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The effect of 360-degree rotatable product images on purchase intention

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ABSTRACT

In three experiments, we tested the effectiveness of 360-degree rotatable product images on retail websites. In Study 1, participants reported higher purchase intention in response to a 360-degree rotatable image than a two-dimensional static image. In Study 2, participants who were primed for cognitive busyness by writing about activities that kept them busy (vs. writing about typical daily activities) reported lower purchase intention than in Study 1. In Study 3, we found a similar effect by directly manipulating cognitive busyness: participants memorized long or short number strings while performing a shopping task. Furthermore, sensory vividness fully mediated the effect of 360-degree rotatable images on purchase intention for the less busy participants, not the highly busy participants. Theoretical and practical implications for virtual product presentation are discussed.

360-degree rotatable images constitute a new form of three-dimensional (3D) product display technology. Conventional stereoscopic 3D product display (Yim et al., 2012) requires a pair of polarized glasses (i.e., binocular vision) to convey the illusion of depth in the moving product image. In contrast, 360-degree rotatable images allow people to use a mouse or finger to rotate, pinch, and zoom in on a product image, making it viewable from multiple angles. For example, 360-degree rotatable product images on Amazon allow shoppers to interact with and inspect an item from all sides before purchasing it.

To enhance the virtual shopping experience, online retailers are increasingly using 360-degree rotatable product images that can be viewed from various angles. Retailers such as Amazon and Nordstrom encourage online vendors to use the more vivid and engaging product displays. 360-degree rotatable images on Amazon product pages are expected to increase conversion rates by 6–8% (Masters, 2018).

Scholars have found that virtual presentation formats can significantly shape information processing and decision making (Choi et al., 2019; Li et al., 2016). In particular, dynamic 3D product images lead to more favorable product evaluation, in terms of functionality, performance, and features, than static images (Algharabat et al., 2017; Choi and Taylor, 2014; Jiang and Benbasat, 2007). That is, viewers exposed to 3D product images tended to pay more attention, process information more accurately (Yim et al., 2012), and feel more stimulated (Choi and Taylor, 2014; Schlosser, 2003).

Although marketers tend to believe that interactive 3D product displays make pre-purchase product experiences more lively and appealing than conventional static product displays, consumer receptivity to 360-degree rotatable product images remains unclear. Scholars have examined the persuasive effect of 3D images in advertising (Choi and Taylor, 2014; Li et al., 2002; Yim et al., 2012), virtual worlds (Jin, 2009; Nah et al., 2011), and online games (Yim et al., 2018), but they have not clearly determined whether 360-degree rotatable images on retail websites can strengthen online shopping purchase intention. In this study, we examined this impact on online purchase intention, which is a valid proxy for online shopping behavior (Brown et al., 2003).

To fill the gap in the literature, we sought to identify a boundary condition for the observed effect of virtual product presentation. We proposed that cognitive busyness, which is a mental state that results from engaging in demanding activities that tax working memory (Palomares, 2011), would alter consumer responses to 360-degree rotatable product images. Exploring the role of cognitive busyness is important because 3D virtual environments can increase the cognitive resource demands of processing visual information (Van Der Land et al., 2013). Cognitive busyness is also relevant to multitasking (Lalwani, 2009). Consumers who multitask are frequently distracted by informational overload, especially in online environments (Oh et al., 2019; Yoon et al., 2011). Consumers browse multiple shopping sites while watching TV, chatting with friends, and engaging in other activities that draw their attention away from shopping. Such cognitive busyness is likely to limit the cognitive resources they can allocate to online shopping decisions.

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Therefore, the purpose of this study was two-fold. First, we tested whether 360-degree rotatable product images would enhance purchase intention on retail websites. Second, we investigated how the effect of 360-degree rotatable (vs. static) images might vary depending on cognitive busyness. In particular, we focused on sensory vividness—the clarity of sensory information represented in working memory (Biocca et al., 2001)—as the underlying mechanism for the joint effect of visual presentation format and cognitive busyness.

Our findings contribute to the literature on online shopping behavior. While scholars have examined potential determinants of online shopping behavior using retail technology, such as virtual reality, augmented reality, and stereoscopic 3D advertising (Baek et al., 2018; Choi and Taylor, 2014; Yim et al., 2012, 2017; Wodehouse and Abba, 2016), few have tested the effect of 360-degree rotatable product images. Our findings shed new light on the importance of *cognitive busyness as a moderator of this effect.* Our results also have practice implications for online retail strategies. When using 360-degree rotatable images to create a visually stimulating buying experience, digital retailers should consider whether their online shoppers are mentally busy, perhaps as a result of multitasking activities and rich media distraction.

1. Literature review and hypotheses development

1.1. Consumer responses to 3D display technology

To depict product features and performance capabilities more effectively, retail websites are increasingly adopting multisensory virtual product presentation (Choi et al., 2013, 2015; Jiang and Benbasat, 2007). They typically use pictures and text to present product features (Choi et al., 2019; Park et al., 2008), but static visual and textual information often fails to give shoppers the rich sensory experiences they want from online shopping (Jiang and Benbasat, 2007). Consequently, many online retailers are using various 3D image display tools to enhance consumer engagement with products.

Scholars have found that 3D images elicit more positive virtual product experiences than two-dimensional (2D) images (Debbabi et al., 2010; Li et al., 2002; Nah et al., 2011; Yim et al., 2012). This positive effect of 3D images on purchase intention occurs across various product categories (Choi and Taylor, 2014) and online shopping contexts (Jin, 2009). A conceptual explanation for this common finding is the idea of "presence" (Yim et al., 2012). The (tele) presence theory (Steuer, 1992) posits that individuals experience a feeling of "being there" in a computer-mediated environment. Telepresence is the perception that the virtual environment feels "more real than the actual physical environment" (Novak et al., 2000, p. 29). In this vein, Li et al. (2002) reported that consumers infer that 3D advertising has the capacity to create virtual product experiences. This inferential process leads to a sense of presence, in turn favorably influencing product knowledge, brand attitude, and purchase intention.

In addition, mental imagery—the mental simulation of using a product (Herd and Mehta, 2019)—plays a role when people experience presence in digital media environments (Rodríguez-Ardura and Martínez-López, 2014). Mental imagery enables individuals to encode incoming product information through a variety of sensory modalities, including sight, hearing, touch, taste, and smell (Schlosser, 2003). Empirical evidence suggests that 3D product images evoke deeper visual mental imagery processing than 2D product images, ultimately enhancing purchase intention (Choi and Taylor, 2014).

3D product presentation arguably (a) allows consumers to evaluate product functionality more easily and (b) enhances brand attitude, satisfaction, and purchase intention better than 2D product presentation (Algharabat et al., 2017; Jiang and Benbasat, 2007). In online shopping environments, consumers tend to favor websites that use both videos and virtual product presentation (Jiang and Benbasat, 2007). Similarly, consumers report that 3D product presentation provides more detailed and accurate information (Ozok and Komlodi, 2009) and enables them to scan, recognize, and recall images rapidly, leading to stronger purchase intention (Algharabat et al., 2017).

Building on the conceptual framework of telepresence and mental imagery (Choi and Taylor, 2014; Rodríguez-Ardura and Martínez-López, 2014; Schlosser, 2003; Steuer, 1992), we proposed that 360-degree rotatable images would allow consumers to explore products from multiple angles. Thus, we hypothesized that *360-degree rotatable presentation would be more effective than static product presentation* in drawing attention and providing sensory experiences that evoke mental connections with products under purchase consideration (Choi and Taylor, 2014; Schlosser, 2003):

H1. 360-degree rotatable product images (vs. static product images) will elicit stronger purchase intention.

1.2. Moderating role of cognitive busyness

Online shoppers frequently multitask, so they often experience divided attention and have limited cognitive resources to devote to any one task. Cognitive busyness is "a subjective state that results from individuals' assessment of how engaged they are in activities" (Wilcox et al., 2016, p. 371). Cognitive busyness can also fatigue working memory (Atalay et al., 2017), limit attention to focal tasks (Lalwani, 2009), and increase stress (Dalton and Spiller, 2012; Oh et al., 2019).

On the positive side, cognitively busy individuals might feel a sense of self-importance (Gershuny, 2011; McGinnity and Russel, 2007), be more self-controlled (Kim et al., 2019), and avoid cognitive distractions in order to maintain their feelings of self-importance. On the negative side, cognitive busyness can decrease the ability to process information, potentially leading to poor decision making (Malhotra, 1982). For example, consumers who are cognitively busy might be unable to process information and, thus, be more resistant to persuasion (Lalwani, 2009), less able to perform tasks, and more likely to rely on heuristics when evaluating products (Kardes et al., 2004; Yoon et al., 2011).

Several theoretical models explain the effects of busyness, including cognitive load theory (Sweller, 1994), capacity model of attention (Kahneman, 1973), and the limited capacity model of motivated mediated message processing (Lang, 2006). These theoretical models suggest that people have limited working memory available for processing information (Choi et al., 2018; Jeong and Hwang, 2016; Jiang and Benbasat, 2007; Lang, 2006). Cognitive load theory (Sweller, 1994) suggests that information overload further depletes information processing capacity, causing poor decision making (Jiang and Benbasat, 2007; Malhotra, 1982) and taxing the capacity to hold and process information in short-term memory (Yoon et al., 2011). When people are presented with information, two sources of cognitive load can impact working memory (Sweller, 1994): intrinsic and extraneous. Intrinsic cognitive load is related to the inherent complexity of the information, whereas extraneous cognitive load is artificially imposed by information unrelated to the focal task. High cognitive load often reduces executive capacity to maintain task priority, allowing attention to wander (Lavie, 2010; Oh et al., 2019). Similarly, when people perform multiple tasks simultaneously (Yoon et al., 2011), cognitive busyness reduces attention, comprehension, and recall (Jeong and Hwang, 2016; Malhotra, 1982).

Scholars have explored the information-load paradigm in the context of online product presentation (Li et al., 2016). *Interestingly, when consumers face highly complex product evaluation tasks, virtual product images are not superior to static images because higher* information processing requirements tend to decrease learning (Jiang and Benbasat, 2007). That is, when people spend excessive cognitive effort to perform complex tasks, they tend to simplify task execution strategies to preserve resources. In one study, Jiang and Benbasat (2007), using four presentation formats (i.e., static pictures, video without narration, video with narration, and virtual product presentation), found that under moderate task complexity, participants gained higher product understanding from the videos and virtual product presentation; however, under high task

complexity, the effects of dynamic and static presentation did not differ. Similarly, high task complexity tends to increase information processing, use more cognitive resources, and shorten attention span (Kahneman, 1973).

In the context of e-commerce, we expected that consumers would exert varying levels of cognitive effort when exploring online products presented in different formats. For example, to understand the experiential features presented in a 360-degree rotatable image, consumers must pay attention to dynamic changes in spatial orientation (Oh et al., 2019). Thus, they are likely to expend more resources and effort processing 360-degree rotatable product images (Hong et al., 2004). In contrast, when viewing static product images, they can control information acquisition effortlessly, at their own pace.

Building on these findings, we proposed that when consumers were either cognitively busy or primed to be so, they would lack sufficient attentional resources to process images appropriately. For the dynamic changes involved in a 360-degree rotatable product image to be fully effective, consumers must pay more attention than they might to a static product image and have sufficient attentional resources to process the rotating image. If they are simultaneously allocating a large amount of attentional resources to another task (i.e., multitasking), they are likely to run out of attentional resources for image processing (Jiang and Benbasat, 2007), attenuating the otherwise superior effect of a rotatable product image. In other words, we expected that cognitively busy consumers would tangentially engage in viewing the presentation, thereby lessening the effect of the 360-degree image on purchase intention. In contrast, non-cognitively busy consumers might have ample information processing capacity to be fully immersed in the viewing experience.

H2a. For non-cognitively busy participants, 360-degree rotatable product images will elicit higher purchase intention than static product images.

H2b. For cognitively busy participants, 360-degree rotatable product images and static product images will elicit equal purchase intention.

1.3. Sensory vividness

Sensory vividness in virtual environments indicates that consumers have stored rich sensory information *about product functionality* in their working memories (Biocca et al., 2001). In e-commerce situations, virtual product presentation generates strong sensory vividness in resulting mental imagery (Choi et al., 2013; Choi et al., 2015; Coyle and Thorson, 2001; Flavian et al., 2017; Schlosser, 2003). Indeed, 3D images provide rich sensory cues that evoke memories of sight, touch, sound, smell, and taste to attract attention *and* evoke vivid mental images of product usage (Choi and Taylor, 2014; Schlosser, 2003). *The persuasive impact of sensory vividness (or modality richness) on purchase intention is more evident in 3D (vs. 2D) virtual environments (*Kerrebroeck et al., 2017; Jin, 2009*).* Schlosser (2003) confirmed that virtual product experience through vividness of mental imagery increased purchase intention.

Extending this logic to 360-degree rotatable product images, we expected that *interactive presentation formats with* zooming and rotation functions would give consumers impressions *of sensory vividness even in the absence of physical stimuli, allowing consumers to feel as if they were really seeing and touching the product, increasing their confidence and purchase intention (*Yim et al., 2017*). This illusion is likely to evoke more vivid mental images of product usage and strengthen purchase intention (*Flavian et al., 2017*). Accordingly, we proposed that* 360-degree rotatable product images would be more likely to elicit vivid mental images that are rich in sensory (e.g., visual) detail, whereas static product views would more likely produce nonvivid mental images that are faint and not easily connected to virtual product usage (Schlosser, 2003), suggesting the mediating role of sensory vividness.

*Given that vivid information increases working memory (*Collins et al., 1988*), we based our theoretical reasoning on the link between vividness and cognitive busyness. Previous findings about vividness effects suggest that increased (decreased) cognitive demands are likely to inhibit (enhance) the processing of vivid mental imagery* (Jia et al., 2017; Petrova and Cialdini, 2005; Shiv and Huber, 2000). *For instance,* Shiv and Huber (2000) found a detrimental effect of cognitive load on mental imagery, suggesting that imposed cognitive load distracts from the creation a vivid mental imagery of product-related behaviors. Scholars have further *postulated that cognitive busyness tends to interfere with the activation of mental imagery (*Sinha and Lu, 2019*). Following the same reasoning, we proposed that sensory vividness would mediate the effect of 360-degree rotatable* images on purchase intention *only when consumers were not cognitively busy, for whom such mediation would disappear because the mental state of busyness might disrupt vivid imagery generation.*

Similarly, multitasking that imposes limitations on working memory can lead to cognitive overload (Lalwani, 2009). *Multitasking consumers who appear to be cognitively busy might fail to observe differences in the vivid mental imagery generated by 360-degree rotatable and static images. This prediction is based on* the information-load paradigm*, which posits that individuals under high-cognitive load tend to simplify their tasks. Our prediction aligns with findings that virtual (static) product images are more (equally) effective under low (high) task complexity (*Jiang and Benbasat, 2007*) That is, if consumers are involved in a single task only, making them less busy,* 360-degree rotatable product presentation *should positively affect sensory vividness, in turn strengthening purchase intention. However, the mediation is less likely to occur for cognitively busy multitasking consumers.*

H3. For non-cognitively busy participants, sensory vividness will mediate the effect of the 360-degree presentation on purchase intention; for cognitively busy participants, the mediation will not be observed.

2. Methodology

We conducted three experiments to test our hypotheses. In Study 1, we attempted to find evidence for the effect of 360-degree rotatable (vs. static) product images on purchase intention. In Study 2, we further examined the moderating role of cognitive busyness in shifting consumer response to 360-degree rotatable presentation. In Study 3, we sought evidence of the mediation mechanism underlying our predictions. We selected stimulus products from previous research (e.g., Baek et al., 2018; Carlson et al., 2013; Krishna et al., 2013): flip-flop sandals (Study 1), sunglasses (Study 2), and chocolate chip cookies (Study 3). According to GFK Mediamark Research and Intelligence, an aggregated market resource for U.S. consumer buying behavior and media use, college students are one of the largest groups who buy these products (see https://www.gfkmrismartsystem.com).

3. Study 1

In Study 1, we tested whether 360-degree rotatable product images (vs. static product images) would evoke stronger purchase intention. To control for possible confounding variables (e.g., pre-existing brand image and attitude) associated with a real brand, we designed a fictitious brand of flip-flop sandals, *Walka*, for our one-factor (product presentation format: 360-degree rotatable vs. static image) between-subjects design in a controlled lab setting.

3.1. Method

We recruited 103 undergraduate students (35.9% men and 64.1% women) from a northeastern U.S. university to participate in exchange for course credit. The average age of the participants was 21.2 years. Anglo-Americans/Caucasians comprised 75.7% of the participants, followed by Asians (9.7%), Latinos (6.8%), Multiracial (5.8%), and African Americans (1.9%).

Study participants first viewed one of the two stimulus images of flip-flops: 360-degree rotatable ($n = 51$) or static ($n = 52$). Participants in the

rotatable image condition used a mouse to zoom in and out and to rotate the product photo. In the static image condition, they viewed a static 2D product photo. Participants then indicated their likelihood of purchasing the flip-flops on a three-item, 7-point Likert-type scale anchored by *unlikely/likely*, *impossible/possible*, and *improbable/probable* (Baek and Yoon, 2017). We averaged the three items to generate an index for purchase intention ($\alpha = 0.91$). Participants also answered demographic questions about age, gender, and ethnicity.

3.2. Results

We performed an independent samples *t*-test to examine whether the rotatable image was more effective than the static image for generating purchase intention. As H1 predicted, participants who viewed the rotatable image indicated stronger purchase intention than those who viewed the static image ($M_{rotatable} = 4.05$, $M_{static} = 3.12$, $t = 3.15$, $p < .01$). Thus, H1 was supported.

3.3. Discussion

Study 1 findings confirmed our prediction that a rotatable image would elicit stronger purchase intention than a static image. Consistent with previous findings that 3D advertising is more effective in enhancing consumer purchase intention than 2D advertising (Choi and Taylor, 2014; Li et al., 2002; Yim et al., 2012), our findings demonstrate that 360-degree rotatable (vs. static) product images led to stronger purchase intention. We suggest that retailer websites consider using 360-degree rotatable images to enhance virtual product experience and increase purchase intention. Nonetheless, we question whether 360-degree rotatable images might be more or less effective under certain conditions. In Study 2, we examined that possibility by investigating the moderating role of cognitive busyness.

4. Study 2

To examine the moderating role of cognitive busyness in the effect we observed in Study 1, we used a 2 (busyness priming: busy vs. control) × 2 (product presentation format: 360-degree rotatable vs. static image) between-subjects design in a controlled lab setting. To enhance validity, we used *Ray-Ban*, a real brand of sunglasses that can be considered gender-neutral (Baek et al., 2018; Childs and Jin, 2016).

4.1. Method

We recruited 160 undergraduate students (63.7% men and 36.3% women) from a northeastern U.S. university to participate in exchange for course credit. The average age of the participants was 19.5 years. Anglo-Americans/Caucasians comprised 84.4% of the participants, followed by Asians (8.1%), Latinos (3.8%), African Americans (2.5%), and Multiracial (1.3%).

When participants arrived at the lab, we randomly assigned them to one of four experimental conditions: busy/360-degree image ($n = 39$), control/360-degree image ($n = 39$), busy/static image ($n = 42$), and control/static image ($n = 40$). To prime cognitive busyness, we asked study participants to undertake an essay-writing task adapted from previous research (Kim et al., 2019). Kim et al. (2019) developed and validated the recall-writing task to make busyness salient. Following their experimental procedures, in the busy condition, we asked participants to think about and write down three tasks/activities that keep them busy. In the control condition, we asked them to think and write about three tasks/activities they perform on a typical day. Next, participants viewed either the 360-degree rotatable or static image of a pair of Ray-Ban sunglasses. Finally, participants completed questionnaires about purchase intention ($\alpha = 0.96$) and demographics. Because we used a real brand, we measured pre-existing brand attitude as a covariate that might influence purchase intention using a three-item, 7-point Likert-type scale anchored by *bad/good*, *unfavorable/favorable*, and *dislike/like*. Our correlation matrix revealed that pre-existing brand attitude significantly correlated with purchase intention ($r = 0.34$, $p < .01$), so we treated brand attitude as a covariate.

4.2. Results

Manipulation check. For the busyness manipulation check, participants indicated their perception of the extent of their busyness (1 = *not at all busy*, 7 = *very busy*). Participants in the busy condition reported being busier than participants in the control condition ($M_{busy} = 6.04$, $M_{control} = 2.42$, $t = 20.34$, $p < .001$). Thus, the busyness manipulation was successful.

Purchase intention. We performed a 2 (busyness priming: busy vs. control) × 2 (product presentation format: 360-degree rotatable vs. static image) ANCOVA with purchase intention as the dependent variable and pre-existing brand attitude as a covariate ($F(1, 155) = 23.38$, $p < .001$). The results revealed a main effect of product presentation format ($F(1, 155) = 21.23$, $p < .001$); participants who viewed the rotatable image ($n = 78$, $M_{rotatable} = 5.83$) had stronger purchase intention than those who viewed the static image ($n = 82$, $M_{static} = 4.89$), supporting H1. However, busyness priming had no main effect ($F(1, 155) = 0.13$, $p = .72$).

As hypothesized, we observed a significant two-way interaction effect on purchase intention. As Fig. 1 shows, follow-up comparisons revealed that in the control condition, participants who viewed the rotatable image reported stronger purchase intention than those who viewed the static image ($M_{rotatable} = 6.07$, $M_{static} = 4.71$, $F(1, 155) = 22.16$, $p < .001$). In the busy condition, no significant difference emerged ($M_{rotatable} = 5.58$, $M_{static} = 5.06$, $F(1, 155) = 3.21$, $p = .08$). Thus, H2a and H2b were supported.

4.3. Discussion

The findings from Study 2 supported our hypotheses. Specifically, we found a similar pattern regarding the effect of virtual product presentation on purchase intention. Most importantly, Study 2 revealed evidence for a boundary condition for the observed effect. Participants tended to have stronger purchase intention when presented with the 360-degree rotatable product image. However, when participants were primed to be busy, the effect was weaker. These findings are consistent with previous findings. Jiang and Benbasat (2007) showed that the superior effect of virtual product presentation (vs. static images) was weaker when understanding product features became a highly complex task. Similarly, in our study, feelings of busyness might have limited the resources required for greater visual information processing when viewing 360-degree rotatable images.

5. Study 3

In Study 3, we conceptually replicated the Study 2 findings, with three exceptions. First, rather than using an essay-writing task, we directly manipulated busyness using a validated memorization task ((Lalwani, 2009; Shiv and Fedorikhin, 1999; Yoon et al., 2011). Second, we tested whether sensory vividness mediated the effect of virtual product presentation format and busyness. Finally, we used a fictitious chocolate chip cookie brand, *Terla*. We used a 2 (busyness: high vs. low) × 2 (product presentation format: 360-degree rotatable vs. static image) between-subjects design in a controlled lab setting.

5.1. Method

We recruited 219 undergraduate students (53% men and 47% women) from a northeastern U.S. university to participate in exchange for course credit. The average age of the participants was 20.4 years. Anglo-Americans/Caucasians comprised 82.6% of the participants,

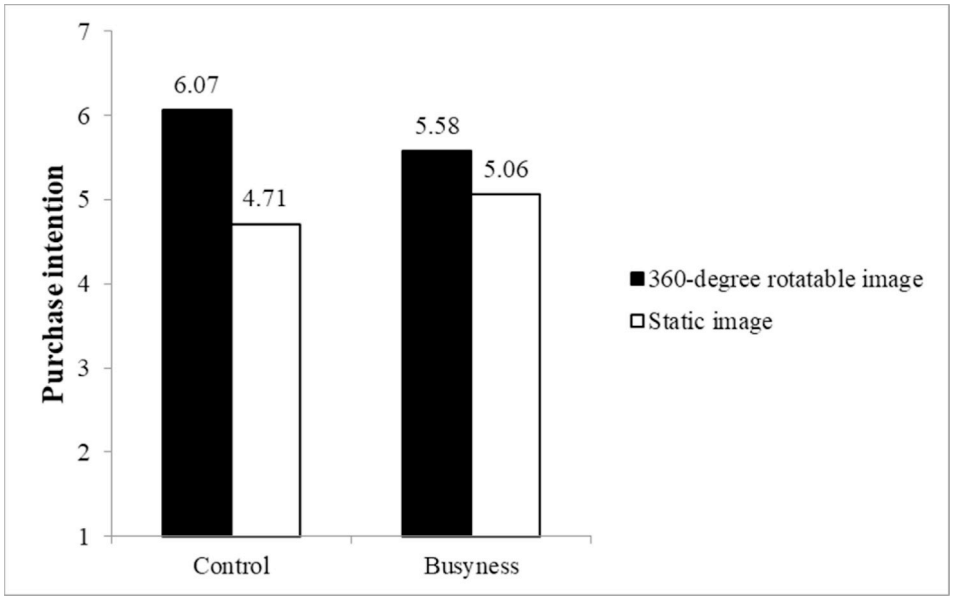

Fig. 1. Study 2 results: Effect of product presentation format and busyness on purchase intention.

followed by Asians (6.4%), African Americans (4.6%), Multiracial (4.6%), and Latinos (1.8%).

When participants arrived at the lab, we randomly assigned them to one of four experimental conditions: high busyness/360-degree image ($n = 55$), low busyness/360-degree image ($n = 55$), high busyness/static image ($n = 55$), and low busyness/static image ($n = 54$). We manipulated cognitive busyness using a memorization task that scholars had widely used and validated in previous studies (Lalwani, 2009; Shiv and Fedorikhin, 1999; Yoon et al., 2011). Study participants first viewed a set of numbers on a computer screen. In the high busyness condition, we instructed participants to memorize an eight-digit set (i.e., 94658952); in the low busyness condition, we instructed them to memorize a two-digit set (i.e., 12). Next, they viewed one of the two stimuli, either a 360-degree rotatable or a static image of chocolate cookies. Participants then responded to a questionnaire about sensory vividness with three items on a 5-point Likert-type scale (1 = *no image*, 2 = *vague and unclear image*, 3 = *recognizable but not clear or vivid image*, 4 = *vivid, almost real image*, and 5 = *very vivid and clear image*; $\alpha = 0.75$): (1) "How vividly can you imagine the taste of this chocolate chip cookie?" (2) "How vividly can you imagine the smell of this chocolate chip cookie?" and (3) "How vividly can you imagine the texture of this chocolate chip cookie if you were to eat it?" (Schlosser, 2003). We used the measure for purchase intention ($\alpha = 0.93$) from Studies 1 and 2. Finally, participants answered demographic questions about age, gender, and ethnicity and reported their levels of hunger. Our correlation matrix confirmed that perceived hunger significantly correlated with purchase intention ($r = 0.30$, $p < .01$).

5.2. Results

Manipulation check. We used the manipulation check for cognitive busyness (Yoon et al., 2011) to determine whether participants used mental effort to remember the numbers. Two independent coders identified whether participants accurately recalled the eight digits (vs. two digits) in the high (vs. low) busyness condition using a binary scale (1 = correct, 0 = incorrect). Intercoder reliability was higher (Cohen's kappa = .94) than the recommended threshold (0.70) (Cohen, 1960).

Purchase intention. We performed a 2 (busyness: high vs. low) × 2 (product presentation format: 360-degree rotatable vs. static image) ANCOVA with purchase intention as the dependent variable and perceived hunger as a covariate. The results revealed that product presentation format had a main effect (F (1, 214) = 4.23, $p < .05$). Participants who viewed the rotatable image ($M_{rotatable} = 4.85$) had stronger purchase intention than those who viewed the static image ($M_{static} = 4.48$), supporting H1. However, busyness had no main effect on purchase intention (F (1, 214) = 0.01, $p = .93$). Notably, we found a significant two-way interaction effect on purchase intention (F (1, 214) = 7.97, $p < .01$). As Fig. 2 shows, follow-up comparisons revealed that participants in the low busyness condition who viewed the rotatable image reported stronger purchase intention ($M_{rotatable} = 5.11$, $M_{static} = 4.24$, F (1, 214) = 4.25, $p < .05$). In the high busyness condition, the two images evoked no significant difference ($M_{rotatable} = 4.59$, $M_{static} = 4.72$, F (1, 214) = 0.30, $p = .59$). Accordingly, H2a and H2b were supported.

Moderated mediation. We performed a moderated mediation analysis with 5000 bootstrapped samples using model 8 of the PROCESS SPSS macro (Preacher and Hayes, 2004) to test the mediating effect of sensory vividness on the relationship between product presentation format and purchase intention across levels of busyness. Our independent samples t-test confirmed that participants who viewed the 360-degree rotatable image indicated higher sensory vividness than those who viewed the static image ($M_{rotatable} = 3.26$, $M_{static} = 2.71$, $t = 3.06$, $p < .01$). As Fig. 3 shows, in the low busyness condition, product presentation format predicted sensory vividness ($\beta = 0.34$, $p < .001$), and sensory vividness predicted purchase intention ($\beta = 0.38$, $p < .001$). Product presentation format had a significant direct effect on purchase intention

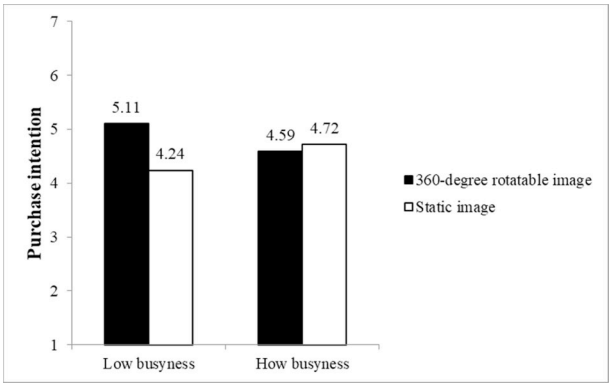

Fig. 2. Study 3 results: Effect of product presentation format and busyness on purchase intention.

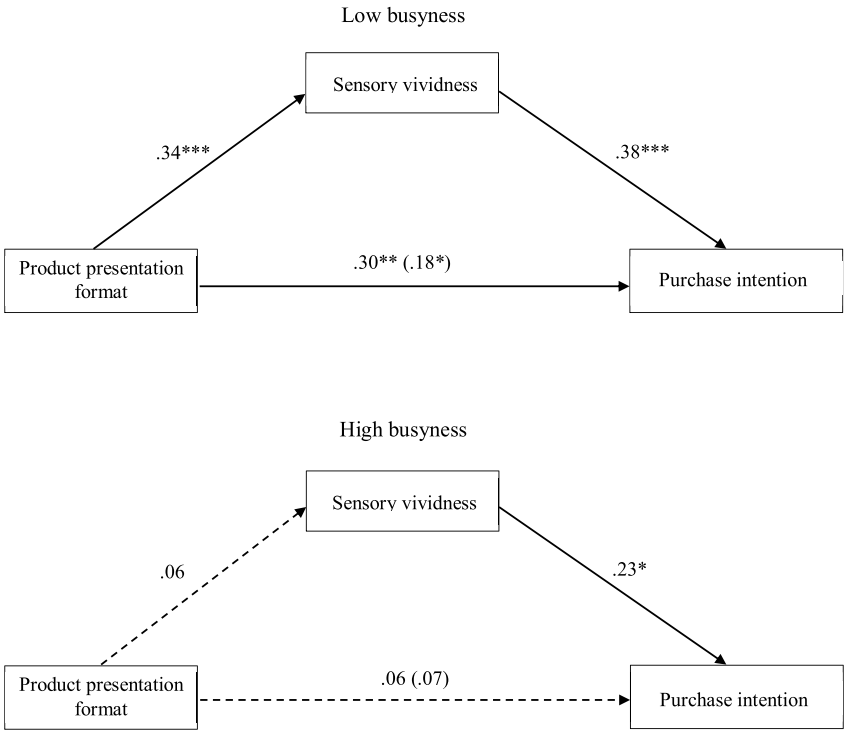

Fig. 3. Mediated Moderation Model of Sensory Vividness.
Note. Standardized coefficient values in parentheses indicate the effect of product presentation format (1 = 360-degree rotatable image, 0 = static image) on purchase intention when controlling for sensory vividness; $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

($\beta = 0.30$, $p < .01$) but a lower indirect effect on purchase intention when sensory vividness was included ($\beta = 0.18$, $p = .05$). However, in the high busyness condition, product presentation format did not predict sensory vividness ($\beta = 0.06$, $p = .56$), but sensory vividness predicted purchase intention ($\beta = 0.23$, $p < .05$). Product presentation format had nonsignificant direct and indirect effects on purchase intention ($\beta = 0.06$, $p = .57$) when we included sensory vividness ($\beta = 0.07$, $p = .47$).

Study 3 findings confirmed that sensory vividness mediated the conditional indirect effect of product presentation format on purchase intention in the low busyness condition (95% CI = −0.47 to −0.08), but not in the high busyness condition (95% CI = −0.17 to 0.09). Overall, sensory vividness fully mediated the effect of product presentation format on purchase intention for less busy participants but not for highly busy participants, supporting H3.

5.3. Discussion

Study 3 revealed converging evidence for the interactive effect of virtual product presentation and cognitive busyness on purchase intention using a different product category. As expected, participants in the low busyness condition had stronger purchase intention after viewing the rotatable vs. static product image, supporting H2a. No significant differences in purchase intention emerged in the high busyness condition. This finding supports our original hypothesis that busy participants would be less impressed by the 360-degree rotatable image presentation (H2b). Furthermore, the results of Study 3 shed light on the process underlying the observed effect in certain contexts. That is, we identified sensory vividness as an underlying mediating mechanism for the matching effects between rotatable vs. static images and low vs. high busyness.

6. General discussion

In the three studies we conducted, we examined the effect of 360-degree rotatable and static product images in an online shopping environment. Study 1 findings indicate that exposure to a rotatable (vs. static) image evoked stronger purchase intention. Findings from Studies 2 and 3 show that non-cognitively busy participants reported stronger purchase intention after viewing a rotatable (vs. static) image, but the effect was lower when participants were cognitively busy. Additionally, sensory vividness mediated the effect of rotatable product image presentation only for non-busy participants.

6.1. Theoretical implications

Our findings have several theoretical implications. First, the findings contribute to existing literature addressing how 3D (vs. 2D) advertising enhances brand evaluation (e.g., Li et al., 2002). However, few scholars have examined the robust effects of 360-degree rotatable images—a new and popular presentation format on retail websites. Our findings fill that gap. Second, our findings contribute to the literature about virtual product experience, which has primarily focused on antecedents and consequences of telepresence in response to immersive virtual environments (Coyle and Thorson, 2001; Debbabi et al., 2010; Nah et al., 2011; Yim et al., 2012). Instead of re-exploring the construct of telepresence in 3D environments, we tested cognitive busyness as a key moderator of the virtual product image effects on purchase intention. By integrating various theoretical traditions drawn from telepresence theory (Steuer, 1992), the mental imagery model (Schlosser, 2003), and cognitive load theory (Sweller, 1994), we demonstrated that 360-degree rotatable images might become less effective when consumers are cognitively busy.

Our findings also extend prior research about the way various online product presentation formats (e.g. videos, images, and text) affect product knowledge and website diagnosticity (Jiang and Benbasat, 2007) by identifying a boundary condition that might activate and alleviate the effects on virtual shopping experiences. Our findings show that highly busy study participants reported similar purchase intention for a fashion product or an indulgent food choice in response to rotatable or static presentation formats. However, for participants who perceived

low or non-busyness, the rotatable image was more effective.

Finally, by highlighting the mediating role of sensory vividness, our findings provide new insights into the underlying effects of 360-degree rotatable image presentation. In this vein, Choi and Taylor (2014) showed that the vividness of mental imagery mediated 3D advertising effectiveness on purchase intention. Our findings extend the scope of their study to 360-degree display technology, which can readily be embedded in retail websites. Our results suggest that the mediating effect of sensory vividness depends on situational factors that make busyness salient (Study 2) or that impose cognitive demands on working memory (Study 3). Additionally, by identifying a previously unexplored mechanism of sensory vividness, our findings contribute to the literature on visual imagery effects on information processing and persuasion (Collins et al., 1988; Jia et al., 2017; Petrova and Cialdini, 2005).

6.2. Practical implications

Our findings have important marketing implications for online shopping environments and user interface when designing the visual layout of retail webpages. 360-degree rotatable images are often presented in multitasking media environments. Given that online shoppers are often mentally busy with multitasking activities, digital retailers should be cautious about using rotatable images when the website is cluttered with distracting elements, such as additional call-to-action messages, banner ads, and large navigations on product pages.

When retail website space is viewed as more complex with payment options, product information, promotional coupons, and pop-up/banner ads, displaying static images might more easily gain consumer attention than 360-degree rotatable images, thereby leading to higher conversion rates. Digital retailers who consider integrating 360-degree rotatable images into their websites need to provide clear product descriptions, call-to-action messages, an easy checkout process, and a simple navigation menu to minimize cognitive busyness. In this regard, website designers and digital retailers can enhance the online shopping experience by implementing proper product display technology and optimizing website design and functionality.

Importantly, digital retailers should be mindful that sensory vividness can enhance virtual shopping experiences. Given that digital visualization technology offers new ways to create pseudo-realistic product-buying experiences, practitioners should strategically use vivid imagery and rich sensory information when implementing 360-degree rotatable images in immersive virtual environments. A fruitful avenue for future research would be to examine other emerging presentation formats in online and offline stores, such as augmented and virtual reality with haptic devices (e.g., Baek et al., 2018; Farah et al., 2019).

6.3. Limitations and directions for future research

Our study has limitations that open pathways to future research. First, our sample consisted of college students, a suitable population for testing theory (Baek and Reid, 2013), but their homogeneity might limit the generalizability of our results. Thus, scholars could enhance external validity by replicating our findings using non-student samples with a broader demographic spectrum. Another limitation is that we conducted three studies in a controlled lab setting to maximize control over extraneous factors. Thus, scholars should consider replicating our findings in a field setting to enhance generalizability. Scholars might replicate our results across various product characteristics (e.g., hedonic vs. utilitarian consumption, high vs. low purchase involvement, and search vs. experience goods). Finally, we examined sensory vividness to account for the effect of virtual product presentation and cognitive busyness. Exploring other potential factors (e.g., telepresence and interactivity) in relation with the vividness of mental imagery could be a promising path for future research (Coyle and Thorson, 2001; Schlosser, 2003).

7. Conclusion

360-degree rotatable product images are commonly used by retail websites to enhance the virtual shopping experience. We found that 360-degree rotatable product images were superior to static product images but that the former strategy could backfire when consumers are cognitively busy. We also shed light on the relationship between vividness and cognitive busyness in 3D virtual environments. To our knowledge, the current study is the first to show that sensory vividness can strongly shape product evaluation for consumers who interact with 360-degree rotatable (vs. static) images. Our findings should encourage further research in the field of retailing. Studying emerging virtual display technologies should help advance the theoretical and practical understanding of cognitive busyness and sensory vividness in the retailing context.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jretconser.2020.102062.

Appendix

Snapshot of 360-degree rotatable viewing stimulus in Studies 1, 2, and 3.


View 360°


View 360°

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