel, time, and effort in processing not only returns and refunds but also consumers' complaints, which creates additional complexities in logistics and stock management. Therefore, understanding which factors may influence the accuracy of consumers' product size estimations can help retailers reduce return rates for products purchased online.

Our study thus has several significant practical implications. The results suggest that online shoppers who evaluate unfamiliar products on PCs may become overly confident and end up evaluating the size less accurately than those on smartphones if rely mainly on their subjective evaluation based on product images. Accuracy may also differ according to their shopping motivation; if shoppers on PCs are driven by utilitarian motivations, they put more effort into carefully evaluating product attributes and are more likely to estimate product sizes more accurately than those with hedonic motivations.

Therefore, we recommend online retailers and marketers to be mindful that their customers' device type can affect the accuracy of product size estimations when these customers browse product information online. In particular, we encourage online retailers and marketers to ensure that they code their websites to collect device-related information (e.g., UA string) and proactively utilize these data to better understand overall patterns of size-related issues in relation to product familiarity (e.g., new/unfamiliar products) and shopping motivations (e.g., items usually purchased for fun) and optimize product showcases online.

Retailers and marketers should also enhance the visual information about product sizes by visually presenting product size differences[1] rather than displaying same-size images[2] regardless of product size. To that end, retailers could add more product images from multiple angles, display reference objects (e.g., a 12-oz. soda can) next to such images, and/or provide videos showcasing the products. Those changes can better enable shoppers to estimate product sizes accurately, largely because they do not require reading lengthy text descriptions and thus lower the odds of product returns for reasons related to size.

Advanced technologies may also help online retailers reduce the adverse effects of device type on product size estimation; virtual reality (VR) and augmented reality (AR) will certainly boost consumer confidence about particular product attributes, including size perceptions.

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[1] e.g., iPhone website: https://apple.com/iphone/compare
[2] e.g., Best Buy's iPhone page: https://www.bestbuy.com/site/mobile-cell-phones/iphone/pcmcat305200050000.c?id=pcmcat305200050000

Future research and limitations

Our findings suggest that online shoppers are likely to inaccurately estimate product sizes when evaluating products on PCs than doing so on smartphones depending on their familiarity with products and shopping motivations. Although those findings provide a meaningful foundation for understanding how the type of device affects estimations of product size, further research is needed to verify whether specific features of devices contribute to the effects that we observed. Researchers may also want to test product attributes that we did not measure in our study, including product volume.

Furthermore, researchers need to examine whether the device-type effects found in this research have spill-over effects on offline product evaluations in multi-channel shopping occasions when consumers webroom (view multiple products online before purchasing one offline). In addition, comparing the effects among different age groups will also add more details to the findings as the elderly, for instance, may be less familiar with smaller devices (smartphones) than younger consumers.

Future research may also investigate whether the device-type effects observed here are consistent in VR and AR environments as an increasing number of online retailers are currently adopting VR/AR features on their websites. Moreover, it will be interesting to examine if these effects are extended to non-profit or pro-social marketing environments by measuring, for instance, consumers' willingness to donate funds or time. Testing the size of the consideration set may also add more insights into the effects found in this study as the number of product options affects consumers' confidence about their choice (Chan & Wang, 2018).

Conclusion

Overall, our study has yielded new findings about the complex mechanisms behind how cross-device effects influence the accuracy of product size estimations in online shopping. In turn, those findings showcase device type as an online retail cue that affects consumers' evaluations of products. The findings thus fill the important gap in marketing literature, of which little addresses how device type alters the accuracy of online shoppers' product size estimations. As an introductory work on that dynamic, the study has also furnished a foundation for future research examining the more specific effects of devices on online shoppers' decision-making when it comes to purchases.

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