

Opinion paper on climate change

Virtual technologies in supporting sustainable consumption: From a single-sensory stimulus to a multi-sensory experience

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ABSTRACT

Virtual technologies will change the way we consume in the digital environment in the future. Such technologies can provide consumers with a multi-sensory experience in contrast to the single-sensory stimulus in the conventional online environment. As human senses play a key role in consumption choices, we argue that virtual technologies provide greater opportunities to influence consumer decisions than the present digital environment. Consequently, we suggest that virtual technologies can potentially be used to nudge consumers towards sustainable consumption. We discuss technology-assisted sensory marketing, present the cognitive and emotive aspects of virtual reality, and propose applications of virtual reality technologies to encourage sustainable consumption. Our opinion paper concludes that virtual technologies are likely to change many aspects of human life and can have significant positive effects on the environment and climate change.

1. Introduction

It is nothing new that the production, processing, packaging, transport, and consumption of consumer goods require the use of natural resources and that they pollute the environment. Indeed, human consumption has a direct impact on the environment, but it is also a major force for change through consumption choices (e.g., Halder, Hansen, Kangas, & Laukkanen, 2020). The human senses play a key role in consumption choices (Biswas, 2019) and these sensations can influence decision-making unconsciously (Krishna & Schwarz, 2014). Consequently, retailers can nudge consumer decisions by altering sensory cues (Biswas, Szocs, Krishna, & Lehmann, 2014; van Kleef, Vrijhof, Polet, Vingerhoeds, & de Wijk, 2014) and have significant managerial implications (Biswas, 2019). In fact, the most pleasurable experiences in life involve the simultaneous stimulation of multiple senses (Krishna, 2012; Tynan & McKechnie, 2009). However, consumption today increasingly takes place in digital environments that are limited in providing sensory cues to consumers and in practice provide only single-sensory stimulus. Does this deficiency put our ability to influence consumer experiences and choices at risk?

Virtual reality (VR), is the main representative of emerging digital technologies and has shown its advantages at mimicking real-world

environments, providing lifelike multimodal and multisensory stimuli (Bonetti, Warnaby, & Quinn, 2018) and creating another new reality (Xi & Hamari, 2021). Multisensory technologies and sensory devices provide more opportunities for consumers to interact with digital objects in multiple ways, to receive sensory feedback, and communicate with others. Given that much sensory information regarding a product and the shopping environment can be substituted and re-created in virtual reality, VR will be able to affect consumer perception, judgment, and behavior in virtual environments, and create novel experiences (Xi & Hamari, 2021). Indeed, Gartner (2020) predicts that multisensory experiences will be among the most promising technological trends of the future.

As future consumers will increasingly make consumption decisions in virtual reality, it is critical to understand if and how virtual reality environments can power consumption decisions. However, the existing research on how consumers interact with immersive technologies is scarce (Labrecque, 2020) and the impact on the overall consumer experience is yet to be verified (Mishra, Shukla, Rana, & Dwivedi, 2021). Indeed, we do not currently know whether it is possible to influence consumers' consumption decisions and trigger product choices in a virtual environment using sensory cues. Let us assume this is possible. Let us be inspired by the sustainable development goal number 12 set by

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the United Nations (United Nations, 2015) calling to ensure sustainable consumption and production patterns. Recent research in a conventional retail store suggests that incidental exposure to nature-related sensory cues influences pro-environmental consumption choices (Esteky, 2021), but could we use virtual technologies to nudge consumers towards more sustainable consumption choices in the digital environment? In this paper we argue that emerging digital technologies in virtual reality can provide sensory stimuli that have the potential to reinforce sustainable consumption choices. By reviewing the existing literature related to sensory marketing and VR, we suggest potential interplay between multi-technological modalities (visual, olfactory, auditory, and haptic) in virtual reality which could lead to sustainable decisions, green choices, and prosocial behavior.

2. Sensory marketing and information technology

Sensory marketing seeks to understand and illuminate how consumers receive and perceive sensations through their senses. Thus, sensory marketing is centered on the five human senses of vision, taste, touch, smell, and hearing. According to Krishna (2010), sensory marketing is “marketing that engages the consumer’s senses and affects their perception, judgment, and behavior.” She continues, “Sensory marketing is an application of the understanding of sensation and perception to the field of marketing—to consumer perception, cognition, emotion, learning, preference, choice, or evaluation.”

Sensory marketing has traditionally focused on the consumer’s sensory reactions in physical surroundings (Hultén, 2011; Krishna, 2012), such as in grocery stores (e.g., Swahn, Mossberg, Öström, & Gustafsson, 2012) and restaurants (e.g., Castillo-Villar & Villasante-Arellano, 2020). Only quite recently, Petit, Velasco, and Spence (2019) introduced the concept of *digital sensory marketing*, in which they combine sensory marketing research with the theories and constructs that aim to understand human interaction with information technology. In brief, digital sensory marketing is the evolution of sensory marketing in the online environment (Petit, Cheok, Spence, Velasco, & Karunanayaka, 2015) and it explores how existing and novel technologies might help to stimulate customer experience through multisensory representation (Heller, Chylinski, de Ruyter, Mahr, & Keeling, 2019; Lv, Li, & Xia, 2020; Petit et al., 2015, 2019; Wedel, Bigné, & Zhang, 2020). The existing research on digital sensory marketing has mainly focused on audio-visual interaction, primarily because technologies and devices related to vision and audition are more well-established and widely available (Cornelio, Velasco, & Obrist, 2021) than technologies providing other sensory stimuli.

Sensory-enabling technologies include technologies and devices that are already considered to be the mainstream (Cornelio et al., 2021; Petit et al., 2019), but also technologies that are not yet widespread, but under rapid development (for a review see, e.g., Cornelio et al., 2021). Some of these emerging technologies include head-mounted displays, body-tracking sensors, motion-tracked controllers, haptic gloves, and other wearables (Xi & Hamari, 2021). The customer experience gained by interacting with these multisensory modalities in virtual reality is highly immersive creating a strong illusion of reality (Meißner, Pfeiffer, Peukert, Dietrich, & Pfeiffer, 2020). Table 1 presents selected studies on technology-assisted sensory marketing.

3. VR technologies and sustainable consumption

VR technologies especially the different sensory modalities which provide visual, audio, olfactory, and somatosensory stimuli (Fig. 1) are re-creating a new reality close to what we have in physical reality—i.e., being seamlessly present and immersed in our surroundings (Xi & Hamari, 2021) where all the human senses can be stimulated. The existing behaviors and ways of thinking can be retained while new paradigms have been created coming from the positive and negative effects of VR technologies on individuals. For several decades, research

Table 1
Selected studies on technology-assisted sensory marketing.

Article	Key findings
Baus and Bouchard (2017)	Sense of presence is higher when an unpleasant odor is used compared to pleasant odor.
Baus, Bouchard, and Nolet (2019)	Pleasant odours congruent with virtual environment produce higher levels of reality than unpleasant odours. However, the sense of presence or realism were unaffected.
Brasel and Gips (2014)	Touch screens increase perceived psychological ownership and touch-based devices increase product valuations when compared to computers. Interacting with products via touch screens increase user engagement in settings involving both visual rotation and tactile simulation.
Cano, Perry, Ashman, and Waite (2017)	VR HMD increase sensory stimulation compared to traditional PCs. Congruent pleasant scent together with VR HMD create even better sensory stimulation on the affective and conative images of a destination.
Flavián, Ibáñez-Sánchez, and Orús (2021)	Multisensory cues (visual and auditory) positively influence visitors’ emotional states and sense of presence enriching the visitor experience of a digital museum. The best visitor experience comes when visual and auditory cues are combined.
Guo, Fan, Lehto, and Day (2021)	Haptic cues (descriptive information provided by the company, as well as online reviews) increase the consumers’ willingness to book hotel rooms online.
Lv et al. (2020)	Vicarious product touch increases expected ease of use and purchase intention.
Pino et al. (2020)	Adding any sensory modality (olfactory or haptic) in a VR environment increases the sense of presence. Moreover, combining the sensory modalities in a VR experience increases the sense of presence even further.
Ranasinghe et al. (2018)	Auditory confirmation of successful payment transaction increases trust in the retailer and positively influences satisfaction and purchase intention.
Reynolds-McIlroy and Morrin (2019)	Mood-induction procedure in multisensory VR environment produces relaxation and presence. Levels of relaxation and sense of presence are higher when touch is stimulated.
Serrano, Baños, and Botella (2016)	Tactile priming together with ethically congruent visual and auditory cues increase consumers’ willingness-to-pay for an ethical brand.
Yoganathan, Osburg, and Akhtar (2019)	

on judgment and decision making has meandered between the rational (economic man/homo economicus) and irrational/emotional perspective (humanistic man). The main research stream tends to emphasize immersive, hedonic, and fantasy ‘experientiality’ in the virtual world such as enjoyment (Peukert, Pfeiffer, Meißner, Pfeiffer, & Weinhardt, 2019), novelty (Elor, Powell, Mahmood, Teodorescu, & Kurniawan, 2021), and vividness (Zeng, Cao, Lin, & Xiao, 2020), while the other stream focuses on the cognitive related aspects involving efficiency, and utilitarian performance, such as knowledge acquisition (Taçgin, 2020), information seeking (Lee, Lee, & Jeong, 2021), and cognitive functioning (Gamito et al., 2020).

3.1. Cognitive aspects of VR

Virtual reality has been postulated to reduce the total cost and difficulty of information processing, which is the core aspect of cognitive functioning. Naturalistic virtual environments have advantages in conducting cognitive interventions such as general cognition, executive functioning, attention, and memory (Gamito et al., 2020). Additionally, the sensory stimulus provided by digital modalities reduces the cost of information acquisition and consequently shortens the decision-making process (Suh & Lee, 2005), while the interactivity with information systems strengthens the consumer learning process and the

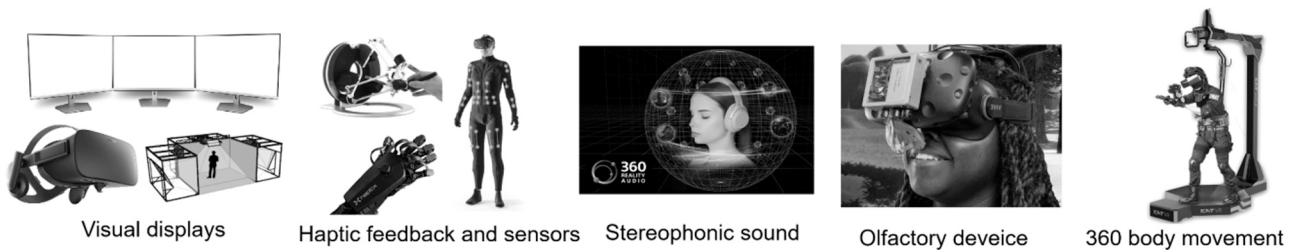


Fig. 1. Examples of existing multisensory technologies and devices.

Source: <https://softwarefocus.net/virtual-reality/vr-tech-that-turns-smells-into-temperature.html>, <https://unboundvr.de/media/catalog/product/cache/8/thumbnail/600x600/e4d92e6acead517e7b5c12e0dc06587/a/i/aim.png>.

internalization of knowledge. This results in better cognitive performance concerning, for example, recall and recognition (Xi & Hamari, 2021; Martínez-Navarro, Bigné, Guixeres, Alcañiz, & Torrecilla, 2019), being concentrated (Ko, Jang, Lee, Yun, & Kim, 2020) and self-efficacy (Shu, Huang, Chang, & Chen, 2019) for high-quality decision making.

First, the cognitive benefits of VR might be due to the media or information richness theory, which argues that richer mediums of communication can lead to a better understanding of messages and tasks with greater ambiguity (Kandaurova & Lee, 2019) and higher efficiency in communication (Lee et al., 2021). When customers are exposed to virtual reality, they are exposed to a variety of communication cues as well as rich media experiences. Virtual reality is a more immersive media that incorporates aspects such as 360-degree visual and audio dimensions, olfactory stimulus, tactile sensation, as well as the capacity to interact with objects and interfaces. As a result, VR has the potential to increase the depth of information processing. Therefore, it is likely that consumers will be willing to spend more cognitive resources and effectively process green-related information, which will eventually help the internalization of such green-related information.

In addition, the cognitive capabilities in VR are often connected with mindfulness and self-efficacy, which play important roles in increasing individuals' motivation and willingness to engage in activities. Self-efficacy is a term that refers to people's belief in their capacity to carry out the actions required to achieve a specific result (Bandura, 1978). Self-efficacy can give consumers an internal incentive to make decisions, and increase decision-making confidence and satisfaction. All these factors can help to achieve goals such as well-being, a positive mental state, as well as reducing irrational thinking. Regarding mindfulness, this refers to the awareness of the present moment and experiences in daily life—contributing to genuine intrinsic and social-oriented values and curbing materialistic and hedonistic values (Gentina, Daniel, & Tang, 2021). The earlier literature suggests that mindfulness reduces avaricious monetary attitudes, enhances ethical beliefs, environmental concerns, and emission-reducing behavior in consumption (see, e.g., Gentina et al., 2021; Ndubisi, 2014).

3.2. Emotive aspects of VR

In terms of the emotional aspect of VR, it has been especially postulated to revolutionize how we can induce empathy towards others as VR technologies enable consumers to embody others and be placed in other cultural or socio-economic surroundings—therefore, VR has also been aptly referred to as the “empathy machine” (e.g., Bujić, Salminen, Macey, & Hamari, 2020). Therefore, beyond the promise of VR making us more rational consumers through more multimodal and multifaceted information delivery and functioning as an entertainment technology, VR is perhaps most promising in affecting our consumption practices by exposing us to experiences, lives, and realities that would otherwise be unreachable. Beyond making these facets available, VR technologies hold special potential through their engrossing immersiveness that may promote not just the transfer of information but also feelings and experiences by being in the shoes of others and thus promoting emotional

intelligence, which in turn would serve to shift our consumption attitudes and practices towards global and shared sustainability.

While VR technologies may enable such embodiment, multimodal and multisensory VR also offers capabilities for direct affective synchronicity—i.e., sensing and feeling the emotional states of others (Järvelä et al., 2021) by converting biosignals of the human body and transferring them to be received by users through different interfaces. This may involve seeing the emotional state others on a heads-up-display, sensing it through changes in the environment, or sensing it through a haptic suit or other modalities. The opportunities to translate the emotional states of others to be sensed by consumers in multimodal/multisensory spaces are only limited by the imagination. However, these VR-enabled environments offer fruitful avenues for the future study of emotional intelligence in B2B, B2C or C2C contexts.

While in the above cases, VR is postulated to start breaching the emotional distance between people, and thus, leading to more sustainable consumer decision making, people may also feel ‘emotionally’ closer to ecological systems. Anecdotally, it is often postulated that humans have grown apart from nature due to industrialization, urbanization, and technology, which further is postulated to reduce our appreciation and sustainable attitudes towards nature. There is a certain irony that now, we may use VR technology to bring humanity yet again closer to nature (Nukarinen et al., 2022). In a similar way to ‘standing in the shoes of others’, VR may also be employed in immersing consumers in different ecological systems, and beyond the possible positive restorative effects of VR forest experiences, also helping to understand the complexities, causes and effects in nature as well as by even embodying and acting out the lifetimes of species in different contexts (Pimentel & Kalyanaraman, 2021; Rativa, Postma, & Van Zaanen, 2020).

3.3. Scenarios: applications of VR technologies for sustainable consumption

3.3.1. VR technologies for green information presentation

Multisensory modalities can facilitate consumers to process and internalize green information. For example, products with green labels and information can be displayed in the fully immersive environment via VR head-mounted displays. The richness and vividness of information can deepen consumers' understanding towards green consumption, which nudges greener choices. In addition, combined with other sensory modalities which provide stimulation of auditory, olfactory, kinesthetic, and tactile senses, pro-environmental information can be displayed in different information formats. Digital ‘green’ scents such as forest and fresh cut grass smells, environmental haptic cues such as wooden textures, and nature-related immersive sounds may stimulate consumers to make pro-environmental consumption choices in virtual reality.

3.3.2. VR technologies for promoting consumers' awareness of sustainability

Given VR has advantages in mindfulness and self-efficacy practice, it can be used as an effective tool for cognitive training on strengthening

consumers' environmentally friendly, ethical, and sustainable beliefs. For example, consumers can experience and explore relatively extreme events and situations such as natural disasters, environmental pollution, natural resource depletion, disease, and human rights issues in virtual reality, while remaining in a safe setting. The simulation of different dimensions of human sense provides a highly immersive and realistic experience for consumers to understand the importance of sustainable development and green choices. In addition, the cognitive capacity of consumers can be improved via virtual tasks in virtual reality, which is beneficial for rational and high-quality decision making. For instance, based on different sensory feedback, consumers can learn how to evaluate risks and expected outcomes when facing complex tasks and multiple choices.

3.3.3. VR technologies for enhancing consumers' prosocial behaviors

Currently, the development of VR technologies is moving towards providing more social features and functions. Virtual avatars, the sense of embodiment and multiple identities in virtual reality are reshaping consumers' social communication and interaction paradigms. Empathy and concern for others' welfare and rights, as well as egoistic concerns, can motivate consumers (Sanstock, 2007) to conduct more prosocial behaviors such as helping, sharing, donating, cooperating, and volunteering. For example, when users can embody an avatar in virtual environments and take perspectives of another person, they would show greater willingness to donate (Li & Kyung Kim, 2021); the additional tactile clues from a virtual assistant lead to more positive experiences (Zhao, Ham, & van der Vlist, 2017); and other sensory modalities can be designed in virtual reality for encouraging collaboration behaviors.

4. Conclusions

The most obvious opportunity for virtual technologies in terms of promoting sustainable consumption relates to lessening the need to travel from one place to another, and this applies not only to leisure travelling in virtual reality, which has become one of the trends of today, but also to other aspects of human life such as meeting with other people, working, and shopping. Once technological development is taken a bit further and VR devices become more end-user friendly, this is likely to change many aspects of human life, which can have a remarkable environmentally friendly impact and reduce the carbon footprint. Additionally, virtual technologies enable an effective way to promote sustainable consumer behavior and to illustrate the impact that our every-day consumption decisions have in real life. We hope to see such developments more in the future.

The on-going development of virtual technologies enables new opportunities to control and deliver sensory stimulation and multisensory interaction beyond traditional laboratory settings in real-world environments (Cornelio et al., 2021). VR headsets are constantly developing and becoming more user friendly, and they operate in a standalone mode, which enables their use in real-world environments, for instance at a restaurant, a grocery store, or alternatively at home to better understand the real-life choices that consumers make in terms of sustainable consumption. Combining VR with other sensory-enabling technologies such as wearables and body-responsive technologies may deepen our understanding of how multi-sensory stimuli affect consumers' sustainable choices and decision-making. We believe that taking multisensory research to real-world environments can significantly alter our understanding in terms of multi-sensory interaction, and consumers' sustainable decisions, green choices, and prosocial behaviors.

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