

Sport spectatorship in a virtual environment: how sensory experiences impact consumption intentions

Kyu-soo Chung, Chad Goebert and John David Johnson
*Exercise Science and Sport Management,
WellStar College of Health and Human Services, Kennesaw State University,
Kennesaw, Georgia, USA*

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Abstract

Purpose – With the advance of Web 3.0 and the range of sensory experiences offered by virtual reality (VR) to sport fans, this study examines how VR spectators' sensory experiences affect their intentions to consume VR products and services. For this purpose, the study puts forth an expanded stimulus-organism-response (S-O-R) model. In this framework, the stimuli are the sensory imagery and stimuli, the organism factors are presence and arousal and the response is the consumption intention. This model adeptly encapsulates the comprehensive process of stimuli while spectating a sporting event in a virtual environment.

Design/methodology/approach – For a VR stimulus, researchers developed a 3-min collegiate women's volleyball game. Watching the game in VR were 131 collegiate students, who were then questioned about their visual and aural imagination of the game stimuli, perceived visual and aural stimuli, sense of presence, arousal and VR consumption intentions. To ensure the validity and reliability of the measurement model, confirmatory factor analysis was first conducted. Subsequently, the model was subjected to path analysis.

Findings – The measurement model demonstrated both validity and reliability. The subsequent path analysis yielded the model's satisfactory fit. In particular, the mental visualization of VR spectators significantly influenced their perception of visual stimuli, while their imaginative engagement with auditory aspects impacted their perception of aural stimuli. The observed visual stimuli positively impacted the degree of presence experienced and the level of arousal induced. Similarly, the auditory stimuli exerted comparable effects on presence and arousal. The sense of arousal exhibited a considerable influence on the sense of presence. Furthermore, arousal emerged as a substantial determinant of individuals' VR consumption intentions.

Originality/value – The study highlights that the affective status of VR sport spectators is dominant in determining their consumption intentions. Also, the study finds the decisive role of presence in processing sensory stimuli in virtual sport spectating. It also provides managerial insight into designing and customizing VR sport experiences to be more enjoyable and impactful.

Keywords Virtual reality, Sensory stimuli, Sensory experience, Sport VR, VR consumption, VR sport spectators

Paper type Research paper

Introduction

Virtual reality (VR) has become a popular way for sport spectators to experience the thrill of a live sporting event. VR technology enables individuals to enter a 360° virtual environment that simulates a realistic sporting experience. With the emergence of Web 3.0, VR is becoming increasingly powerful, especially in the sport industry. Companies such as Meta, for instance, offer National Basketball Association (NBA) games on their platform, enabling individuals to



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not only watch and consume games in VR but also to adopt new consumption behaviors such as collecting non-fungible tokens and taking part in the decentralizing culture of Web 3.0 (Cohen, 2023). Still, sport management and marketing have little knowledge regarding VR sport consumers' experiences, particularly their sensory experiences. This study examines the impact of VR on the sport-viewing experience, focusing on the dynamics of sensory experiences and behavioral intentions in a virtual sporting environment.

Biocca (1997) suggested that a VR user's experience is influenced by the virtual environment's components as well as the features of both the imaginal and actual environments associated with the virtual environment. Applying Biocca's notion of a VR environment, the present study proposes that sensory imagery can be used to capture the imaginal experience of VR sport spectators. Their experience in the virtual environment is also influenced by in-the-moment perceptions of sensory stimuli, sense of presence and arousal. Furthermore, the study suggests that VR spectators' intention to consume VR products and services may impact their post-VR experience in the physical environment.

VR spectators are naturally going to compare the stimuli they perceive in VR with real-world stimuli. To make what they imagine more real, they utilize sensory features that could be loaded onto their sensory modalities. This mental process is called sensory imagery (MacInnis and Price, 1987). Several studies have found that people's perceptions of stimuli depend on their sensory imagery, especially when situational contingencies affect their perceptions (Elder *et al.*, 2017; Heller *et al.*, 2019). A prime example of contingency is VR's technology-mediated environment (Flavián *et al.*, 2021), where virtual stimuli are far from genuine and are mediated by technology.

While a virtual environment consists of diverse stimuli, VR spectators become stimulated by only a few stimuli that dominate the environment (Steuer, 1992); the spectators naturally evaluate the quality and type of the stimuli. This process is called stimuli perception, resulting in diverse outcomes (Foley and Bates, 2019). One prevailing outcome suitable for a virtual environment is a sense of presence. A sense of presence reflects how real and genuine a person perceives the VR environment to be (Witmer and Singer, 1998). Additionally, how excited and stimulated a person becomes while watching a VR sporting event can be reflected in arousal, an emotional outcome originating from stimuli perception (Uhm *et al.*, 2020). Finally, the VR spectators' consumption intention, such as their willingness to visit or purchase, can reflect the physical environment that corresponds with the virtual environment (An *et al.*, 2021; Loureiro *et al.*, 2021).

One prevailing theory concerning people's technology consumption is the technology acceptance model (TAM) (Davis, 1989; Kwak and McDaniel, 2011). TAM conceptualizes how individuals' attitudes toward technology influence their adoption of it. Although TAM has been extensively utilized in various studies, it does not specifically address how VR spectators process sensory stimuli as they interact with various features of a virtual environment. How people perceive external stimuli, process them internally and respond through behavior is explained by the stimulus-organism-response (S-O-R) model, proposed by Mehrabian and Russell (1974).

A number of studies have applied the S-O-R model to technology-mediated environments, including VR, to understand how users perceive and respond to stimuli in these environments (An *et al.*, 2021; Flavián *et al.*, 2019; Kim *et al.*, 2020; Loureiro *et al.*, 2021). Given the distinct nature of a virtual environment compared to conventional retail contexts, the S-O-R model's original three factors might confine a comprehensive view of the entirety of stimulus processing. Sport consumers' virtual environment projects a technology-mediated consumption that the extended S-O-R model should encompass emerging characteristics suitable for the new milieu. Accordingly, the current study, with focus on VR sport spectators, introduces sensory imagery as a precursor to sensory stimuli while also considering presence and arousal as two key organism factors. VR spectators'

consumption intentions are set as a stimuli processing outcome. By adopting the extended S-O-R model, this study provides insights into the mechanisms behind how sport spectators process sensory stimuli in a virtual sporting environment, particularly the dynamics of a virtual environment's imaginative, virtual and physical environments in shaping a sport VR user's experience.

The growing market for sport VR highlights the importance of understanding how users experience and respond to these environments. In this regard, the findings have practical implications for marketing the VR sport experience and could be used to guide the development of future sport markets in the emerging Web 3.0.

Literature review

Virtual reality in sport

VR offers a distinct platform with a more immersive and lifelike viewing environment. Such features have given rise to various studies exploring their potential for improving athletic performance and sport training skills (Neumann *et al.*, 2018). Nevertheless, research is still in its early stages concerning VR in the context of sport consumers' live experiences. Kim and Ko (2019) delved into this unexplored area by examining how VR spectators' flow experience is influenced by media, personal and game factors. Their study revealed that VR's features, such as vividness, interactivity and telepresence, significantly enhance the viewing experience of VR spectators. Interestingly, the impact of VR technology on flow experience was more significant for a less committed group than a more committed one, suggesting VR's role in fostering engagement in sports. In another study, Hwang and Chung (2023) utilized VR to investigate how it aids users in reducing stress levels and encouraging participation in extreme sports. The authors found that the sensation-seeking tendency and sense of presence were influential in reducing stress and fostering intentions for sport participation. Similarly, Uhm *et al.* (2020) explored the effect of the sense of presence on VR users' arousal and attitude toward the luge. The study highlighted the crucial role of presence in creating an immersive environment, underscoring that VR's interactivity is as essential as its technological aspects, particularly in the realm of sport VR.

Collectively, these studies' findings showcase VR's significant potential to make sport experiences more enriching by creating more immersive and interactive environments. These studies primarily delve into the cognitive perceptions of VR sport consumers while in a virtual environment. Yet sensory stimuli play a fundamental role in influencing cognitive and psychological characteristics, and these authors notably neglect to incorporate into their theoretical frameworks such components that exist within the VR environment. However, numerous systematic endeavors beyond the realm of sport studies have integrated VR users' sensory stimuli to grasp the characteristics of VR users suitable for a virtual environment. For example, a recent study (Alyahya and McLean, 2022) investigated how VR users' intentions to visit a destination are impacted by their mental imagery, sense of presence and attitudes toward that destination in VR. Additionally, the study explored how the perceived volume of sensory stimuli among VR users influenced the dynamics, revealing variations in the relationships based on the intensity of sensory stimuli.

Considering the concerted efforts of professional sport entities to cultivate a market for VR sport spectating, it seems vital to that effort to thoroughly examine the VR sport spectators' viewing experiences (Capasa *et al.*, 2022; Kim and Ko, 2019). The absence of sensory stimuli in these studies inevitably leads to a limited and incomplete understanding of the VR sport consumer experience. As VR strives to offer a comprehensive user experience, the pivotal role of sensory experiences in a virtual environment, particularly in sport consumer experience, is poised to gain more attention.

Extended S-O-R model

The S-O-R model captures the process by which consumers are exposed to external stimuli (Mehrabian and Russell, 1974). By focusing on the sequential process from sensation through perception to outcomes, the model conceptualizes how consumers perceive stimuli and internally process them to result in various behavioral responses. Numerous studies have applied the S-O-R model to different consumption contexts, including sport-consumption settings (Chung, 2020, 2023; Chung and Lee, 2023; Chung *et al.*, 2015, 2016).

Chung and Lee (2023) conducted a study utilizing the S-O-R model to examine how baseball simulation users perceived and processed visual, aural and tactile stimuli, leading to their intentions to play baseball and revisit the simulation. The study considered telepresence and pleasure as mediating variables influenced by the stimuli and revealed the distinct roles of each stimulus in shaping users' intentions. The S-O-R model proved to be effective at capturing the dynamics of stimuli perception and processing, especially in a simulation context where technology-mediated stimuli are prevalent. In another study, Chung (2020) investigated the social interactions of motorsport spectators, exploring how their social behaviors were impacted by the level of stimuli sensations experienced at a racing venue. By employing the S-O-R model, the study provided insights into the behaviors of motorsport spectators, differentiating them from spectators of other sports. Furthermore, Chung *et al.* (2015) applied the S-O-R model to incorporate sport spectators' five sensory stimuli into their psychological and emotional characteristics and their behavioral outcomes. The study demonstrated that the spectators' perceived stimuli selectively influenced arousal and satisfaction, depending on the nature of the stimuli. The model's emphasis on stimuli processing enabled the identification of these dynamics.

Employing the traditional S-O-R model to sequentially capture the entire processing of stimuli, Chung's studies systematically delineate how sensory stimuli in diverse sport contexts align with the S-O-R model, underscoring the model's theoretical strengths and empirical applications. However, these studies lack a framework for accounting for the inherent dynamic status of stimuli perceivers – such as their prior sensory cues or imagery – and the processing of stimuli. VR sport spectating in particular introduces an environment where stimuli are not naturally occurring but rather technologically mediated, distinguishing it from traditional sport spectating. Given this limitation, it is imperative to extend the S-O-R model to encompass more context-specific characteristics and test an extended model tailored to technology-mediated sporting environments.

Numerous studies applying the extended S-O-R model have attempted, in conceptualizing the model's extension, to specify different types of stimuli, diversify the types of emotions or separate behavioral outcomes. In Kim *et al.*'s (2020) study, the cognitive and affective responses of VR tourists were assigned to the organism, with their attachment to VR and destination visit intention categorized as the response. Tian and Xi (2023) designed sport clothing shoppers' purchase attitudes as the organism, purchase intentions as the response and the stimuli were delineated as functionality, expressiveness and esthetics.

Based on these studies' extended models, the current study frames sensory imagery as a preeminent determinant in perceiving the stimuli. Also, the study incorporates VR sport spectators' sense of presence and arousal as two organism mediators to process the stimuli. Since VR sport consumption is highly experiential, the extended model's sequence effectively captures the varied sensory experiences of spectators as they process stimuli in each stage. Also, the model's capacity to account for mediating variables and capture the intricacies of stimuli processing makes it a versatile tool for understanding sport behaviors in response to technology-mediated stimuli. Therefore, the present study's extended S-O-R model aims to capture the complete spectrum of sensory stimuli processing among VR sport spectators.

Situational stimuli

Although VR spectators encounter various stimuli in their virtual environment, their experience is not impacted by all of them. Instead, the spectators typically perceive only a few stimuli that are primarily loaded on their selected sensory modalities; such stimuli tend to shape their overall experience. These prevalent stimuli are known as situational stimuli (Steuer, 1992). For example, during a sporting event projected on a VR platform, spectators mainly rely on their visual and auditory senses to watch the game and hear the associated sounds. The present study delineates VR spectators' sensory stimuli as visual components projected onto their visual organs for viewing in a virtual sporting environment. The study also characterizes VR spectators' aural stimuli as all audible sounds associated with a sporting game and its related events, delivered to their auditory organs for hearing in a virtual sporting setting.

Meanwhile, their tactile, olfactory and gustatory senses remain inactive unless they choose to consume ancillary services, such as food and drink. In the present study, VR spectators primarily experience situational stimuli through their visual and auditory senses as they watch and hear the game. Other senses, such as smell, taste and touch, play a relatively minor role.

Sensory imagery and stimuli perception

When a consumer is exposed to various stimuli in a given environment, their sensory modalities are activated by these stimuli. These sensory modalities are the receptors for stimuli sensation, referring to a consumer's five senses, namely sight, hearing, smell, taste and touch (Krishna, 2013). Subsequently, consumers tend to identify and evaluate the type and degree of stimuli, which involves cognitive processes that utilize various sensory cues to apprehend the stimuli (Foley and Bates, 2019). Depending on how consumers perceive the stimuli, this cognitive work results in affective and behavioral outcomes accordingly.

In the present study, the VR stimuli mainly comprise visual and auditory components. For instance, VR spectators keep their eyes on the players' athletic motions, the ball's movements and the game mechanics. On the other hand, the aural stimuli of VR spectators include the game's announcements, the crowd cheering and music and promotional sounds. As VR spectators are so stimulated, each sense is engaged in perceiving them. Therefore, to examine VR spectators' stimuli perception, the current study focuses on the stimuli loading on their visual and auditory senses.

Sensory imagery refers to consumers' imagination of the stimuli that may be loaded on their sensory modalities, which occurs before the actual stimuli are experienced (Elder *et al.*, 2017; Flavián *et al.*, 2021; Heller *et al.*, 2019). Based on prior experiences and cues from actual stimuli, VR users tend to activate their sensory imagery to anticipate the mediated stimuli, especially when they are unable to physically experience the content due to situational contingencies. It encompasses various senses or a single sensory dimension.

In the context of this study, VR spectators may mentally simulate their typical visual perception of players' movements and the ball during a sporting event. They might also anticipate the overall immersive experience of watching the game in VR, including the sounds of the virtual crowd and other auditory elements. Numerous studies have found that people's mental representations of sensory cues affect the way they perceive actual stimuli in a respective sense (Berger and Ehrsson, 2013; Elder *et al.*, 2017; Heller *et al.*, 2019). This finding enables the researchers to set sensory imagery as an antecedent of sensory stimuli and to examine the effect, among VR spectators, of sensory imagery on sensory perception. Hence, some insight may be gained by examining the interplay between sensory imagery and stimuli perception – insight into how such perception leads to diverse outcomes, particularly in a virtual environment where stimuli are contingent.

Sensory imagery holistically encompasses various senses or occurs in a single sensory dimension (Berger and Ehrsson, 2013; Kim *et al.*, 2021). The study's sensory imagery as an antecedent of sensory stimuli perception aims to examine how these different forms of imagery and stimuli perception might interact in a virtual environment. Testing this cross-activation holds significant importance in comprehending the behaviors of VR spectators, as the artificially simulated stimuli in VR are uncommon in their daily sensory processing. For this aim, the study put forward the following four hypotheses:

- H1. VR spectators' visual imagery will positively affect their visual stimuli perception.
- H2. VR spectators' visual imagery will positively affect their aural stimuli perception.
- H3. VR spectators' aural imagery will positively affect their aural stimuli perception.
- H4. VR spectators' aural imagery will positively affect their visual stimuli perception.

Sense of presence

The stimuli experienced by VR users are technology-mediated. In this artificial context, VR users may doubt the authenticity and realism of the VR stimuli and of their immediate environment. Although presence is composed of various components, such as vividness, interactivity and realism, the current study's VR stimuli are merely the projection of an actual sporting game and its venue onto a 360° platform, voiding the interaction between VR users and the VR environment. Thus, the aforementioned sense of presence refers to the feeling people have when they are in a virtual environment but feel as though they are in an actual one (Witmer and Singer, 1998). In other words, concerning a sense of presence, the current study focuses only on how VR spectators perceive the realism of the projected environment, only on whether they feel as if they are in the actual venue.

Various studies have investigated how the sense of presence in VR is a mediating factor, linking the impact of sensory sensations to consequential aspects of the experience. In a baseball simulation, for instance, Chung and Lee (2023) demonstrated the crucial role of telepresence in mediating the effects of technology-mediated sensory stimuli on pleasure and behavioral intentions. Additionally, the level of presence experienced in a virtual environment depends on the quality and quantity of sensory stimuli elicited (Dinh *et al.*, 1999). Lastly, Witmer and Singer's (1998) measure of VR presence factored in sensory stimuli perception by specifying visual, aural and haptic senses, indicating the crucial role of sensory stimuli in perceiving the presence of VR. Based on these studies, the present study formulates two hypotheses to explore the direct impact of visual and aural stimuli on VR users' sense of presence.

- H5. The visual stimuli presented to VR spectators will positively influence their sense of presence.
- H6. The aural stimuli provided to VR spectators will positively influence their sense of presence.

Arousal

Arousal refers to the degree of emotional reaction to a stimulus that ranges along a continuum from calmness to excitement (Russell *et al.*, 1989). In the case of sport spectators, emotions can vary as they consume a sport and its associated products and services. However, a common emotion experienced by spectators is excitement-induced arousal (Chung *et al.*, 2015, 2016; Uhm *et al.*, 2020). In the current study, such arousal is sufficiently stimulated through the 360° view of the sporting venue.

According to the S-O-R model, consumers process external stimuli internally, and their emotions mediate the relationship between perceived stimuli and behavioral

outcomes. Several studies adopting the extended S-O-R model set cognitive and affective mediators to catch the transmission of external stimuli more accurately (Kim *et al.*, 2020; Tian and Xi, 2023). VR requires its users to process technology-mediated stimuli, including the dynamics suitable for a virtual environment. In this vein, including arousal as another mediator is crucial to explaining how VR's technology-mediated stimuli are processed by affective emotion and the cognitive sense of VR. As a result, the study poses hypothesizes that while watching a sport game in VR, spectators' sensory stimuli impact their arousal.

H7. The visual stimuli presented to VR spectators will positively influence their level of arousal.

H8. The aural stimuli provided to VR spectators will positively influence their level of arousal.

Lee *et al.* (2013) uncovered that users engaging in virtual golf simulations did not manifest a significant impact of telepresence on their perceived enjoyment. In contrast, Uhm *et al.* (2020) reached a disparate conclusion, proposing that spectators watching a winter sport in VR exhibited elevated levels of their sense of presence and arousal. This would indicate an interconnected relationship in the realm of sport VR. While arousal and pleasure are distinct affective emotions, these studies' conflicting results might be attributed to the differentiation between sport-spectating and sport-participating behaviors. Additionally, the study's different platform types (i.e. immersive VR vs computer-mediated simulation) contributed to these findings. These contradictory outcomes underscore the significance of contextual features in forming sport consumers' characteristics across various technology-oriented sporting environments. Consequently, given the present study's VR-spectating context similar to that of Uhm *et al.* (2020), it is hypothesized that the sense of presence experienced by VR spectators will indeed impact their level of arousal.

H9. The sense of presence among VR spectators will positively affect their level of arousal.

VR consumption

The S-O-R model posits that consumers internally process external stimuli, resulting in behavioral outcomes such as shopping referrals, product purchases, repeat purchases or store visits, where consumption behaviors arise from the processing of stimuli (An *et al.*, 2021; Loureiro *et al.*, 2021). Ajzen (1991) introduced the theory of planned behavior, asserting that behavioral intentions serve as indicators of actual behavior. Building upon Ajzen's perspective, numerous studies have explored VR users' intentions to use VR or to engage in sporting activities beyond the VR environment as a precursor to their actual behaviors (Hwang and Chung, 2023; Kim *et al.*, 2020; Uhm *et al.*, 2020).

As VR technology rapidly advances and the commercial market expands, it has become increasingly crucial for marketers to comprehend the intentions of VR spectators, especially regarding purchasing VR devices and subscriptions to VR sport games. However, existing studies on VR sport spectators have primarily focused on spectators' intentions to use VR again, limiting the scope of understanding their behaviors (Capasa *et al.*, 2022; Uhm *et al.*, 2020). Therefore, the current study specifies VR spectators' behavioral intentions to purchase VR and its ancillary products and services as the study model's ultimate dependent variable. The final hypothesis is articulated as follows:

H10. The level of arousal experienced by VR spectators will positively influence their intentions to consume VR products.

In summary, the current study generates ten hypotheses to predict the causal relations among sensory imagery, sensory stimuli, presence, arousal and consumption intentions. All hypothesized relations are shown in [Figure 1](#).

Method

Data collection procedure and samples

In a study by [Liu et al. \(2020\)](#) that compared college students to an elderly cohort, the former consistently exhibited distinct patterns in their VR experiences and associated characteristics. Notably, they appeared to be more inclined to purchase VR devices even when the group's perceived positive VR experience was lower than that observed in the elder group. The young group successfully handled a few uncontrollable factors, such as discomfort during VR usage and perceived difficulty navigating VR interfaces, highlighting their persistence in embracing and engaging with VR technology easily. What are reliable and distinct features about college students is their increased likelihood of adopting VR technology. Consequently, the researchers employed a convenience sampling technique to recruit study participants from a pool of students at a public university in the American Southeast.

Upon joining the study, the subjects were invited to the research location at a time designated for participation. The room was a closed location designated for this research project where external stimuli would not affect the VR experience. One researcher assisted the subjects in completing their consent forms and preliminary questions. Another researcher prepared the VR content on the hardware and assisted the subjects as they put on a set of VR goggles and headphones. After one researcher explained the tutorial to proceed with the VR content, the subjects were free to watch the game in VR. Only one subject at a time participated in the data collection.

One researcher read each question and presented all answer options, while another recorded the subject's responses instead of allowing the subjects to respond directly to the survey. This way, the researchers could capture the subjects' in-the-moment experiences. Each data collection session required approximately 30 min per participant. The data collection occurred before the outbreak of the COVID-19 pandemic, eliminating safety restrictions on recruitment and in-person interactions with study participants. The data collection took approximately two months. Despite the swift progress in VR technology toward enhancing user interactivity and interface design, the study's VR stimuli, which lack specific VR interface components, should be projected with consistent quality across various VR specifications. Thus, the study's VR experience would not differ from that of recent VR devices, surpassing the threshold of the study's VR equipment.

The final sample consisted of 131 subjects, 76 males (58%) and 55 females (42%). Their average age was 21.9 years old. Thirty participants (22.9%) had prior experience with VR.

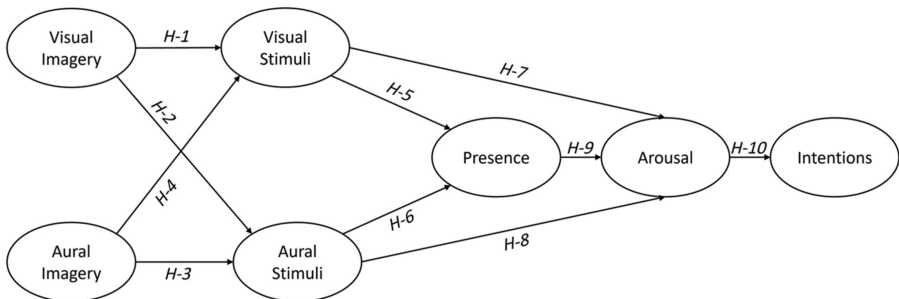


Figure 1.
Research design

Source(s): Authors' own creation

VR stimuli and display specification

To vividly capture the venue's entire scene and players' athletic motions, researchers deemed it appropriate to record, for the study's VR stimuli, an indoor sporting event. The researchers arranged six 360° cameras to record the complete environment of an National Collegiate Athletics Association (NCAA) Division-I women's volleyball game in their institution. Due to its competitiveness, the institution's volleyball program was then popular among the students. In fact, after the study's data collection, the team advanced to the conference's championship game.

The audio was recorded on stereo devices. The six VR-compatible video files were edited with Kolor's Autopano Giga 4.4 software. The entire game was condensed into a concise, three-minute highlight reel. This compilation featured exhilarating moments from the game, such as intense rallies culminating in points, players executing dramatic dives and spikes, as well as point celebrations. Although the three-minute duration might seem brief for eliciting a diverse range of experiential responses in a nonvirtual setting, the video proved ample for participants to immerse themselves in the virtual environment and sensibly perceive the stimuli. In this manner, the study aimed to preemptively address the potential impact of time, as participants were already well acclimatized to the virtual milieu. The video is available at <https://www.youtube.com/watch?v=VdxNfW3xxgo&feature=youtu.be>.

The VR-compatible video file was loaded on a Samsung Galaxy S6 Edge smartphone. The phone's screen is 5.1 inches in size, and its resolution is 2,560 by 1,440 pixels per inch. For the VR headset, the research team selected the Samsung Gear VR Oculus, as it supports a head-tracking system in which the screen is mounted to the VR user's face. The headset's operating platform is Android, and its resolution is at least 1,280 by 1,440 per eye. Its field view is 101° and the frame rate is 60 Hz, which is greater than the manufacturer's suggested minimum rate of 15 Hz. Also, the study's VR equipment was commercial market oriented and user-friendly, so technological convenience would not interfere with the subjects' virtual experience. Regarding audio, a JBL E45BT wireless, over-the-head headphone was used. The headphone's audible frequency range was 20 Hz–20 kHz, which was enough to cover the full range of sounds recorded on stereo devices at the event.

Although the VR equipment utilized in the study was state-of-the-art during data collection, it may only partially align with the latest advancements in VR technology, which could offer more vivid and realistic sensory stimuli. Nevertheless, the study's VR setup remains optimal for operating the virtual environment, ensuring compatibility with the specified VR stimuli designed for the study's data collection.

Measures

The researchers first referred to the study's developed VR content encompassing the sporting game's entire venue without VR interface components. This approach allowed the researchers to implement game-related viewing components into VR spectators' sensory imagery and perception in developing the specific items suitable for the study's VR stimuli.

Referring to the sensory stimuli perception constructs derived from previous studies (Andrade *et al.*, 2014; Chung, 2023, 2020; Chung and Lee, 2023; Chung *et al.*, 2015, 2016), the researchers developed three items aimed at gauging the sensory imagery experienced by VR spectators, encompassing both visual and aural sensations. These benchmark items exhibited robust validity and reliability in sport consumption, spanning diverse contexts such as live sporting events and sport simulations. Spectators' volleyball watching in VR was also considered for the study's context in developing the items. The reliability of the sensory imagery items was rigorously evaluated through three approaches: Cronbach's α , item-total correlations and inter-item correlations.

Drawing upon prior research (Chung, 2023, 2020; Chung and Lee, 2023; Chung *et al.*, 2015, 2016), the researchers utilized three items to gauge sport consumers' visual and aural sensory

perceptions. These items were appropriately tailored to suit the context of volleyball spectating in the VR environment, with minor adjustments to align with this specific context. Notably, all the items exhibited satisfactory levels of reliability.

The researchers also assessed the participants' sense of presence by measuring their perception of realism through the visual and auditory stimuli in the VR game (Witmer and Singer, 1998). Additionally, the participants' levels of arousal were measured (Loureiro *et al.*, 2021). Lastly, the researchers measured their intentions to consume VR-related products and services (Rynarzewska, 2018). All the questions were adopted from previous studies, and we slightly adjusted the wording of the questions to fit the context of a volleyball game. The reliability of all items was satisfactory.

Prior to the VR experience, the researchers measured their imagery for the visual and auditory components of the VR game. They assessed the participants' visual and auditory perceptions of stimuli and other characteristics throughout the VR gaming session. Finally, they measured VR consumption intentions after the participants watched the VR game.

A seven-point Likert-type scale was used to measure the participants' responses to the questions. The scale ranged from 1 (not at all) to 7 (very much). The researchers used SPSS 29 to present descriptive statistics and reliability information for each question in Table 1.

Data analysis

The researchers used AMOS 26 to conduct a confirmatory factor analysis to ascertain the reliability and validity of the study's measurement model. After satisfying the requirements of the measurement model, the researchers averaged a construct's items into a global construct and checked for each construct's data normality. All constructs' skewness and kurtosis were within the normal range (Hair *et al.*, 1998) except for visual stimuli (skewness: -1.87 and kurtosis: 4.17), arousal (-1.70, 4.02) and consumption intention (-1.76, 3.53). The researchers performed square root transformations to adjust these measures of skewness and kurtosis. The adjusted skewness was 1.36 for visual stimuli, 1.04 for arousal and 1.05 for consumption intention. In that order, the adjusted kurtosis was 1.85, 0.99 and 1.08.

The study's primary objective was to concurrently explore the connections between aural and visual sensory imagery, aural and visual sensory stimuli, presence, arousal and consumption intention. Additionally, the study sought to articulate a model, grounded in the S-O-R model, that conceptualizes the processing of sensory stimuli in a virtual environment. Therefore, path analysis was selected as the data analysis technique for its flexibility and comprehensiveness in achieving this objective (Suhr, 2008).

The proposed model encompasses various constructs that act as mediators in the relationships among the observed variables. Consequently, the bootstrapping method in path analysis was deemed appropriate to discern direct and indirect effects. It is worth noting that path analysis, unlike structural equation modeling, does not offer a straightforward test for assessing model fit, requiring a relatively smaller sample size for data analysis (Suhr, 2008). Therefore, the current study set 1,000 for the number of bootstrap samples with a 95% confidence level.

Results

Confirmatory factor analysis

A few absolute fit indices were selected for the measurement model's acceptable fit ($\chi^2 = 224.97$, $df = 168$, normed $\chi^2 = 1.34$, $p = 0.002$, root mean square error of approximation (RMSEA) = 0.05). As for the model's incremental fit, a few indices were adopted (comparative fit index (CFI) = 0.96 and incremental fit index (IFI) = 0.96).

Construct (Cronbach's α)	Item (To what degree do you ... ?)	Mean (<i>SD</i>)	Item-to-total correlation	Inter-item correlation
Visual Imagery (0.87)	anticipate watching a game before the VR experience	5.29 (1.17)	0.61	0.68
	anticipate watching players' motions before the VR experience	5.27 (1.27)	0.72	
	anticipate seeing the ball moving around before the VR experience	5.43 (1.27)	0.82	
Aural Imagery (0.82)	anticipate various sounds of a game before the VR experience	5.55 (1.40)	0.71	0.60
	anticipate spectators' cheering sounds before the VR experience	5.27 (1.50)	0.65	
	anticipate players' cheering sounds before the VR experience	4.88 (1.52)	0.74	
Visual Stimuli (0.77)	perceive the players' moves during the VR experience	6.53 (0.65)	0.59	0.54
	perceive the ball's movement during the VR experience	6.62 (0.71)	0.65	
	perceive watching the game during the VR experience	6.42 (0.80)	0.61	
Aural Stimuli (0.77)	perceive announcements during the VR experience	5.25 (1.36)	0.70	0.56
	perceive the crowd cheering during the VR experience	6.11 (1.05)	0.58	
	perceive music or promotional sounds during the VR experience	4.59 (1.75)	0.61	
Presence (0.76)	perceive you are really "there" during the VR experience	6.41 (0.88)	0.57	0.51
	perceive players' movements are real during the VR experience	6.24 (1.01)	0.56	
	perceive listening to the game is natural during the VR experience	5.98 (0.91)	0.62	
Arousal (0.91)	feel excited during the VR experience	6.15 (0.99)	0.71	0.77
	feel thrilled during the VR experience	6.21 (1.02)	0.86	
	feel simulated during the VR experience	6.23 (0.98)	0.87	
Consumption Intention (0.89)	intend to use a virtual reality device again	6.22 (1.20)	0.67	0.72
	intend to subscribe to sport VR content	5.74 (1.38)	0.86	
	intend to subscribe to the team- related VR content	5.59 (1.53)	0.84	

Source(s): Authors' own creation

Table 1.
Item descriptions,
descriptive statistics,
and reliabilities

Three indicators proved the model's convergent validity (Fornell and Larcker, 1981). First, the constructs' average variance extracted (AVE) ranged from 0.51 to 0.79. Second, the constructs' composite reliabilities ranged from 0.66 to 0.92. Lastly, all constructs' standardized loadings ranged from 0.66 to 0.94.

All squared correlations of the study were lower than the lowest AVE 0.51, indicating the model's discriminant validity (Fornell and Larcker, 1981).

In the current study, the respondents had to answer independent and dependent variables simultaneously. This cross-sectional nature could cause common method bias (CMB) (Podsakoff *et al.*, 2003). Harman's single-factor analysis resulted in 33.26% of total variance loading, indicating it was free of CMB. More details of the model's confirmatory factor analysis are presented in Table 2.

Table 2.
Confirmatory factor
analysis

Construct	Standardized loading	Composite reliability	AVE	A	B	Correlation				
						C	D	E	F	G
A	0.78–0.93	0.82	0.70	1						
B	0.75–0.84	0.69	0.61	0.57	1					
C	0.70–0.76	0.87	0.54	0.29	0.24	1				
D	0.71–0.80	0.66	0.56	0.11	0.26	0.20	1			
E	0.66–0.78	0.78	0.51	0.22	0.24	0.53	0.49	1		
F	0.78–0.94	0.92	0.79	0.34	0.29	0.42	0.37	0.68	1	
G	0.69–0.94	0.84	0.74	0.40	0.27	0.28	0.39	0.46	0.55	1

Note(s): A: visual imagery, B: aural imagery, C: visual stimuli, D: aural stimuli, E: presence, F: arousal, G: consumption intention. All correlations were significant at a 0.01 level except for the correlation of A and D
Source(s): Authors' own creation

Path analysis

Since a path analysis does not include a straightforward model fit test, a few selected indices indicate a model's goodness of fit. The study's path analysis yielded a satisfactory model fit, $\chi^2 = 31.98$, $df = 10$, normed $\chi^2 = 3.20$, $p < 0.001$ and CFI = 0.92 (Hu and Bentler, 1999; Klein, 1998).

In the model's comprehensive testing, visual imagery had a positive effect on visual stimuli (standardized $\gamma_1 = 0.22$, S.E. = 0.07, $t = 2.20$ and $p < 0.05$), but its effect on aural stimuli was not significant ($\gamma_2 = -0.06$, S.E. = 0.11, $t = -0.63$ and $p = 0.53$). Aural imagery also had a positive effect on aural stimuli ($\gamma_3 = 0.30$, S.E. = 0.10, $t = 2.91$ and $p < 0.01$). Its effect on visual stimuli was not significant ($\gamma_4 = 0.12$, S.E. = 0.06, $t = 1.15$ and $p = 0.25$).

Regarding their effect on presence, visual ($\beta_5 = 0.46$, S.E. = 0.08, $t = 6.75$ and $p < 0.001$) and aural ($\beta_6 = 0.41$, S.E. = 0.05, $t = 5.94$ and $p < 0.001$) stimuli were significant, though these stimuli had no significant effect on arousal ($\beta_7 = 0.09$, S.E. = 0.10, $t = 1.23$ and $p = 0.22$ and $\beta_8 = 0.06$, S.E. = 0.06, $t = 0.87$ and $p = 0.39$). Presence had a substantial impact on arousal ($\beta_9 = 0.59$, S.E. = 0.09, $t = 7.04$ and $p < 0.001$), and arousal also had a great effect on consumption intention ($\beta_{10} = 0.54$, S.E. = 0.09, $t = 7.32$ and $p < 0.001$). Each construct's standardized coefficient is addressed in Figure 2. Also, all direct, indirect and total effects and their significances are described in Table 3.

Path comparison

The researchers developed a new model that includes team identification as a controlling factor of presence and arousal in addition to the study's original model. This inclusion was based on the substantial findings that team identification affects cognitive and affective status in consuming VR sport (Kim and Ko, 2019). Path analysis was conducted to compare

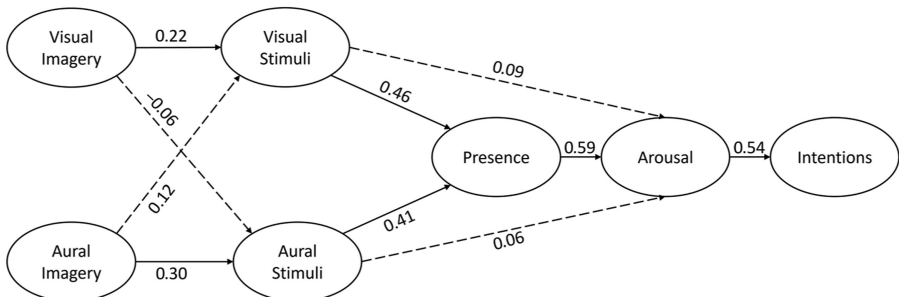


Figure 2.
Path analysis results

Source(s): Authors' own creation

	Direct	Indirect	Total
On Visual stimuli ($R^2 = 9\%$)			
Visual imagery	0.22 ($p = 0.05$) −0.01 < CI < 0.42	–	0.22 ($p = 0.05$) −0.01 < CI < 0.42
Aural imagery	0.12 ($p = 0.25$) −0.09 < CI < 0.31	–	0.12 ($p = 0.25$) −0.09 < CI < 0.31
On aural stimuli ($R^2 = 7\%$)			
Visual imagery	−0.06 ($p = 0.54$) −0.27 < CI < 0.16	–	−0.06 ($p = 0.56$) −0.27 < CI < 0.16
Aural imagery	0.30 ($p < 0.001$) 0.10 < CI < 0.48	–	0.30 ($p < 0.001$) 0.10 < CI < 0.48
On presence ($R^2 = 40\%$)			
Visual imagery	–	0.08 ($p = 0.35$) −0.08 < CI < 0.24	0.08 ($p = 0.35$) −0.08 < CI < 0.24
Aural imagery	–	0.17 ($p < 0.001$) 0.05 < CI < 0.31	0.17 ($p < 0.01$) 0.05 < CI < 0.31
Visual stimuli	0.46 ($p < 0.001$) 0.27 < CI < 0.61	–	0.46 ($p < 0.001$) 0.27 < CI < 0.61
Aural stimuli	0.41 ($p < 0.001$) 0.28 < CI < 0.53	–	0.41 ($p < 0.001$) 0.28 < CI < 0.53
On arousal ($R^2 = 45\%$)			
Visual imagery	–	0.06 ($p = 0.35$) −0.06 < CI < 0.20	0.06 ($p = 0.35$) −0.06 < CI < 0.20
Aural imagery	–	0.13 ($p < 0.001$) 0.03 < CI < 0.25	0.13 ($p < 0.001$) 0.03 < CI < 0.25
Visual stimuli	0.09 ($p = 0.34$) −0.09 < CI < 0.27	0.27 ($p < 0.001$) 0.15 < CI < 0.40	0.36 ($p < 0.001$) 0.12 < CI < 0.55
Aural stimuli	0.06 ($p = 0.39$) −0.08 < CI < 0.23	0.24 ($p < 0.001$) 0.14 < CI < 0.35	0.30 ($p < 0.001$) 0.15 < CI < 0.47
Presence	0.59 ($p < 0.001$) 0.43 < CI < 0.74	–	0.59 ($p < 0.001$) 0.43 < CI < 0.74
On intention ($R^2 = 29\%$)			
Visual imagery	–	0.03 ($p = 0.35$) −0.03 < CI < 0.11	0.03 ($p = 0.35$) −0.03 < CI < 0.11
Aural imagery	–	0.07 ($p < 0.001$) 0.02 < CI < 0.14	0.07 ($p < 0.001$) 0.02 < CI < 0.14
Visual stimuli	–	0.20 ($p < 0.001$) 0.05 < CI < 0.33	0.20 ($p < 0.001$) 0.05 < CI < 0.33
Aural stimuli	–	0.16 ($p < 0.001$) 0.08 < CI < 0.26	0.16 ($p < 0.001$) 0.08 < CI < 0.26
Presence	–	0.32 ($p < 0.001$) 0.20 < CI < 0.44	0.32 ($p < 0.001$) 0.20 < CI < 0.44
Arousal	0.54 ($p < 0.001$) 0.40 < CI < 0.67	–	0.54 ($p < 0.001$) 0.40 < CI < 0.67

Source(s): Authors' own creation

Table 3.
Direct, indirect and
total effects

the magnitude and significance of each path between the original model and the new model. Also compared were each model's model fit indices.

In the results, team identification had a significant controlling effect of negative 0.21 on presence ($p < 0.001$) and of negative 0.22 on arousal ($p < 0.001$). However, these controlling effects did not change the patterns of the original model regarding each path's magnitude and statistical significance. Furthermore, including team identification resulted in the model's unacceptable fit indices, $\chi^2 = 66.84$, $df = 15$, normed $\chi^2 = 4.46$, $p < 0.001$ and CFI = 0.84 (Hu and Bentler, 1999). Table 4 shows the models' comparisons regarding path coefficients and model fit.

Table 4.
Model comparison

	Path	Original model	Model with control
Path	Visual imagery → Visual Stimuli	0.22 ($p < 0.05$)	0.22 ($p < 0.001$)
	Visual imagery → Aural Stimuli	−0.06 ($p = 0.53$)	−0.06 ($p = 0.53$)
	Aural imagery → Visual Stimuli	0.12 ($p = 0.25$)	0.12 ($p = 0.25$)
	Aural imagery → Aural Stimuli	0.30 ($p < 0.01$)	0.30 ($p < 0.05$)
	Visual stimuli → Presence	0.46 ($p < 0.001$)	0.41 ($p < 0.001$)
	Aural stimuli → Presence	0.41 ($p < 0.001$)	0.38 ($p < 0.001$)
	Visual stimuli → Arousal	0.09 ($p = 0.22$)	0.05 ($p = 0.46$)
	Aural stimuli → Arousal	0.06 ($p = 0.39$)	0.05 ($p = 0.51$)
	Presence → Arousal	0.59 ($p < 0.001$)	0.53 ($p < 0.001$)
	Arousal → Intention	0.54 ($p < 0.001$)	0.52 ($p < 0.001$)
Model	Normed χ^2	3.20 ($p < 0.001$)	4.46 ($p < 0.001$)
Fit	CFI	0.92	0.84
	NFI	0.90	0.81
Source(s): Authors' own creation			

Discussion

The current study tested a model that showed that sport VR spectators' intentions to consume VR products were affected by their sensory imagery and stimuli, presence and arousal. All designed paths were significantly positive except for the effect of visual imagery on aural stimuli and that of aural imagery on visual stimuli. Neither were the effects of visual nor aural stimuli significant on arousal. Notably, the study highlighted the pivotal role of VR spectators' sense of presence in mediating their sensory sensations to arousal. Additionally, the level of arousal experienced by VR spectators emerged as a significant determinant of their intentions to consume VR products.

A number of studies have shown that the sensory imagery of VR users interacts with their sensory stimuli perception, leading to a multisensory experience with consequences (Alyahya and McLean, 2022; Kim *et al.*, 2021; Lachini *et al.*, 2019). This interaction does not necessarily evoke stimuli perception in the same sense, indicating that it can occur within the same sensory modality or across multiple modalities (Berger and Ehrsson, 2013; Kim *et al.*, 2021). The current study discovered that the visual stimuli sensation of VR spectators is influenced by visual imagery exclusively, while the aural sensation is solely influenced by aural imagery. The study found no reciprocal cross-activations between the imagery associated with visual stimuli and the perception of aural stimuli and vice versa among VR spectators. This intriguing finding suggests that the alignment between the imagined stimuli and the actual stimuli in terms of quality and intensity is a critical determinant for the convergence of sensory imagery and perception (Fröhlich and Wachsmuth, 2013; Steuer, 1992).

VR spectators rely primarily on a few preferred senses to perceive situational stimuli, and the perceptions of these preferred senses override those of other senses, which is the concept of "minimal cues" (Sanchez-Vives and Slater, 2005). Based on minimal cues, some studies have argued that a virtual environment's prevalent situational stimuli play a more prominent role than other minor stimuli (Arias *et al.*, 2011; Gonçalves *et al.*, 2019; Sanchez-Vives and Slater, 2005). In line with this, the current study found that VR spectators' visual and aural stimuli are heavily loaded on their presence in a virtual spectating environment. It should be noted that the current study's VR projection was displayed on a head-mounted display goggle; VR spectators were able to discern the sounds' origins by looking around, detecting visual and aural stimuli simultaneously. Thus, it seems possible that in the spectators' concurrent perceptions of stimuli, their presence was highly activated at the venue.

VR spectators' sense of presence, which is the perceived realism of the immediate environment, plays a pivotal mediating role in transmitting the technology-mediated visual

and aural stimuli. However, the spectators' visual stimuli perception did not affect arousal directly. The spectators' aural stimuli perception results in the same dynamics in affecting presence and arousal. The distinctive role of presence gains further prominence when we consider the negligible impact that visual and aural stimuli have on arousal. This result mirrors the virtual environment, where all sensory inputs are mediated without inherent authenticity. Consequently, the processing of sensory stimuli within the virtual milieu falls within the purview of the sense of presence.

The present study reveals presence to have a significant influence on arousal, with arousal impacting in parallel fashion VR consumption intentions. This outcome underscores the pivotal role played by the sense of presence engendered by the VR experience in shaping the emotional state of VR spectators. Additionally, it suggests a direct link between heightened arousal levels and an increased propensity for VR consumption. These findings resonate with parallel investigations in VR (Uhm *et al.*, 2020) and prior inquiries rooted in the S-O-R model (Chung *et al.*, 2015, 2016). Importantly, the current study expands upon these precedents by encompassing VR spectators' processing of technology-mediated stimuli, reinforcing the notion that presence and arousal stand as decisive determinants in shaping VR spectators' intentions toward VR consumption.

Regarding the mediators incorporated in the model, all indirect effects were observed to be significant. Notably, none of the factors – presence, arousal and consumption intentions – were found to be indirectly influenced by the visual imagery of VR spectators. However, their aural imagery, unlike their visual counterpart, exhibited a noteworthy indirect impact. This interesting result may be attributed to two key factors.

First, Baños *et al.* (2005) suggested that VR users initially rely heavily on visual imagery when entering a virtual environment. However, this reliance diminishes over time as users become more immersed in the virtual environment. The brief time of remaining in visual imagery is particularly relevant for VR spectators adapting to the contrast between their initial visual imagery and the perception of visual stimuli. In essence, the visual imagery of VR spectators is transient, especially as they begin to engage with various visual elements in their immediate virtual environment. Second, the researchers posit that the abundance of auditory stimuli at the venue plays a role in the indirect effects observed in aural imagery. In the VR stimuli employed in the study, the presence of a live band, for instance, overlaid the spectators' loud cheering in the reverberant venue, intensifying the auditory experience of the VR spectators. The incongruity between aural imagery and aural stimuli perception among VR spectators was relatively minor compared to the disparity observed in the visual sense. Consequently, within the congruency of the auditory sense, the aural imagery of VR spectators exerted significant indirect effects, whereas visual imagery did not.

Following the S-O-R model, consumers process external stimuli, where the internal evaluation of these stimuli, encompassing presence and arousal, is contingent on how each factor works. The present study tested the extended S-O-R model and revealed that the interplay of sensory imagery and stimuli, coupled with presence and arousal, provides a more precise prediction of consumption intentions among VR sport spectators, surpassing the inclusion of team identification as a controlling factor for presence and arousal. While prior research has underscored the paramount role of presence within a virtual environment (Lachini *et al.*, 2019; Schuemie *et al.*, 2001; Witmer and Singer, 1998; Yang and Zhang, 2022), the current study's findings align with and echo this emphasis. However, it is essential to clarify that this does not imply that VR spectators' perception of the virtual environment's realism singularly dictates their consumption intentions. Rather, it suggests that presence operates as a potent catalyst, adeptly heightening VR spectators' sensory experiences and thereby holding strategic value in influencing their consumption intentions.

Theoretical implications

The original framework of the S-O-R model encounters a notable challenge in adequately capturing consumers' evolving experiences, especially within a virtual environment where sensory stimuli are intricately mediated by technology. To address this, the current study enriches the S-O-R model by incorporating the pivotal elements of sensory imagery and presence, thoughtfully tailored to align with the distinct characteristics of a virtual setting. Sensory imagery assumes the role of an antecedent, preceding in the S-O-R model the stimuli component, effectively capturing the situational contingency of VR. In a parallel vein, presence is established as a direct mediator (organism), connecting the effect of stimuli to the response element within the S-O-R model. By introducing this extended framework, the study endeavors to unveil how VR sport spectators navigate sensory stimuli and subsequently manifest behaviors in a virtual environment.

Notably, the study discovered that VR sport spectators' intentions to consume VR are well predicted by the extended S-O-R model, which comprehensively captures the dynamics of sensory stimuli processing. The model's accountability is superior when omitting the effect of the spectators' team identification on presence and arousal. Despite the decisive role of team identification in sport spectators' behaviors (Clarke *et al.*, 2022), this finding suggests the extended model's robustness regarding processing technology-mediated sensory stimuli in a virtual environment.

As VR technology continues to evolve and offer increasingly diverse sensory stimuli on its platform, it becomes increasingly important to understand the sensory experience of VR sport spectators. The findings of this study bring a new level of understanding to the field of sport-consumer behavior, particularly regarding how sensory imagery and stimuli influence virtual spectating behavior and how manipulated stimuli, presence and arousal work together in a virtual environment.

Practical implications

The advent of Web 3.0 has brought about a new consumer behavior characterized by embracing virtual culture and its seamless integration into daily life. This evolving consumption trend is enabled by VR technology. Sports organizations should thus prioritize the accessibility of their games and associated features through VR, thereby granting sport consumers an enriched sensory immersion. By adopting this approach, they are poised to harness the emergent opportunities embedded within the dynamic landscape of Web 3.0.

The findings of the present study cast a spotlight on the pivotal significance of presence in the sensory experience of VR spectators. This underscores the need for sports practitioners to emphasize how VR spectators perceive the authenticity of the virtual environment. Consequently, enhancing the sensory encounter for VR spectators calls for a twofold approach: the orchestration of stimuli within their viewing experience and the alignment of their perceptual encounter with real-world stimuli during the spectating process. Both dimensions should be strategically harnessed in promotional and marketing endeavors. By recognizing the crucial role that sensory stimuli play, field practitioners will be better equipped to design and tailor their VR programs to meet the needs of their target audience.

Limitations and future research

The present study was situated within an NCAA D-1 women's volleyball match. While the popularity of this team within the institution served to substantiate the game for the choice of VR stimuli, it is important to acknowledge that the nature of, say, football or basketball could influence the manner in which VR spectators process sensory stimuli in a virtual environment. Specifically, factors like the VR spectators' familiarity with a particular sport

or their psychological traits like team identification and sport commitment may lead to dynamics distinct from those observed here.

Furthermore, it is worth noting that the participants examined in this study were college students, who are known for their inclination toward adopting the latest technological trends. Consequently, the study's findings may be constrained when extending them to other demographic groups.

Lastly, it should be noted that the study found an effect of VR spectators' sensory experience on their intentions to consume VR devices and services. While Ajen's (1991) planned behavior theory and substantial studies suggest a direct connection between consumers' consumption intentions and actual consuming behaviors, future studies should reveal how VR spectators' sensory experiences are related to their actual consumption, especially the degree and quality of the consumption.

Conclusion

The study's findings reveal that the most potent impact on VR spectators' intentions to consume VR content is delivered by arousal, while sensory imagery, sensory stimuli and presence also contribute to this effect. This finding sheds new light on how VR sport spectators process and interact with sensory stimuli in the virtual environment and how their sensory experience affects their consumption intentions. By leveraging these insights, sport practitioners can amplify the marketing and implementation of VR technology within the sports domain. The strategic design and delivery of a high-caliber sensory experience for VR sport spectators could unlock a plethora of opportunities for sport marketers and practitioners, facilitating the evolution of the VR sport market in tandem with the advancements of Web 3.0's innovative environment.

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Corresponding author

Kyu-soo Chung can be contacted at: kchung2@kennesaw.edu

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