

Haptic Sensory Perception and Customer Experience in a 360-Virtual Store: Does Time Spent Play a Role?

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Abstract

Building on stimulus(S)-organism(O)-response(R) theory, this research examines the effects of haptic sensory perception on user experience and satisfaction in a 360-virtual store. We postulate that time spent in a 360-virtual store reinforces the effects in the S-O-R model. The results support the theory that haptic sensory perception triggered by a 360-virtual store (stimulus) improves customer experience (organism) and that the experience further enhances virtual store satisfaction (response). We find that the time spent in a virtual store reinforces the former effect, but not the latter effect. The results of an experiment involving 587 respondents further suggest that this finding only holds true to users who are merely browsing, but not to users tasked with searching for a specific product in the 360-virtual store. We encourage management to create sensory cues in virtual stores to improve user experience and satisfaction, and virtual in-store stimuli to increase time spent in the store.

1. Introduction

With the boom of global e-commerce, online shopping platforms have become vital tools for increasing sales volumes. In 2020, global online retail sales reached 4.28 trillion US dollars, and are projected to grow to 5.4 trillion US dollars in 2022 [1]. The COVID-19 pandemic has further accelerated e-commerce and the trend is expected to continue [2].

Despite the convenience of spatial and temporal freedom in shopping, e-commerce currently lacks important sensory cues available in brick-and-mortar stores. The current lack of true multisensory interaction

is, indeed, a missed opportunity in online retailing [3]. Therefore, this study examines: how haptic sensory perception in a 360-virtual store influences customer's shopping experience and how time spent in a virtual store moderates this effect? While at a brick-and-mortar store consumers can physically observe, touch, and smell the product, the current technology limits these sensory experiences in an online environment. Buying in an online store instead of a regular store poses a greater risk to consumers because the products cannot be observed concretely, leading to unsuccessful online transactions and a decrease in satisfaction [4][5].

Online shopping inevitably diminishes consumer sensory experiences, and the haptic experience especially. Haptic experience is an indispensable part of the shopping process [6,7,8], and the lack of touch may cause frustration among consumers [6]. To retain consumers and improve satisfaction, some online retailers adopt a combination of text, 3D images, music, and other technologies to compensate for the loss of haptic experience [3]. Reality-enhancing technologies, such as 360-virtual stores, enable greater interactivity and liveliness in online and virtual environments than conventional e-commerce [9,10]. 360-virtual stores adopt real scene virtual reality technology based on panoramic images to create a retail environment that is as authentic to the real shopping experience as possible. Compared to traditional online stores, 360-virtual stores typically mimic real brick-and-mortar stores, and they, therefore, provide more immersive and realistic shopping experiences for consumers [11,12]. For example, consumers can tour around in an interactive 360-virtual store, view detailed attributes of products through 360-degree rotation, and zooming in and out to inspect the material. Indeed, the 360-virtual store helps consumers feel physically present, albeit in a virtual environment.

Despite the advantages that 360-virtual stores offer to customers, current academic research on virtual reality focuses primarily on technology. Therefore, in this study we focus on customer experience in a 360-virtual store and examine how visually observed haptic sensory perception in a 360-virtual store affects shopping experience and how it further enhances virtual store satisfaction. In an experiment we objectively recorded the time consumers spent in a 360-virtual store, and we further postulate that the time spent reinforces the above effects, as consumers are likely to get immersed in a 360-virtual store. Following Schlosser [13], we study two groups of users, those who are merely browsing in a virtual store for entertainment and those who are using the virtual store in a goal-oriented search for a specific product. We expect that the objective to search or browse has an impact on the role of time spent in a 360-virtual store. We use the Stimulus-Organism-Response (S-O-R) theory to provide the framework for the study.

2. Literature review and hypotheses development

2.1. Stimulus-organism-response theory

Mehrabian and Russell initially proposed the Stimulus-Organism-Response (S-O-R) theory for elaborating relationships between the environment and human behavior [14]. The model explains that external influences (Stimuli) affect the emotional and cognitive condition of individuals (Organism), prompting certain behavioral results (Response) [15]. Scholars have widely applied S-O-R theory to study in-store shopping environments and consumer behavior both in traditional and online store settings [14,16,17,18].

The earlier research finds that online shopping provides different environmental cues from conventional brick-and-mortar shopping: the former lacks environmental characteristics, such as haptic cues, olfactory cues, and social cues, while it tends to emphasize on verbal and pictorial cues [19,20]. Eroglu, Machleit, and Davis [19] illustrated that although many sensory cues are missing, online shops can provide a unique atmosphere that will affect consumers' reactions by manipulating limited sensory stimulus that can produce affective reactions in site visitors. In their model, they propose that online environment cues influence affective and cognitive internal states, which then leads to approach or avoidance responses.

In traditional S-O-R paradigm, approach or avoidance are generally considered as the behavioral response. Some studies have extended the S-O-R model by studying new response variables, such as

customer satisfaction and purchase intention [18,19,21], to widen the scope of reactions affective experiential state causes. For example, Eroglu et al. [19] include satisfaction as an example of approach behavior in their S-O-R model of consumer response to online shopping. Silva et al. [22] discover that haptic imagery has a positive influence on the perceived product quality and purchase intention. Ha and Im [21] established a model of satisfaction in a retail shopping context and integrated it with the S-O-R model, results of their study showing that affect and cognition are independent contributors to customer satisfaction. In our study, haptic sensory perception, which is triggered by the 360-virtual store environment, represents the stimuli (S), affective experiential state refers to the organism (O), and virtual store satisfaction is the response (R).

2.2. Stimulus – haptic sensory perception

The importance of haptics has been recognized for centuries [23]. As the primary source of input to the perceptual system of human beings, it assists individuals in acquiring information, manipulates the environment and plays a crucial role in emotion perception [24,25]. In marketing research, haptic sense often shapes the consumer perception and behavior [23]. For example, Mooy and Robben [26], and Peck and Childers [6] show that touch has a vital influence on the product evaluation. Peck and Childers [6] further prove that touch effectively enhances the consumer purchase experience and leads to greater confidence in the product judgment.

However, haptic stimuli are more challenging in the online environment. Therefore, extending the positive impact of haptics to online stores has recently attracted increasing attention among researchers. Some scholars examine whether it is possible to compensate for or replace the sense of touch that consumers lack in the online environment [6,27,28]. McCabe and Nowlis [28] draw a conclusion that when the touch properties are described verbally, the difference in preference is reduced between shopping in a physical store versus in an online store. Peck and Childers [6] and Rodrigues et al. [29] report parallel results. They find that using an accurate written, visual, or verbal description to illustrate the product characteristics compensates for the lack of touch. Peck, Barger and Webb [30] further discover that perceived touch, that is imagining touching an object, could produce effects similar to actual touch. The more vivid the haptic imagery, the greater the perception of control and the feeling of ownership. Their experiment suggests that imagined touch could serve as a surrogate for touching an object.

The 360 virtual store allows consumers to view products closer and farther, rotate products, take a closer look at materials used, and include other features that allow consumers to visually view such product features, usually obtained from a physical store by touching products with hands. This triggers a haptic sensory perception that this study considers a stimulus.

In an online shopping, consumers cannot directly touch products, to feel the texture, and test the quality of the product, but simulating sensory elements to allow consumers to form a virtual sense of products will help consumers make purchase-related decisions [30,31]. We refer to such an experience as a virtual touch, which means that consumers get a virtual haptic experience of products through technologies [32,33].

2.3. Organism – affective experiential state

According to the S–O–R theory, the organism (O) refers to an individual's feelings and emotions responding to the stimulus. This experiential state intervenes the relationship between environmental stimulus and consumer behavior [14]. In online commerce, shoppers receive a wide range of sensory stimulus from e-retailer websites such as visual images, banners, text-based information, video, or audio delivery. Consumers interpret these data to form an impression of the e-retailer websites [34].

Eroglu, Machleit, and Davis [19] hypothesize that online environmental stimuli (S) are comprised of high task relevant cues and low task relevant cues. High task relevant cues include site descriptors which appear on the screen, to facilitate and enable a visitor's shopping goal attainment (e.g., descriptions of products, return policy, navigation aids, or delivery). Whereas low task-relevant cues are information that is inconsequential for completing the shopping task (e.g., animation, fonts, background music, and other items for decorative purpose). Those online environmental cues are proposed to trigger the internal states of consumers and to increase the experiential or hedonic value of shopping [19].

Many studies highlight the influence of sensory-enabling technologies on online experiences. Li et al. [35] prove that a 3D environment provides a greater level of enjoyment than physical and 2D environments. Eroglu et al. [19] find that online stimulus has a significant influence on individual's mood states, along with satisfaction, attitudes, and approach/avoidance behaviors. Peck and Childers [6] discover that haptically motivated consumers experience frustration when they cannot touch the product. Rantala, et al. [36] also discover that different touch gestures can lead to different emotional results.

Given that the sense of touch provides a powerful way of eliciting and modulating human emotion, it also seems realistic that computer-mediated touch has the potential for evoking the affective experiential state of humans [31]. Therefore, we hypothesize:

H1: The greater the level of haptic sensory perception in a virtual store, the greater the level of the affective experiential state.

2.4. Response – virtual store satisfaction

Oliver defined satisfaction as the perception of happiness and fulfillment when the retailer performance reaches or exceeds consumer expectations [37]. The topic of consumer satisfaction has long been of great attention to marketers. To some degree, this interest is driven by the notion that customer satisfaction can bring long-term benefits, including increased customer loyalty and profitability [38,39,40].

Satisfaction in online shopping results from consumers' evaluation and impression of the website performance across a diverse number of attributes [18,41,42]. Previous research shows that consumption experience plays a significant role in predicting customer satisfaction [34,43]. In their study on customer experience, Mattila and Wirtz [44] demonstrate that satisfaction is closely related to consumers' affective reaction. Rose et al. [34] find that affective experiential state has a highly significant effect on online shopping satisfaction. Im and Ha [21] discover comparable results and add that not only emotions but also cognition induced by environmental cues influence customer satisfaction. Thus, we hypothesize:

H2: The greater the level of the affective experiential state, the greater the level of virtual store satisfaction.

2.5. Time spent in the virtual store

The earlier research conducted in physical brick-and-mortar stores suggests that in-store stimuli, such as store atmosphere, and the experienced pleasantness of the in-store environment positively relates to the time spent in the store [43,45,46]. Kim and Eastin [47] report that hedonic shopping motivations have a positive effect on pre-purchase browsing time in online stores. However, it remains unclear whether this holds when consumers shop in 360-virtual stores, as overall, studies on the impact of shopping time are scarce in the existing online shopping literature. Among the few studies that exist, Zhao, Ham and van der Vlist [48]

report that consumers tend to spend more time and money in a VR shop when they were touched by a virtual shop assistant. Assuming that the time spent in a 360-virtual store gives the consumer better opportunities for sensory perception, we test if the time spent moderates the effects of the stimuli on organism and organism on response. It is generally considered that the time a consumer spends in a store may be an important determinant for increased purchase volume. We, therefore, hypothesize that:

H3a: The time spent in the virtual store strengthens the positive effect of haptic sensory perception on the affective experiential state.

H3b: The time spent in the virtual store strengthens the positive effect of the affective experiential state on virtual store satisfaction.

2.6. Browsers vs. searchers

Schlosser [13] suggest that consumers experience products differently in the online environment depending on whether their objective is to browse or to search. Browsing refers to individuals looking for entertainment in the virtual environment, while search behavior is motivated by consumers' information needs to fulfill a specific goal. Searching behavior is purposive and task-specific behavior by its very nature, in comparison to browsing which tends to be recreational behavior [49]. For browsers, shopping represents a hedonic activity, because spending time and interacting with products satisfies their need of pleasure-seeking [50]. The longer a consumer browses through a retail store, the greater the chances that one will acquire a larger number of products and end up consuming more dollars. This is likely the case both in a brick-and-mortar store and in the online environment. For searchers, shopping represents a goal-oriented activity [50], as they are more interested in completing the task efficiently and on time [51]. They are more

likely to follow the shopping list and get in and out of the shop as quickly as possible.

Hence, in the online environment, the shopping experience is likely to differ depending on whether the consumer is browsing for entertainment or searching to find useful information [13]. Scholars discovered that online users who seek hedonic benefits were less concerned with the time they spent [51], while people seeking utilitarian benefits are unlikely to want to engage in time-consuming activities [51,52]. It is reasonable to believe that the task-specificity of individuals in a virtual store determines the role the time spent has on the affective experience of shopping. Based on this reasoning we assume that time spent in a virtual store reinforces the relationships between stimulus, organism, and response among individuals who are browsing in the store without a specific task. However, we assume that the time spent does not change the shopping experience among individuals having a goal-oriented task to find information or a specific product in the virtual environment. Consequently, we hypothesize:

H4a: The time spent in the virtual store strengthens the positive effect of haptic sensory perception on the affective experiential state only among browsers, but not among searchers.

H4b: The time spent in the virtual store only strengthens the positive effect of affective experiential state on virtual store satisfaction among browsers, but not among searchers.

Figure 1 illustrates the conceptual model and the hypotheses of the study.

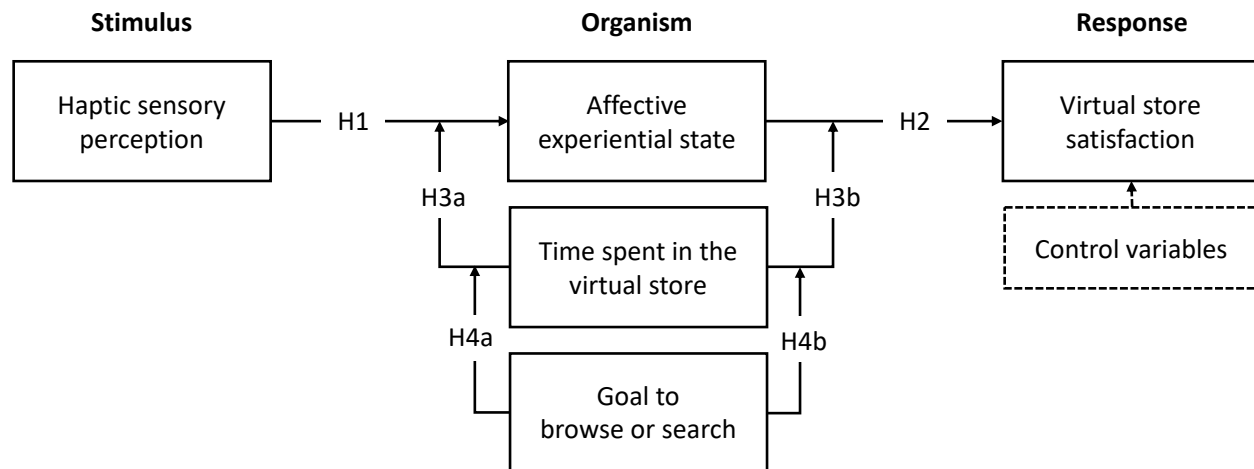


Figure 1. Conceptual model and hypotheses

3. Data and methods

3.1. Questionnaire and data collection

We used an independent commercial market research company to collect the data for this study. The online experiment began with participants filling out their demographic information. Thereafter the respondents were instructed to perform either a browsing or searching task in the BoConcept 360 virtual store: (<https://www.boconcept.com/en-gb/inspiration/virtual-store-visit>). BoConcept is a Danish furniture retailer and 360 virtual store mimics their store in UK.

We assigned a browsing task for group 1 (browsers) and requested the participants to spend a minimum of 3 minutes in the virtual store exploring and touring the store at their own pace. For group 2 (searchers), we assigned a searching task in which we instructed the respondents to similarly spend a minimum of 3 minutes in the virtual store and find a specific product in the virtual store. We recorded the time each respondent spent in the virtual store. This generated a decimal minute measure that we used as an interaction term called time spent in the S-O-R model. The respondents spent 5.5 minutes, on average, in the virtual store. After the experiment task, we assigned an online questionnaire to each participant, with questionnaire items measuring their virtual shopping experience.

We adopted a four-item haptic sensory perception scale from Haase and Wiedman [53] and a three-item scale of affective experiential state from Rose et al. [34]. We use a five-point Likert scale, ranging from 1

= *Strongly disagree* to 5 = *Strongly agree* to measure haptic sensory perception and a seven-point semantic differential scale to measure the affective experiential state. Virtual store satisfaction is a single item measure, using a seven-point scale ranging from 1 = *Unsatisfied* to 7 = *Satisfied*.

We control for the effects of age (continuous variable), gender (1 = male and 2 = female), and respondent's previous experience of 360-virtual shopping (0 = No and 1 = Yes) in the model. The sample consists of a total of 587 valid responses.

3.2. Construct validation

A confirmatory factor analysis with haptic sensory perception and affective experiential state indicated that the measurement is adequate in terms of goodness-of-fit indices ($\chi^2(13)=43.048$, $p<0.001$, CFI=0.989, RMSEA=0.061). The factor loadings were all significant and greater than 0.681 and the model indicated no concerns in terms of convergent or discriminant validity (Table 1).

4. Results

We used structural equation modeling in Mplus 8.2 with MLR estimator to test the hypotheses. The results of the structural model (n=587 responses) show that haptic sensory perception has a highly significant positive effect on the affective experiential state ($\beta=0.751$; $p<0.001$), supporting H1 (Figure 2). Further, the affective experiential state has a highly significant positive effect on virtual shopping satisfaction ($\beta=0.762$; $p<0.001$), lending support to H2. To better understand relationships between study variables, we

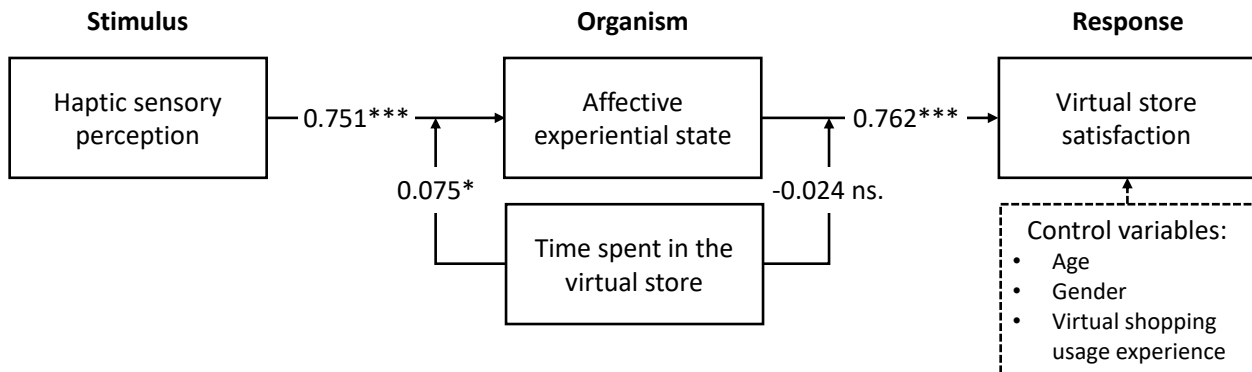
performed a post hoc analysis to explore whether affective experiential state represents a true mediator between haptic sensory perception and shopping satisfaction. Haptic sensory perception has a complementary mediation effect on shopping satisfaction. Thus, both a direct and a mediated positive effect exists between the constructs, and both point in the same direction [54].

The results also support hypothesis H3a as the interaction effect (haptic x time) is statistically significant with a 90 percent confidence level ($\beta=0.075$; $p=0.060$). However, the results do not

support H3b as the interaction effect of time is statistically non-significant on the path between the affective experiential state and virtual shopping satisfaction ($\beta=-0.024$; $p<0.363$). A look at the control variables shows that the effect of age is statistically non-significant ($\beta=-0.011$; $p<0.675$), but both gender ($\beta=-0.070$; $p<0.005$) and virtual shopping usage experience ($\beta=0.066$; $p<0.018$) have statistically significant effects on virtual shopping satisfaction. This indicates that virtual store satisfaction is greater among males than females, and among those with previous experience of virtual shopping.

Table 1. Construct validation

Measurement items	Std. loading	AVE	CR
Haptic sensory perception (Haase & Wiedmann, 2018)		0.641	0.876
1. Comfortable	0.883		
2. Handy	0.827		
3. Soothing	0.794		
4. Well-shaped	0.686		
Affective experiential state (Rose et al., 2012)		0.701	0.875
1. Unhappy – Happy	0.829		
2. Melancholic – Contented	0.834		
3. Annoyed – Pleased	0.848		



Note: *** = $p<0.01$; ** = $p<0.05$; * = $p<0.10$; ns = not statistically significant

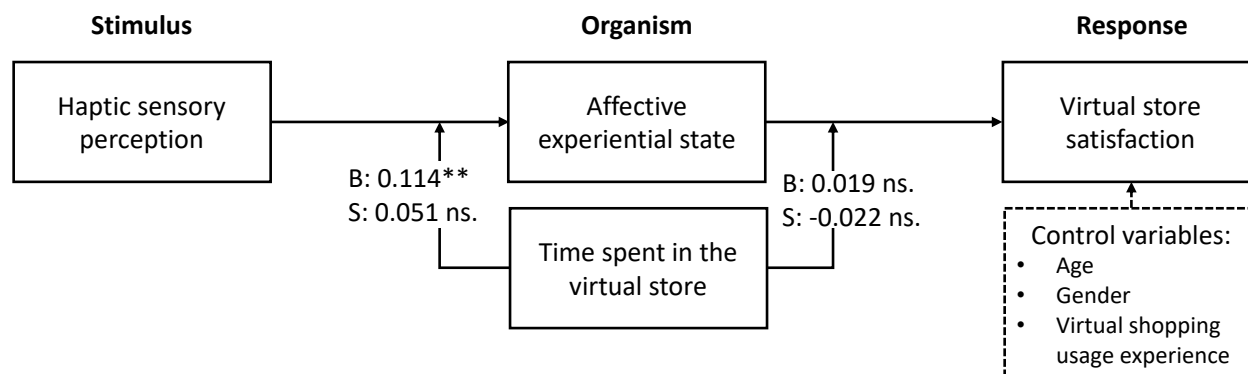
Figure 2. Results of the main and interaction effects

For the purposes of testing H4a and H4b, we created a multigroup moderation model to explore how time spent in the virtual store influences the virtual shopping experience between those who were just browsing in the virtual store (Browsers $n=293$), in comparison to those who were assigned a task to search for a specific product in the virtual store (Searchers $n=294$).

The results show that the time spent in the virtual store differs notably between the two groups on the path between haptic sensory perception and affective experiential state. The interaction effect of time spent in the virtual store is positive and statistically

significant for those who were just browsing in the virtual store ($\beta=0.114$; $p=0.028$), while the effect is statistically non-significant for those who were searching for a specific product in the virtual store ($\beta=0.051$; $p>0.10$). This supports our hypothesis H4a.

The interaction effect of time spent in the virtual store on the path between affective experiential state and virtual shopping satisfaction is statistically non-significant for both Browsers ($\beta=0.019$; $p>0.10$) and Searchers ($\beta=-0.022$; $p>0.10$), and does not notably differ between the groups. This result rejects our hypothesis H4b (Figure 3).



Note: *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$; ns. = not significant

Figure 3. Results of the multigroup moderation

5. Conclusions

Grounded on the Stimulus-Organism-Response (S-O-R) framework [14], this study demonstrates that visually observed haptic sensory perception in a 360-virtual store influences the shopping experience of a consumer, and the experience enhances virtual store satisfaction. Compared to “conventional” online environments, a 360-virtual shopping environment can provide consumers with a greater level of the feeling of being physically present, and, therefore, we expect that the time spent in the virtual store is likely to strengthen consumer experience in the virtual store. Therefore, we analyze whether the time spent in a virtual store shapes the effects in the S-O-R model and whether the interaction is different across browsers and goal-oriented searchers. Our results demonstrate that, indeed, the time spent in the virtual store plays a role. However, the role of time spent differs based on the objective of using the 360-virtual store for shopping, that is, whether consumers browse the store for entertainment or have a goal-oriented task to find a specific product in the virtual store [13]. The results suggest that the time spent in the virtual store only strengthens the influence of haptic sensory perception on the affective experiential state among consumers who are merely browsing, but not among consumers who visit the virtual store for a goal-oriented purpose, such as looking for a specific product. This finding corroborates the prior findings of Schlosser [13].

This study makes several contributions to the scholarly literature on the consumer shopping experience in a 360-virtual shopping environment. 360-shopping environments are still quite uncommon, but they are expected to become ever popular in the near future [3]. 360-virtual reality has already become

more common in, for example, promoting tourism destinations [55] and advertising real estate properties [56]. In the context of real-estate properties, Pleyers and Poncin [56] show that a customer visit in a 360-virtual environment results a better visiting experience and more positive attitude toward both the products and the provider. Similarly, in promoting tourism destinations, Rahimizian et al. [57] find 360-degree videos to be a beneficial tool in promoting consumers attitudes and behavioral intentions. Consistent to this, we believe that 360-virtual shopping environment opens similar possibilities in terms of promoting the shopping experience of consumers in online shopping. 360-virtual stores, thus, have high potential for online retailers, and it is imperative to learn more about consumer behavior in such environments.

Indeed, 360-virtual reality enables opportunities for online retailers in terms of offering consumers with a more immersive and realistic online shopping environment. This, according to our findings results in an enhanced shopping experience for consumers and leads to a greater customer satisfaction. Previous studies conducted among video game players evince that immersion generated by video games influences consumers’ psychological perception of time passing [58]. This is likely to hold also in other environments that evoke immersion and the feeling of “being there”, such as 360-virtual shopping environments. 360 virtual shopping environment results in a more realistic feeling of shopping compared to traditional online stores. This can make consumers to lose their sense of time passing and thus, consumers are likely to spend more time in a 360-virtual store when it mimics a real store environment and provides interactive elements for consumers to engage with. Time spent in a 360-virtual store, according to our findings, strengthens the influence that haptic sensory perception has on

affective experiential state particularly among the group that was just browsing the 360-virtual store, but not among goal-oriented searchers. Managerially this relation between time spent and haptic perception is important as prior research shows that consumers who like using touch more also have a higher tendency for impulse purchasing [59]. More time spent inside the virtual store together with haptic cues offers more opportunities for consumers to make impulse purchases.

Prior studies have mainly compared 360-virtual environments with other media [60], such as static photos [56]. We add to this discussion by showing that differences exist in the customer experience, depending on the fundamental objective, why consumers are involved in 360-virtual shopping environments. We, thus, demonstrate that the objective of consumers to either browse or search in a virtual store has an impact on the customer experience. Compared to traditional online shopping environment, 360-virtual environment mimics “real” shopping environment, and consumers can experience the products in their real shopping surroundings. Additionally, consumers can view the products from closer and farther, and from different perspectives and angles, which reinforces their haptic appeal albeit in the virtual environment. Indeed, recent studies evince, that consumers are capable to transfer a sensory experience from one sensory modality to another, and thus visual and haptic appeal reinforce each other [61]. Recent research has explored alternative means to compensate and overcome the lack of touch online [62], and 360-virtual reality enables one potential avenue in this respect, while waiting virtual touch related technologies, such as virtual haptic gloves to popularize.

As the time spent in the virtual store appears to play a role in generating positive customer experiences, especially for those who are just browsing in the store, we encourage marketers to design in-store stimuli to attract consumers to stay longer at the store.

6. Limitation and future research

As with all research, this study has limitations that need some consideration, which we address here and provide some suggestions for future research avenues. This study was conducted in a 360-virtual store which is more interactive compared to a conventional online store, however, we suggest future studies to explore customer shopping experience using a wider range of AR and VR applications, to better understand how haptic sensory perception triggered by such environments impacts consumer’s virtual shopping experience. This study was conducted under

uncontrolled conditions in a real 360-virtual store, which could affect the results due to, for example, the different devices the respondents used. That provides a fruitful avenue for future research to explore haptic sensory perception of a virtual store using different devices (e.g., mobile vs. laptop). Regarding limitations of this study, it is noteworthy that hypothesis H3a only gets supported at 90 percent confidence level, which we believe is due to the fact that “time spent” is an objective measure in the study. Objective measures generally provide poorer statistical significances, and we therefore recommend future research to take a more detailed look at this interaction effect following, for example, the recommendations provided by Kingsley et al. [63]

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