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Submission date: 08-Aug-2022 11:24AM (UTC+0700)
Submission ID: 1880099207
File name: V17I07A104-H6X7MEmWxyBVKON.pdf (509.77K)
Word count: 6429
Character count: 34930

The Seybold Report

ISSN 1533-9211

DOI 10.5281/zenodo.6938668

VIRTUAL REALITY IN CONSUMER BEHAVIOR IN PURCHASE DECISIONS DURING THE COVID-19 PANDEMIC; LITERATURE REVIEW

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Abstract

Background: The development of virtual reality (VR) technology has the potential to provide great opportunities for food research and consumer behavior during the COVID-19 pandemic to explore current research methodologies further and build new ones. VR is different from the environment we experience in everyday life. Therefore, the extent to which VR can be applied in research on food consumer behavior during the COVID-19 pandemic needs to be assessed based on the evidence provided by VR research. Key findings: VR has been used to construct complex and realistic contextual environments for conducting food sensory evaluation research. VR is also being used as a surrogate (VR Traditional Markets and supermarkets) in real-life settings to investigate consumer buying behavior and food choices during the Covid 19 pandemic. Virtual food and food-related cues are used to induce psychological and physiological responses in consumers. The results support the validity of VR as a tool to investigate consumer behavior towards food during the COVID-19 pandemic. Approach: To better understand VR technology and its potential applications and limitations in food research and consumer behavior during the COVID-19 pandemic, we conducted a systematic review of the literature on VR in food research and consumer behavior. The VR applications discussed in the article are reviewed based on several existing literature sources. The validity of VR for food research and consumer behavior is analyzed.

Keywords: Virtual reality, Food consumer behavior, Sensory evaluation, Eating behavior, Applications, Limitations.

1. INTRODUCTION

Technology can make it easier to carry out interaction activities in a virtual world that is simulated by technology applications, and this is the notion of Virtual Reality (VR). With VR, users feel more visible in the environment. VR is also defined as "a digital environment that is the result of applications that can interact with the environment and as if they were in the real world" (Jerald, 2015, p. 9). The application of VR has attracted the attention of many parties, such as the entertainment industry (video games, et cetera.) and has also made scientific researchers interested in VR. VR is also applied in consumer behavior research in food and beverage purchasing decisions to be used as data for research sampling activities (Hartmann & Siegrist, 2019). The limitations of VR testing are that there are still manual methods (such as data collection in the field and the laboratory), examples such as monitoring methods that are not fully supervised, and the validity is also low (Xu, Demir-Kaymaz, Hartmann, Menozzi, & Siegrist, 2021). VR attracts researchers to conduct research activities on consumer behavior in making food and beverage purchasing decisions during the recent Covid 19 pandemic. VR is also used as a measuring tool for researchers in sampling how high consumers use it. Although VR provides many opportunities for the food and beverage industry, the sales environment is still limited, different from the sales we encounter on a daily basis in the field. So that the

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DOI 10.5281/zenodo.6938668

measurement of food and beverage sales using VR needs to be reviewed how valid it is in this study. Although several studies have provided evidence to support the validity of VR as a data collection tool for consumer behavior research (Pizzi, Scarpi, Pichierri, & Vannucci, 2019; Siegrist et al., 2019; Ung, Menozzi, Hartmann, & Siegrist, 2018; van Herpen, van den Broek, van Trijp, & Yu, 2016; Waterlander, Jiang, Steenhuis, & Ni Mhurchu, 2015; Xu et al., 2021), requires a comprehensive analysis based on systematically reviewed data. So far, no systematic review research has been found that focuses on answering the questions above. So the purpose of this study is to determine whether virtual reality influences consumer behavior in purchasing decisions during the Covid 19 pandemic by comparing several existing literature reviews. The objectives of this research are as follows: 1) to determine which research domains in food research and consumer behavior VR have been used and what types of VR systems are usually used in each research domain; 2) to investigate whether VR is a valid tool for food and consumer behavior research based on a comparison between VR settings and RL settings, and 3) to identify existing gaps in the literature and to inform future experimental and applied practices in the field of food and consumer behavior. The results of this systematic review study are of great importance to researchers and the food industry to obtain more information about the technology and use it in future research studies on product design and marketing research.

2. RESEARCH METHOD

2.1. Literature research

The search for some literature was carried out on the Web Science erect (database searching for several references to supporting research articles) and journals indexed by Scopus in July 2021. The search for some literature on VR was carried out as follows:

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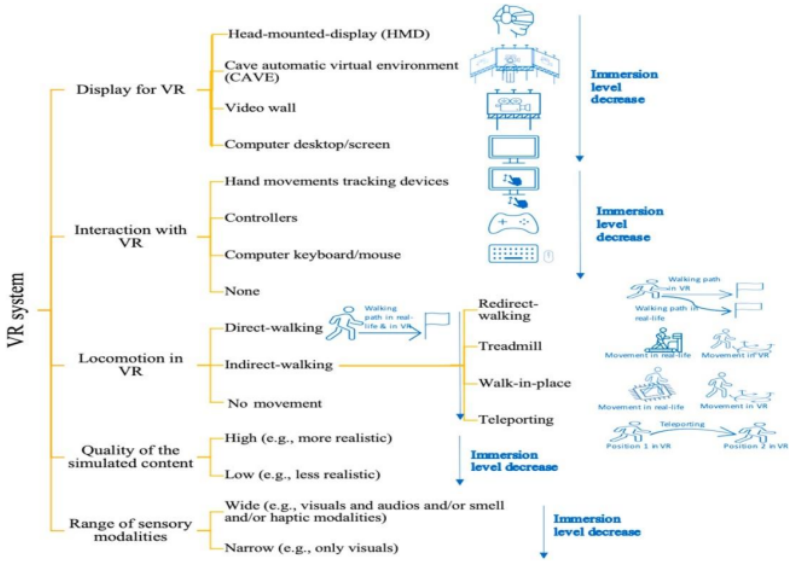

Picture 1: Design a virtual reality (VR) system that can provide different levels of immersion

Only review journal articles and conference proceedings are included. The search was limited to English-language research articles from 2005 to 2021. This date criterion was chosen because VR during the 1990s was still in the exploratory stage. Its application was mainly focused on professional research (e.g., simulated flight, military use) and entertainment. Moreover, VR-related research was not widely published in the first few years of the 21st century (Jerald, 2015).

3. RESULT AND DISCUSSION

There were 85 articles included in this systematic review, with publication dates ranging from 2005 to April 2021. The number of articles included was higher in subsequent years, and the majority of articles (91%) were published from 2015 to April 2021. A summary can be found on picture. 3. A relatively young sample is tested in the study. The mean age of the sample in most of the articles (n 45) was younger than 45 years. No articles were tested with samples older than 65 years (mean age), and only one study tested children (Karkar, Salahuddin, Almaadeed, Aljaam, & Halabi, 2018). The sex distribution of the sample was also examined. In general, the sample in most articles (n 63) included 50% or more female participants. There were 12 articles that tested only female participants. Several articles (n 9) had samples with more male participants. Among them, two articles only use male participants (Alkahtani, Eisa, Kannas, & Shamlan, 2019; Worch et al., 2020). An examination of the residence of the sample shows that most of the studies (n 41) recruited samples in European countries. Among them, samples from Spain and Italy were used the most, followed by Switzerland and the

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ISSN 1533-9211
DOI 10.5281/zenodo.6938668

Netherlands. Studies (n = 25) also frequently recruited samples from the United States. In addition, several studies also recruited samples from New Zealand, China, Australia, and Japan.

3.2. Research domain and test stimuli (food)

Each included article was examined for its research topic and domain based on its research objectives, questions, and interventions. Three main research domains were identified: 1) sensory evaluation of food products in VR; 2) exposure to and responses to virtual food or food-related cues and environments; and 3) consumer behavior towards food in a VR setting. The third research domain can be further classified into the following categories: 1) shopping behavior and product perception in a VR supermarket setting; 2) food choices in a VR buffet setting; and 3) other applications.

3.2.1. Application of VR in studying food sensory evaluation

This research domain accounted for 24% of the articles included. Studies in this research domain examine the application of VR in providing contextual information or environments. They compared participants' sensory evaluations of the same food stimuli in the test environment with or without contextual information (e.g., VR contextual environment, image contextual environment, RL contextual environment, and traditional sensory booth) (Bangcuyo et al., 2015; Hannum et al., 2019; Hathaway & Simons, 2017; Kong et al., 2020; Oliver & Hollis, 2021; Pennanen, Na¨rva¨inen, Vanhatalo, Raisamo, & Sozer, 2020; Picket & Dando, 2019; Sinesio et al., 2019; Stelick, Penano, Riak, & Dando, 2018; (Torrico et al., 2020; Torrico et al., 2021)). Bangcuyo et al. (2015) showed that participants felt significantly more engaged and immersed in a virtual environment with contextual information than in a traditional sensory cubicle. The study also found that different contexts elicit different emotions associated with the evaluated food product (Kong et al., 2020; Torrico et al., 2020, 2021). The results of several studies also acknowledge that context does influence the evaluation of some products, such as wine, coffee, and snacks (Bangcuyo et al., 2015; Barbosa Escobar, Petit, & Velasco, 2021; Chen, Huang, Faber, Makran-sky, & Perez-Cueto, 2020; Hathaway & Simons, 2017; Nivedhan, Mielby, & Wang, 2020; Torrico et al., 2020). However, the magnitude of the impact of VR depends on the product being examined and the properties being evaluated. For example, changing the evaluation environment may change perceptions but not necessarily acceptance of a wine sample (Torrico et al., 2020).

Another study investigated the impact of manipulating the sensory characteristics of food on the evaluation and perception of food. Three studies investigated the impact of VR-based beverage color simulations (i.e., tea, coffee, and juice) on the sensory evaluation of beverages (Ammann, Stucki, & Siegrist, 2020; Huang, Huang, & Wan, 2019; Wang, Meyer, Waters, & Zendle). 2020). Ammann, Stucki, and Siegrist (2020) showed that participants had more difficulty identifying the taste of a product when it was served in a modified color from the original. Wang et al. (2020) suggest that viewing a simulated coffee's color in VR affects the perceived creaminess but not sweetness or liking. Huang et al. (2019) found that simulated actual tea color did not affect taste ratings but that the color participants associated with tea taste did influence their tea saltiness ratings. A study by Huang and colleagues examined the

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DOI 10.5281/zenodo.6938668

effect of the color-taste mismatch of potato chip packaging on product experience and brand perception (Huang & Wan, 2019). They also explored individual differences in reactions to color-taste mismatches (Huang, Zhao, & Wan, 2021). The researchers found that participants were less likely to like a food product if the packaging color did not match the taste label, even though the brand, in that case, was perceived as more innovative. Sugita, Zempo, Mizutani, and Wakatsuki (2017) investigated whether chromatic gradient color transitions from homemade fizzing candy via HMD would alter their impressions and evaluations. They found that impressions could be changed by changing the visual information (color) presented to participants. These studies show that manipulating the characteristics of a food product in VR can affect the perception and preference for the product.

3.3. Comparison between consumer behavior data collected in VR and RL settings

Each included article is vetted to determine what type of VR system is used. Generally, more than half of VR systems are HMD systems (n 48). Desktop VR systems (n 23) were exploited less frequently than HMD systems but more frequently than video wall systems (n 7) and CAVE systems (n 2). Some studies did not specifically describe or explain which VR system they used for their research (n 10). Some articles use more than one VR system; therefore, the total number of VR systems (n 90) is higher than the number of articles included (n 85). Studies examining the comparability of consumer behavior data collected in VR and RL settings are summarized in Table 2. Five studies compare VR simulation stores with physical stores or image simulation stores (Lombart et al., 2020; Pizzi et al., 2019; Siegrist et al., 2019; van Herpen et al., 2016; Waterlander et al., 2015). They all found that consumer behavior in VR simulated stores was highly comparable to consumer behavior in physical stores. Compared to image simulation stores, consumer behavior in VR stores is also closer to consumer behavior in RL (van Herpen et al., 2016). Four studies compared VR buffets to RL buffets or fake food buffets (Cheah et al., 2019; Cheah et al., 2020; Persky et al., 2018; Ung et al., 2018). The study shows that consumer food choices in the VR buffet and RL buffet, or in the VR buffet and fake food buffet, are highly correlated in the number of kilocalories, grams, carbohydrates, and protein they contain. They also found that participants exhibited similar brain activity when making food choices at the RL and VR buffet (Cheah et al., 2019). Two other studies compared consumer perceptions of the health of breakfast cereals or consumer sensory evaluations of lemon juice and cake in the VR and RL environments (Ammann, Stucki, & Siegrist, 2020; Xu et al., 2021). They found that consumer behavior data collected in the VR and RL environments were not statistically significant and that consumer behavior was highly comparable in the two environments.

4. DISCUSSION

4.1. VR and food sensory evaluation research

Based on the results of this systematic review, the application of VR in the sensory evaluation of food is mainly focused on: 1) the use of VR to provide contextual or environmental information for the sensory evaluation of food; and 2) studying the impact of simulated food color on perception and evaluation. One of the advantages of using VR in food sensory

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ISSN 1533-9211
DOI 10.5281/zenodo.6938668

evaluation research is that highly realistic contextual information can be designed and delivered in a fully controlled and standardized laboratory setting. In a VR contextual environment, participants feel like their buffet is drinking beer or coffee in a bar or coffee shop, for example, rather than conducting a scientific experiment. Meanwhile, environmental factors affecting RL learning outcomes can be controlled. Some disadvantages of traditional sensory booths (e.g., different tasting environments from real consumption contexts) can be mitigated.

Studies have also shown that the color of food or food packaging can be successfully simulated in VR to influence the perception and evaluation of food products and brands (Ammann, Stucki, & Siegrist, 2020; Huang et al., 2019; Huang et al., 2021; Huang & Wan). , 2019; Sugita et al., 2017; Wang et al., 2020). For simulating other sensory characteristics of food, such as taste and texture, VR may not be the right tool to use. Other technologies, such as adding flavor with electric sensors, can simulate food taste (Ranasinghe, Jain, Karwita, & Do, 2017). It will be interesting for future research to explore the potential of combining VR and these technologies and applying them to sensory evaluation research.

Highly immersive VR systems are mainly used in this research domain. Although the HMD system is the most frequently used, it may not be the best VR system for sensory evaluation studies. Due to the characteristics of the HMD system, participants were blinded to food samples served in RL. This situation may lead to difficulties in sampling and evaluating samples (Huang et al., 2019). Video wall systems may be a better choice for sensory evaluation studies because participants can be immersed in a contextual environment without being completely blinded by food samples served in the real world. However, HMD systems can be useful if participants can interact with the sample without actually seeing it. For example, a tracker can be used to map the position of a real food sample in RL to the position of its 3D model in VR. This way, participants can interact with real food samples by interacting with 3D models (Nivedhan et al., 2020; Wang et al., 2020).

4.2. VR and food consumer behavior research

Of the 85 articles reviewed, 34 investigated the application of VR to observe consumer shopping behavior and food choices in contextually informed environments of points of sale (i.e., shops or supermarkets) and places of consumption (i.e., buffets). As an innovative alternative to physical supermarkets and RL buffets, VR supermarkets and VR buffets are preferred, especially when examining variables that cannot be easily manipulated or controlled in traditional test environments such as food shape, packaging, color, and labels. , as well as environmental factors (Bigne´ et al., 2016; Blitstein et al., 2020; Goedegebure et al., 2020; Liu et al., 2017; Lombart et al., 2019, Lombart et al., 2020; Verhulst et al., ., 2017, Verhulst et al., 2018; Zhao et al., 2017). Another advantage of using VR in food consumer behavior studies is that methods such as nudging and pricing can be more time and cost-efficient to implement in VR supermarkets and VR buffets than in RL settings (Blom et al., 2021; Hoenink et al., 2020). Meanwhile, the computer generates the virtual environment; thus, the same experimental environment can be ensured as long as the same VR system and hardware are provided. Therefore, the same experiment can be carried out in different places with participants from different cultural or ethnic backgrounds. This may be advantageous, for example, for

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ISSN 1533-9211
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multinational companies. Food development and marketing strategies can be formulated according to consumers' specific preferences in a particular market.

However, using VR for food consumer behavior research also has some limitations. First, the virtual environment may lack some characteristics of the real food choice or consumption environment, such as the touch, weight, or smell of food and the presence of other people (Allman-Farinelli et al., 2019; Kuo et al., 2016; Lombart et al., 2019; Marcum et al., 2018; Persky et al., 2018). Therefore, the influence of these factors on consumer food choices and consumption may not be considered or investigated in most studies. Therefore, VR may not be the best tool to investigate consumers' actual food consumption patterns in RL. Second, the nature of VR implies that compared to the real world, participants may need more time to get to know the virtual environment before starting the experiment so that they will focus on the task itself rather than exploring a new and unfamiliar environment (Pizzi et al., 2019; Siegrist et al., 2019). ; Xu et al., 2021). Especially with VR systems with low immersion levels, the experience may be less natural and far from the RL experience.

4.3. VR exposure and response and food cues

Virtual food or food-related cues have been used to study exposure and response to food cues in the general population and patients with eating disorders. The studies reviewed showed that virtual food or food-related cues can successfully induce emotional reactions related to eating behavior in consumers (Ammann, Hartmann, et al., 2020; Ferrer-Garc, Gutierrez-Maldonado, & Pla, 2013; Ferrer-García, Guti errez-Maldonado et ., 2017; Ferrer-Garcia, Gutierrez-Maldonado, Treasure, & Vilalta-Abella, 2015; Gorini et al., 2010; Gutierrez-Maldonado et al., 2016; Gutierrez-Maldonado et al., 2006; Kuo et al. ., 2016; LedouX et al., 2013; Pla-Sanjuanelo et al., 2019; Tuanquin et al., 2018). However, studies have yielded inconsistent results on the extent to which VR cues are more effective than image cues, which are generally applied or recognized in studies investigating exposure to and responses to food cues (Gorini et al., 2010; LedouX et al., 2013; van der Waal et al., 2021). The possibility that image cues are effective enough may raise the question of why we need a more expensive VR system when images are just as effective. Although the effectiveness of virtual (vs. image) cues is debated, VR may be preferred over image cues because it has greater potential to provide contextual information regarding food. At the same time, compared to actual food cues, VR has the advantage of ensuring that participants will be exposed to the same food cues even at different times and locations. However, additional studies need to be conducted to explore whether VR cues are better than real food cues and images to suggest which cues to use in food cue exposure and response studies.

4.4. The gaps that exist in the literature and future studies

In addition, most of the VR systems or applications implemented in the reviewed studies provided consumers with only one sensory (i.e., visual) modality; some sensory modalities (e.g., olfactory, haptic, and auditory modalities) of food consumption or environmental selection in RL are lost. Future studies could investigate whether adding these sensory modalities to a VR environment will affect consumer behavior. In particular, the research could

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DOI 10.5281/zenodo.6938668

focus on understanding what level of sensory modality is sufficient for consumers to feel immersed and present in a VR environment and behave similarly to how they would behave in food consumption or RL selection environment. Studies can also investigate the impact of different modes of interaction and locomotion in VR systems on food study outcomes and consumer behavior. Meanwhile further studies are needed to help understand the impact of the immersion level of VR systems on consumer behavior, as inconsistent results on this topic have been found in the literature (Lombart et al., 2020; Peukert et al., 2019; Schnack et al., 2019). Finally, studies in sensory evaluation have provided support for the ability to apply VR to simulate food color (Ammann, Stucki, & Siegrist, 2020; Huang et al., 2019; Huang et al., 2021; Huang & Wan, 2019; Sugita et al., 2017; Wang et al., 2020). Given the significant results of food sensory evaluation studies, it would also be interesting to investigate the impact of simulating the visual characteristics of foods. (e.g., color, shape, and size) on food choices and shopping behavior. Future studies should also explore and use the full potential of combining VR systems with eye-tracking and other systems to investigate the relationship between neurophysiologic activity and attention and consumer behavior.

5. CONCLUSION

The current systematic review summarizes the latest scientific evidence regarding the application of VR in food and consumer behavior research to explore the validity of VR and the possibilities and limitations of using VR technology in this area of research. The results show that VR has been widely used in food research and consumer behavior. It has been used in research domains investigating sensory evaluation of food in VR contextual environments, food choices in VR buffets, shopping behavior and product perception in virtual simulated stores, and emotional and physical responses to virtual food or food-related cues or environments. Evidence suggests that VR is a valid tool for research investigating consumer behavior towards food. VR supermarkets and buffets can be used as innovative alternatives to RL tools. VR food cues can also successfully induce food-related emotional responses. However, more evidence may be needed to understand better whether VR food cues can always deliver better results than image cues. Based on the results of this paper, the authors recommend that future research should be carried out with a wider range of food categories. Additional studies investigating the comparability of consumer behavior in VR and RL would be welcome. Future studies may also focus on investigating the impact of providing more than just visual sensory modalities on the outcomes of food studies and consumer behavior.

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