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The impact of virtual reality (VR) technology on sport spectators' flow experience and satisfaction

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ABSTRACT

Virtual Reality Spectatorship (VRS) is becoming an emerging sport media consumption trend as it delivers such optimal experience that maximizes user satisfaction. To clearly understand media user experiences in VRS, the current study aimed to investigate how a media (media type), personal (sport involvement), and game (rivalry) factors influence spectators' flow experience and to examine the impact of flow experience on their satisfaction. We conducted a 2 (media type: VR vs. 2-D screen) \times 2 (rivalry: high vs. low) between subject experimental study where media type and rivalry were manipulated while sport involvement was measured. The results indicated that VRS amplified flow experience via vividness, interactivity, and telepresence to the greater extent than the traditional medium (2-D screen). Interestingly, sport viewers' sport involvement was found to amplify flow experience. Sport involvement also moderated the serial mediation (media \rightarrow vividness and interactivity \rightarrow telepresence \rightarrow flow experience); the effects of VR technology on flow experience was stronger for those who are less interested in the target sport than highly involved sport fans. Lastly, flow experience in VRS was found to substantially enhance user satisfaction.

1. Introduction

Virtual reality (VR) is becoming popular in diverse industries as a useful tool for product design, shopping, education and training, manufacturing process simulation, and entertainment. The VR market is expected to grow to \$120 billion by 2020 (Digi-Capital, 2016). Uptake has been particularly strong in the sport media industry; as VR technologies have advanced and devices have become affordable, the industry has been experimenting with them as a way of giving consumers optimal viewing experiences. For example, the National Basketball Association (NBA) recently launched an online VR subscription package, accessible via PlayStation VR, Windows Mixed Reality headsets, Google Daydream, or Samsung Oculus, which allows sport spectators to watch 27 live games in VR. Additionally, the National Football League (NFL) has produced a YouTube series and highlights in VR, and the NHL provided the 2016 All-Star Game in VR.

Why is virtual reality (VR) becoming more important in the sport media industry? Many sport organizations are facing several challenges including high expectation for high quality services and game watching experiences (Ko, Zhang, Cattani, & Pastore, 2011). Sport fans may prefer attending a sporting event to watching it via media, since the

former offers much more experiential depth. It is difficult to deliver a similar experience via traditional mass media (Ludvigsen & Veeraswamy, 2010). However, today's sport media consumers are increasingly seeking a home-watching experience that is on par with or superior to live sport attendance (King, 2010). VR technologies could support and enhance such experiential depth, giving viewers a sense of being at the game (i.e., telepresence; Steuer, 1992) and, thereby, a dramatically improved experience. As a result, virtual reality spectatorship (VRS) is becoming an emerging consumption trend in the major spectator sport and media industries. In the current study, we define VRS as a sport-watching behavior in a mediated spectating environment wherein virtual reality technologies provide a user with immersive experiences via amplified depth and breadth of sensory information, as well as an interactive user interface.

The primary function of VR is to provide an immersive experience to sport media consumers by enhancing telepresence. In academia, such immersive experiences have been examined using the concept of flow experience. Such an optimal experience is characterized by cognitive absorption, enjoyment, and time distortion (Chen, 2006; Ghani, 1995; Skadberg & Kimmel, 2004). The concept of flow experience is a barometer and enhancer of the quality of the sport consumption experience

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(Kim, Kim, & Kim, 2018), in addition to being a typical aspect of the media user experience (Hoffman & Novak, 2009). Although we intuitively know that VR technologies can enhance user experiences, we do not know much about the underlying mechanism that informs such user experiences in the context of VRS. This lack of understanding led to two major research questions: First, what factors enhance user experiences in VRS? Second, when and how does VRS enhance user experiences and satisfaction? It is theoretically and practically important to explore what produces flow experience in the context of VRS, and to consider when and how that experience can be amplified.

Despite the relevance of this phenomenon, there has been little research into the interaction between VR and the unique aspects of sport in the maximization of flow experience. The existing literature on sport spectators' flow experience (e.g., Kwon & Lee, 2015; Lee, Gipson, & Barnhill, 2017) has assumed that personal factors and/or situational factors determine that experience. However, in the VRS context, sport media consumption occurs via certain mediums (personal computers, mobile phones, TV, and VR devices), so media become major determinants of consumers' flow experiences (c.f. Finneran & Zhang, 2003).

In response to the call for theoretical explanations of the role of media technologies in creating flow experience and enhancing user satisfaction in VRS, the purpose of the current study was to investigate when and how flow experience is enhanced in VRS, and whether such experience contributes to user satisfaction. To create a theoretical framework, we applied and extended telepresence theory (Steuer, 1992) and flow theory (Csikszentmihalyi, 1975). In addition, we examined the role of a specific user characteristic—sport involvement—in flow experience using the Elaboration Likelihood Model (ELM) principle (Petty & Cacioppo, 1986).

2. Theoretical background

2.1. Telepresence and VR technology

Telepresence is defined as “the extent to which one feels present in the mediated environment, rather than in the immediate physical environment” (Steuer, 1992, p. 6). The term has often been used interchangeably with the concept of virtual presence, and several scholars have attempted to conceptualize and distinguish these concepts to clearly explain them (Lee, 2004; Mantovani & Riva, 1999). The concept of virtual presence is defined as the sense of being physically present in an unreal and imaginary environment with auditory, visual, or force displays generated by a medium (Sheridan, 1992). In discussions of virtual presence, that environment is not necessarily real, whereas in discussions of telepresence, the mediated environment being presented is understood to correspond to a real and remote environment (e.g., a basketball arena). Accordingly, we adopted the term “telepresence” to refer to sport media consumers' mediated perceptions of a distant environment.

A sport media viewer has two different environments: a mediated environment in which a sporting competition is actually occurring, and an immediate physical environment in which the viewer physically exists. For example, when a sport media consumer watches an NBA basketball game through a VR, they experience the distant mediated environment through the medium even though they actually exist in their living room (i.e., the physical environment). Sheridan (1992) proposed three determinants of the sense of (tele)presence: 1) the degree of sensory information, 2) the control of sensors relative to the environment, and 3) the ability to modify the physical environment. The degree of sensory information represents the bits of information transmitted to the relevant sensors of the observer. The control of sensors is the capacity of the observer to modify a sensor (i.e., the ability to change their viewpoint in the visual field). The ability to modify the physical environment is determined by the degree of motor control required to alter objects in the environment. In general, the

latter two are conceptualized together as interactivity (Zeltzer, 1992).

In line with Sheridan's conceptualization of presence, scholars have theorized the sense of telepresence as a function of the vividness and interactivity of VR environments (Hoffman & Novak, 1996; Laurel, 1991; Steuer, 1992). Vividness is defined as “the ability of a technology to produce a sensorially rich mediated environment” (Steuer, 1992, p. 10). Furthermore, vividness is determined by sensory breadth (i.e., the number of sensors required for a certain medium) and sensory depth (i.e., the resolution within each sensory channel). For example, radio requires an auditory channel, whereas TV requires both auditory and visual channels. In this case, TV provides more sensory breadth than radio. Similarly, because high-definition television (HDTV) provides higher-resolution images than standard-definition television, it offers more sensory depth than a regular TV. Shin (2017a) argued that the depth and breadth of information enables users to experience sensory, spatial, and social immersion when interacting with a VR environment. Interactivity, meanwhile, is “the extent to which users can participate in modifying the form and content of a mediated environment in real time” (Steuer, 1992, p. 14). It is a function of: 1) the speed with which a user's input is assimilated in the mediated environment; 2) the similarity in modification and control of content between the physical environment and the mediated environment (e.g., the degree to which controlling a viewpoint in the physical environment corresponds to similar control in the mediated environment); and 3) the range of different ways in which the content can be modified.

In any media environment, individuals interact with the environment using their own senses, and the extent to which a certain media technology can reproduce these sensory information determines the level of telepresence (Shih, 1998). In VR, users' perceptions are created by surrounding them with visual images, sounds or other stimuli that produce an engrossing total environment (Shin, 2017a). The existing literature suggests that visual and auditory sensations are particularly strongly related to the sense of telepresence (Hendrix & Barfield, 1996; Slater, Usoh, & Steed, 1994). Similarly, in the context of sport media consumption, visual and auditory information are the dominant sensory inputs. Therefore, they should largely determine sport media consumers' telepresence. However, the current form of VRS focuses on visual sensory inputs by offering enhanced visual depth, width and visual interactivity, but offers the same quality of auditory information as traditional sport media. Hence, in the current study, we focused on telepresence as determined by visual inputs.

According to existing classifications of media types by vividness and interactivity (Hyun, Lee, & Hu, 2009; Steuer, 1992), VR technologies provide a higher level of vividness and interactivity than traditional media, such as TV, computers, or mobiles (Hecht & Reiner, 2006; Lok, 2004; Nah, Eschenbrenner, & DeWester, 2011). Numerous empirical studies have shown that the sense of telepresence increases with the levels of these elements (Cauberghe, Geuens, & De Pelsmacker, 2011; Fortin & Dholakia, 2005; Khalifa & Shen, 2004). For example, Khalifa and Shen (2004) found that vividness and interactivity in virtual communities were significant predictors of telepresence. The existing literature regarding the effect of media structure on the sense of telepresence has shown that VR technologies provide a higher level of telepresence than traditional media (Hecht & Reiner, 2006; Lok, 2004; Nah et al., 2011). Accordingly, the current study assumed that VRS provides a higher level of telepresence than traditional sport media consumed via a two-dimensional screen (e.g., TV, computers, or mobiles) by offering enhanced vividness and interactivity. Therefore, we hypothesized that:

H1. VRS provides a greater telepresence than a 2-D screen via increased vividness and interactivity.

H1a. VRS provides a greater telepresence than a 2-D screen via increased vividness.

H1b. VRS provides a greater telepresence than a 2-D screen via

increased interactivity.

2.2. Flow experience in VRS

Flow experience is defined as “the holistic sensation that people feel when they act with total involvement” (Csikszentmihalyi, 1975, p. 36). Although scholars have agreed on this general definition, approaches to the concept in social science literature vary widely. For example, Skadberg and Kimmel (2004) conceptualized flow experience in terms of enjoyment and time distortion, while Senecal, Gharbi, and Nantel (2002) conceptualized it as comprising enjoyment, control, concentration, and challenge. Shin (2017a, 2018) conceptualized flow experience in the contexts of augmented reality (AR) and virtual reality (VR) as the mental state where complete involvement, enjoyment, and loss of one's senses of time and space are accompanied.

In the current study, we conceptualized flow experience in VRS as a psychological state entailing enjoyment, cognitive absorption, and time distortion. We did so for several reasons. First, sport media consumption is an autotelic experience oriented toward the obtainment of intrinsic rewards such as pleasure and enjoyment (Madrigal, 2006), and that autotelic experience is a major component of flow experience. Second, cognitive absorption is one of the constructs most commonly used to explain flow experience (Chou & Ting, 2003; Csikszentmihalyi, 1991; Koufaris, 2002; Shin, 2017a). According to Csikszentmihalyi (1991), the optimal experience occurs through intense concentration on a limited field of stimulus (i.e., cognitive absorption). The existing literature on flow experience in sport spectatorship has echoed this notion, using cognitive absorption (i.e. concentration) as a key indicator of flow experience (Jang, Kim, Lee, & Hur, 2012; Lee et al., 2017; Madrigal, 2006). Third, time processing and non-temporal processing co-vary in a negative manner, because if an activity (e.g., non-temporal processing) requires extensive attention (i.e., cognitive absorption), less attentive capacity is available for the time processing. Cooper and Tuthill (1952) argued that individuals could underestimate the duration of a time interval in periods of pleasure, amusement, or interest (i.e., flow state), whereas they could overestimate it during experiences of discomfort, anxiety, or boredom (i.e., out of the flow state). Recent sport literature (e.g., Jang et al., 2012; Kwon & Lee, 2015; Lee et al., 2017) has specified that time distortion is an indicator of flow experience.

Csikszentmihalyi, Abuhamdeh, and Nakamura (2014) suggest that three major conditions need to be met for flow experience to occur: 1) a balance between perceived skills and perceived challenges, 2) a clear goal, and 3) immediate feedback. This theorization of flow experience assumes that the interplay between personal and situational factors generates flow experience (Kmicik & Stein, 1992). For example, the eight-channel model of flow experience (Ellis, Voelkl, & Morris, 1994) suggests that individuals experience different psychological states depending on the skill levels (i.e., personal factors) and situational challenges (i.e., situational factors) associated with a certain activity. More specifically, an individual can experience the flow state when his or her skill levels and situational challenges are above the threshold (average value). However, if the perceived skill levels and situational challenges are below the threshold, the flow state might convert into other psychological states, such as boredom or apathy (Csikszentmihalyi, 1975; Ellis et al., 1994).

In the context of sport media, the consumption experience occurs through diverse media (e.g., a computer screen, radio, smartphone, TV, or virtual reality device), and each medium has unique attributes (i.e., interactivity and vividness). The current study therefore assumes that media type is a significant factor in determining sport media consumers' flow experience, because different attributes produce different levels of sensory information. Finneran and Zhang (2003) proposed the Person-Artifact-Task (PAT) model to explain key antecedents to flow experience in computer-mediated environments. In this model, the person,

artifact, and task represent personal, situational, and media factors as determinants of flow experience in media usage contexts. Here, the media “artifact” is a broad and neutral term that denotes a tool used to conduct a target task or activity. An artifact plays a significant role in media users' flow experience by increasing their likelihood of staying focused on the target task or experiencing telepresence (Finneran & Zhang, 2005). In addition, existing literature on media attributes and flow experience has shown that media attributes significantly influence media users' flow experience (e.g., Huang, 2003; Skadberg & Kimmel, 2004; Van Noort, Voorveld, & Van Reijmersdal, 2012). For example, Huang (2003) showed that web users' perceived interactivity and novelty positively influenced their flow experience. In a similar vein, Skadberg and Kimmel (2004) revealed that the interactivity and attractiveness of a website positively influenced users' flow experience. Van Noort et al. (2012) also found that the interactivity of a website led to a more intense flow experience. It can therefore be assumed that different types of media have unique attributes, and that, in the context of sport media consumption, such attributes influence flow experience differently by creating different levels of vividness, interactivity, and telepresence.

Several scholars have considered the concept of telepresence as a key element of flow experience (e.g., Pace, 2004; Shin, 2006; Skadberg & Kimmel, 2004), whereas others have identified the sense of (tele) presence as an antecedent to flow experience (Hoffman & Novak, 1996; Novak, Hoffman, & Yung, 2000; Shin, 2018; Zaman, Anandarajan, & Dai, 2010). Although these two approaches are conceptually and theoretically distinct, we specify telepresence as an antecedent of flow experience in the current study for several reasons. First, flow experience represents pleasurable immersion in a sport consumption experience itself rather than in the perceived reality of virtual environments (Mathwick & Rigdon, 2004; Shin, 2018). Thus, flow experience is considered an active and energized state (positive valence; Shin, 2018) rather than just a sense of being there (neutral valence). Media content (contexts), the artifact (media technology), and personal traits drive flow experience (Shin, 2017a, 2017b, 2018; Finneran & Zhang, 2003; Shin & Biocca, 2018), whereas media structure (the artifact) mainly drives telepresence. Second, telepresence is a necessary condition for flow experience, rather than a sufficient condition. That is, highly involved sport fans may experience flow regardless of the perceived reality of the virtual environments. By incorporating this theoretical assumption, the current study proposes that telepresence is an antecedent to flow experience in VRS. Specifically, it is hypothesized that:

H2. (Parallel Serial Mediation) VRS provides a greater flow experience than a 2-D screen via increased telepresence, which is amplified by vividness and interactivity.

H2a. VRS provides a greater flow experience than a 2-D screen via increased vividness and telepresence.

H2b. VRS provides a greater flow experience than a 2-D screen via increased interactivity and telepresence.

2.3. The role of sport involvement in flow experience

Despite the significance role of advanced media technology (VR) in flow experience, it cannot enhance the sense of engagement or satisfaction by itself. Immersion depends on context and on media users' traits (Shin, 2017a, 2017b, 2018; Shin & Biocca, 2018). In line with this notion and following the basic tenets of flow theory and Finneran and Zhang's (2003) PAT model, we suggest that, in the context of VRS, sport involvement is a user trait and a determinant of flow experience. Involvement is generally defined as an individual's interest in a target object, or the perceived centrality of a target object to his or her ego structure (Zaichkowsky, 1994). It is also conceptualized as an individual's motivational state in relation to a target object (Mittal, 1989). Involvement has received tremendous attention in social psychology

(Kirmani, Sood, & Bridges, 1999; Martín, Camarero, & José, 2011; Michaelidou & Dibb, 2006; Petty & Cacioppo, 1981), and it is a central concern in media use effects research (Sun, 2008). Building from Zaichkowsky's (1985) definition of involvement, we operationalized sport involvement as the degree to which a specific sport (e.g., basketball) is important and interesting to a sport media consumer.

As stated in the previous section, an individual's skills (knowledge and experience) in a certain activity must be above a certain threshold for him or her to experience the flow state (Csikszentmihalyi, 1975). Several scholars found that consumers who were highly involved in a specific product tended to have more knowledge about and experience of the product than those who were less involved with it (Batra & Ray, 1986; Celsi & Olson, 1988; Park & Moon, 2003). Scholars of media entertainment suggest that media enjoyment is a function of the media user's ability (knowledge and experience) to enter the flow experience using a particular medium (Sherry, 2004). This implies that a media user who lacks the interest in and skills to interpret information in certain media content is less likely to experience the flow state. Thus, in the context of VRS, it is assumed that highly involved sport fans should have greater knowledge and experience of a target sport, and skills for interpreting information from the media, than those with low involvement in the target sport.

Furthermore, highly involved sport fans are more likely to be engaged more in spectatorship (Ko, Chang, Jang, Sagas, & Spengler, 2017), intrinsically motivated to engage in the watching experience increases happiness (Jang, Ko, Wann, & Kim, 2017). Such enhanced intrinsic motivation is a major determinant of flow experience (Csikszentmihalyi, 1990). Koufaris (2002) argued that online consumers' involvement with a product influenced their flow experience due to their increased interest in that product. Specifically, online consumers' product involvement positively influenced their shopping enjoyment and concentration, which were major components of flow experience in online shopping contexts. Therefore, in line with the principles of flow theory (i.e., skills above the threshold and intrinsic motivation) and existing empirical evidence, we hypothesize that:

H3. Sport involvement positively influences flow experience.

According to the Elaboration Likelihood Model (ELM: Petty & Cacioppo, 1986), individuals follow a central route or a peripheral route depending on their motivation (involvement) for processing the given information and their ability (skills) to evaluate the information. Scholars have found that individuals employ the central route when they have sufficient motivation and ability to process the given information (i.e., high involvement), whereas they use the peripheral route when they have little motivation or ability to do so (i.e., low involvement; Bhattacherjee & Sanford, 2006; Gregory, Meade, & Thompson, 2013; Martín et al., 2011; Zhou, 2012). For example, Martín et al. (2011) determined that consumers who are highly involved in online shopping tend to evaluate their online shopping experience in terms of more on central cues such as service quality, warranty, and security policy. In contrast, those who are less involved tend to focus on experiential (or peripheral) cues, such as website interactivity.

Given these conditions, it is expected that sport media consumers will focus on different components of their watching experience (sport-related cues vs. non-sport-related cues) depending on their level of sport involvement. Specifically, highly involved sport media consumers would focus more on a target sport game per se, and they would be more likely to experience flow regardless of media artifacts than sport viewers with low involvement. In contrast, less involved sport viewers would be more likely to be influenced by media artifacts when evaluating their watching (i.e., flow) experience than highly involved sport fans. We therefore propose that sport involvement should function as a moderator (i.e., boundary condition) for the effect of media type on flow experience.

H4. (Moderated Mediation) Sport involvement moderates the indirect

effect of media type on flow experience through telepresence. The indirect effect of media type on flow experience is stronger for less involved sport viewers than for highly involved sport viewers.

2.4. The role of rivalry in flow experience

We consider the concept of perceived rivalry to be a determinant of flow experience as a situational (game) factor in the context of sport media consumption. A perceived rivalry is defined as an adversarial relationship with increased importance and competitive stakes (Havard, Gray, Gould, Sharp, & Schaffer, 2013). The perceived rivalry is related to the attractiveness of the contest (Tyler, Morehead, Cobbs, & DeSchrivier, 2017), and used to explain the demand for spectator sports (e.g., Butler, 2002; Tainsky & Jasielec, 2014; Tyler & Cobbs, 2017). Tainsky and Jasielec (2014) found that NFL viewership numbers increased by 14.7% when games featured a division rival. This finding provides empirical evidence for the role of rivalry as a source of increased psychological involvement in and increased attractiveness of sport contests (Havard et al., 2013; Kilduff, Elfenbein, & Staw, 2010). Such increased psychological involvement is a condition that is conducive to flow experience in sport media consumption. Accordingly, it is logical to assume that perceived rivalry is a key situational factor that enhances flow experience in this context. At the same time, rivalry could be considered a boundary condition for the indirect effect of media type on sport media consumers' flow experience through telepresence, because perceived rivalry changes consumers' psychological involvement in the target contest. Specifically, sport viewers may focus more on sport-related cues in a high-rivalry game due to their increased involvement, in which case their flow experience will mainly be influenced by the sporting competition itself rather than telepresence. In contrast, sport viewers may be more influenced by cues that are not relevant to the sport in a low-rivalry game than in a high-rivalry game. Therefore, we propose the following hypotheses:

H5. Game rivalry positively influences flow experience.

H6. (Moderated Mediation) Game rivalry moderates the indirect effect of media type on flow experience through telepresence. The indirect effect of media type on flow experience is stronger in low-rivalry games than high-rivalry games.

2.5. Flow experience and satisfaction

Consumer satisfaction is generally defined as fulfillment resulting from actual experiences relative to expected experiences (Herndon & Whitman, 2001). In the e-business context, Szymanski and Hise (2000) conceptualized and confirmed that satisfaction is a cumulative product of discrete experiences with the service provider. This implies that media users' satisfaction is a function of a set of discrete experiences in media environments. In studies on flow, flow experience has been considered to be a central concept in computer-mediated environments (Chang, 2013). It has also been used to explain online consumer experiences (Siekpe, 2005). In addition, previous studies have shown that flow experience significantly predicts user (consumer) satisfaction in media environments (Chang, 2013; Chang & Zhu, 2012; Reid, 2004; Shin, 2006; Xin Ding, Hu, Verma, & Wardell, 2010). For example, Chang and Zhu (2012) revealed that flow experience positively influenced user satisfaction on social networking sites. Flow experience has also been proven to be a significant predictor of spectators' satisfaction in sport contexts (Kim, 2011, 2016). Building on existing analyses of the relationship between flow experience and satisfaction in media environments and sport spectatorship, we propose that flow experience is a robust predictor of user satisfaction in VRS contexts. This is because it is not only a set of discrete experiences (i.e., cognitive absorption, time distortion, and enjoyment), but also an optimal experience in sport media consumption.

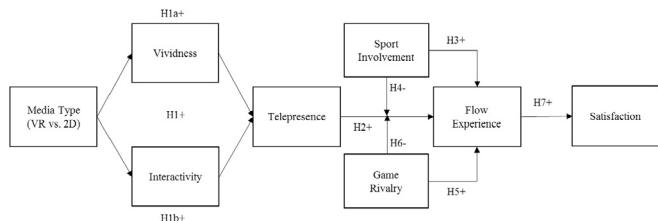


Fig. 1. Research model.

H7. Flow experience positively influences sport spectators' satisfaction in VRS contexts.

The hypotheses of this study are summarized in our research model (see Fig. 1), and the theoretical relationships among key research constructs are examined in the next section.

3. Method

3.1. Design and participants

To test the effects of media type (media factor), rivalry (game factor), and sport involvement (personal factor) on spectators' viewing experiences, we used a 2 (Media Type: VR vs. 2-D) \times 2 (Rivalry: High vs. Low) between-subjects experimental design. Our area of focus was the National Basketball Association (NBA). Since sport involvement is developed through long-term psychological processes (Funk & James, 2001), it is difficult for it to be temporally manipulated. Hence, media type and rivalry were manipulated, while sport (basketball) involvement was a measured selection. Participants were undergraduate students at a major public university in the southeastern United States. They received extra credit for participating in our experimental study.

We conducted a power analysis using G*Power 3.1 software (Paul, Erdfelder, Buchner, & Lang, 2009) to determine the sample size required to detect effects of the manipulations on flow experience (effect size = 0.30, alpha level = .05, power = .80, and number of groups = 4). The results of the power analysis showed that the current study required a total sample size of 126 to secure an actual power of .80. Accordingly, the authors aimed to collect at least 128 cases, (32 cases in each group), and collected 137. Thirty-three of these were in the high rivalry 2-D condition, 35 in the high-rivalry VR condition, 33 in the low-rivalry 2-D condition, and 36 in the low-rivalry VR condition. The data collection for the main study was performed in April 2018. After the exclusion of 9 cases due to participants' prior exposure to the target stimuli, a total of 129 cases were included in the final analysis. The average age of participants was 20.80 ($SD = 1.31$), and 78 (60.5%) were male. Caucasians were the largest racial group, making up 69.8% ($n = 90$) of participants, followed by Hispanics ($n = 20$; 15.5%), African-Americans ($n = 9$; 7.0%), Asians ($n = 9$; 7.0%), and American Indians ($n = 1$; 0.8%).

3.2. Stimuli

The authors conducted a pilot study on March 15th, 2018 to select appropriate stimuli. For that study, we recruited 36 undergraduate students at a major public university in the southeastern United States, in order to investigate their perceived rivalry across 23 NBA games (23 games were provided by the NBA in a virtual reality format). The perceived rivalry was measured using an existing scale (Kilduff et al., 2010), a single-item measure anchored by a Likert-type question: "Please indicate the extent to which you see the teams below as rivals" (1 = No Rivals; 7 = Fierce Rivals). The descriptive statistics obtained from the pilot study showed that perceived rivalry ranged from 1.75 ($SD = 1.31$) to 5.04 ($SD = 1.61$). We selected a game between the Boston Celtics and the New York Knicks for the high-rivalry condition ($M = 5.04$, $SD = 1.61$), and another one between the Brooklyn Nets

and the Phoenix Suns for the low-rivalry condition ($M = 1.78$, $SD = 1.01$).

We also manipulated media type by showing participants the stimulus using either a VR device or 2-D screen. In the VR condition, participants watched the target stimulus using a PlayStation VR headset that weighs 1.3 lbs. And provides 1080 \times 960 resolution, a 100-degree field of view, and a 90–120 Hz refresh rate. In the 2-D screen condition, participants watched the target stimulus via a 2-D computer screen, which was a 19" widescreen flat-panel LCD monitor with 1440 \times 900 resolution. We selected PlayStation from among several media platforms (e.g., Oculus, Daydream, and Mixed Reality) because it provides both NBA season pass (2-D screen) and VR options for NBA viewing. By using the same media platform, we set the same volume level (30 out of 50) in both the VR and 2-D screen conditions in order to control the effect of auditory factors on viewing experiences.

3.3. Measure

3.3.1. Independent variables

For the purpose of the manipulation check, we measured perceived rivalry using the same item as in the pilot study, but included team names: "Indicate the extent to which you see the teams (e.g., Brooklyn Nets vs. Phoenix Suns) as rivals." Subsequently, we also performed an independent-sample *t*-test to check the manipulation of rivalry. The *t*-test showed that a significant difference in perceived rivalry exists between the high-rivalry ($M = 5.28$, $SD = 1.25$, $n = 61$) and the low-rivalry condition ($M = 2.50$, $SD = 1.40$, $n = 68$); $t(127) = -11.931$, $p < .001$. The result indicated that the manipulation was successful. Meanwhile, participants' sport (basketball) involvement was measured using selected measures of Zaichkowsky's (1994) scale, in which the dimensions of irrelevant/relevant, boring/interesting, and unimportant/important were ranked using seven-point semantic-type measures.

3.3.2. Dependent variables

We measured the dependent variables (i.e., vividness, interactivity, telepresence, flow, and satisfaction) using existing scales anchored by 1 (not at all) and 7 (very much). Specifically, we measured vividness with three items adopted and modified from Kelley, Gaidis, and Reingen (1989) and Yim, Chu, and Sauer (2017). We measured interactivity with three items adopted from Yim et al.'s (2017) study. Telepresence was measured with three items adopted from the existing literature on [tele]presence (Kim & Biocca, 1997; Novak et al., 2000).

Based on the extensive literature review, we conceptualized consumers' flow experience as a psychological state characterized by cognitive absorption, time distortion, and enjoyment. Cognitive absorption was measured using three items adopted from Ferguson, Olson, Kutner, and Warner (2014) and Koufaris (2002). There are two approaches to measuring time distortion, one that uses objective measures (difference between actual duration and seeming duration) and another that uses subjective measures (e.g., Novak et al., 2000; Skadberg & Kimmel, 2004). The current study relied on subjective measures of time distortion, because there was a possibility that participants could accurately estimate the time elapsed using the clock in the stimulus, even when they perceived time was passing quickly. Accordingly, time distortion was measured using two subjective items adopted from Skadberg and Kimmel (2004). Enjoyment was measured using three items adopted from Ghani, Supnick, and Rooney (1991). Lastly, we measured satisfaction with two items adopted from the previous studies (Brady, Knight, Cronin, Hult, & Keillor, 2005; Yoshida & James, 2010).

3.3.3. Measurement model validation

We conducted a confirmatory factor analysis (CFA) using Mplus8 to validate the measurement model. Specifically, we examined a six-factor hypothesized model including sport involvement, vividness, interactivity, telepresence, satisfaction, and flow (second-order factor

Table 1
Summary results of measurement model validation (CFA results).

Measurement Items		λ	C.R.	AVE
Vividness (When I watched this game)		.905	.762	
I thought the sensory information provided by the screen was highly vivid.	.902			
I thought the sensory information provided by the screen was highly rich.	.932			
I thought the sensory contents provided by the screen was highly detailed.	.776			
Interactivity (When I watched this game)		.827	.620	
I felt that I had a lot of control over the content of the game.	.693			
I could watch the game in an interactive way.	.941			
I felt I could control my visual perspective.	.704			
Telepresence (When I watched this game)		.875	.703	
I forgot about my physical location.	.673			
I felt I was in the arena.	.906			
I felt my mind was inside the arena.	.915			
Sport Involvement (To me basketball is ...)				
Unimportant/Important	.850	.894	.739	
Irrelevant/Relevant	.931			
Boring/Interesting	.788			
Flow Experience (When I watched this game)		.824	.621	
(Cognitive Absorption) I was totally focused on the game.	.905	.919	.791	
(Cognitive Absorption) I was deeply engrossed in the game.	.948			
(Cognitive Absorption) I was absorbed intensely.	.884			
(Time Distortion) It felt like time flew.	.986	.948	.900	
(Time Distortion) Time seemed to go by very quickly.	.910			
(Enjoyment) It was enjoyable.	.911	.953	.872	
(Enjoyment) It was exciting.	.948			
(Enjoyment) It was fun.	.854			
Satisfaction		.792	.656	
I was satisfied with this game.	.773			
I was satisfied with my viewing experience.	.845			

including cognitive absorption, time distortion, and enjoyment). The hypothesized measurement model indicated an acceptable fit to the data: $\chi^2(191) = 271.763$, $p < .05$; root mean square error of approximation (RMSEA) = 0.057 [90% CI: 0.041 to 0.072]; comparative fit index (CFI) = 0.967; Tucker-Lewis index (TLI) = 0.960; standardized root mean square residual (SRMR) = 0.046. The results of the CFA indicated that all factor loadings were statistically significant (See Table 1). The average variance extracted (AVE) values of the constructs ranged from 0.62 (interactivity) to 0.76 (vividness). In addition, the reliability coefficients ranged from 0.79 (satisfaction) to 0.91 (vividness). These results provide empirical evidence of convergent and discriminant validity of the measurement scale (Hair, Black, Babin, Anderson, & Tatham, 2006). Therefore, we collapsed all items on each of the theorized constructs to yield single variables. Table 2 summarizes the descriptive statistics including the correlations, means, standard

deviations, skewness, and kurtosis of the variables.

3.4. Data analysis

To test the research hypotheses, we performed conditional process modeling with 10,000 resamples for the bootstrap confidence intervals, using the syntax (Model 79: Stride, Gardner, Catley, & Thomas, 2016) in Mplus 8 for estimating moderated-mediation models based on Hayes's (2013) process model. The conditional process modeling estimates 95% confidence intervals for the parallel (Hypothesis 1), serial (Hypothesis 2), and conditional indirect effects (Hypothesis 4 and 6) using specific formulae. For hypothesis 1, we estimated a set of two indirect effects, $a_1 b_1 + a_2 b_2$, where a_1 represents the regression coefficient of media type on vividness, a_2 represents the regression coefficient of media type on interactivity, b_1 represents the regression coefficient of vividness on telepresence, and b_2 represents the regression coefficient of interactivity on telepresence. To test hypothesis 2, we estimated a parallel serial indirect effect, $a_1 b_1 c + a_2 b_2 c$, where c represents the regression coefficient of telepresence on flow experience. Hypothesis 4 was tested by estimating a conditional indirect effect (moderated mediation), $\{[a_1 b_1 c] + [a_1 b_1 e_1 \times \text{level of sport involvement}]\} + \{[a_2 b_2 c] + [a_2 b_2 e_1 \times \text{level of sport involvement}]\}$, where e_1 represents the regression coefficient of the interaction term between telepresence and sport involvement on flow experience. To test hypothesis 6, we estimated a moderated mediation at two levels of rivalry, $\{[a_1 b_1 c] + [a_1 b_1 e_2 \times \text{level of rivalry}]\} + \{[a_2 b_2 c] + [a_2 b_2 e_2 \times \text{level of rivalry}]\}$, where e_2 represents the regression coefficient of the interaction term between telepresence and rivalry on flow experience. The statistical significance of these indirect effects was determined based on whether the 95% confidence intervals included zero or not.

3.5. Procedure

By carefully following the IRB protocol approved from the university where data collection was conducted in February 2018 (IRB201800638), we conducted the main experiment and recruited undergraduate students by offering an extra credit (less than 1% of the final grade) in their class. The main experiment had three phases. In the first phase, participants were randomly assigned to one of the four conditions, and were told that they would participate in a study on sport media consumption. In this phase, participants were briefly informed of the overall procedure, as well as the voluntary nature of participation of the experiment, and then they were asked to sign a consent form. Additionally, they were asked to answer questions regarding their perception of rivalry in the target stimulus (manipulation check), background information (screening questions), and

Table 2
The results of the correlation and the descriptive analysis.

	Media	Rivalry	Inv	Vivid	Inter	Tele	Flow	Sat	IT	RT
Media	1									
Rivalry	0.002	1								
Inv	0.103	0.120	1							
Vivid	0.378	-0.025	0.112	1						
Inter	0.630	-0.086	0.239	0.448	1					
Tele	0.635	-0.005	0.207	0.436	0.585	1				
Flow	0.550	0.055	0.375	0.447	0.541	0.712	1			
Sat	0.479	0.103	0.381	0.454	0.514	0.641	0.719	1		
IT	0.547	0.084	0.667	0.405	0.533	0.838	0.687	0.648	1	
RT	0.038	0.943	0.145	-0.011	-0.058	0.029	0.069	0.083	0.124	1
Mean	-	-	5.235	5.643	4.512	4.664	5.501	5.717	-	-
Variance	-	-	2.014	0.989	2.214	2.721	1.186	1.038	-	-
Skewness	-	-	-0.738	-0.724	-0.154	-0.466	-0.842	-0.702	-	-
Kurtosis	-	-	-0.142	0.976	-0.658	-0.796	1.068	0.461	-	-

Note. Media: Media Type, Inv: Sport Involvement, Vivid: Vividness, Inter: Interactivity, Tele: Telepresence, Sat: Satisfaction, IT: Interaction Term between Sport Involvement and Telepresence, and RT: Interaction term between Rivalry and Telepresence.

involvement in sport (independent variable). In the second phase, participants watched a high- or low-rivalry NBA game via either 2-D screen or VR device for five minutes. In the third phase, participants were asked to answer questions regarding dependent variables (vividness, interactivity, telepresence, flow experience, and satisfaction) and demographic questions. Once participants completed the experiment, they were debriefed and thanked. The average time to complete the experiment for each participant was 20–25 min.

4. Results

The results of hypothesis testing revealed that the indirect effect of media type on telepresence via vividness (*Hypothesis 1a*) was statistically significant ($\beta = 0.272$; 95% CI [0.038 to 0.623]), with a 95% confidence interval not including zero. The indirect effect of media type on telepresence via interactivity (*Hypothesis 1b*) was also statistically significant ($a_2 b_2 = 1.014$; 95% CI [0.596 to 1.455]). The total indirect effect of media type on telepresence through vividness and interactivity (*Hypothesis 1*) was statistically significant ($\beta = 1.286$; 95% CI [0.887 to 1.694]). Taken together, *hypothesis 1* was supported.

The results also showed that the indirect effect of media type on flow experience through vividness and telepresence (*Hypothesis 2a*) was statistically significant ($\beta = 0.207$; 95% CI [0.031 to 0.620]), with a 95% confidence interval not including zero. The indirect effect of media type on flow experience via interactivity and telepresence (*Hypothesis 2b*) was also statistically significant ($\beta = 0.772$; 95% CI [0.376 to 1.342]). The total indirect effect of media type on flow experience through vividness, interactivity, and telepresence (*Hypothesis 2*) was statistically significant ($\beta = 0.980$; 95% CI [0.500 to 1.678]). Therefore, *hypothesis 2* was supported.

Regarding *hypothesis 3*, the results showed that sport involvement had a significant positive impact on flow experience ($\beta = 0.44$, $p < .001$). Therefore, *hypothesis 3* was supported. In terms of *hypothesis 4*, the moderated mediation was statistically significant ($\beta = -0.51$, $p < .05$). Additionally, the indirect effect of media type on flow experience through vividness, interactivity, and telepresence was estimated at each level of sport involvement (produced by the process macro: low [-1 SD] = 3.8, medium [mean] = 5.2, and high [+1 SD] = 6.6). The results revealed that the indirect effect was statistically significant at all levels of sport involvement: low ($\beta = 0.684$; 95% CI [0.441 to 0.983]), medium ($\beta = 0.575$; 95% CI [0.380 to 0.802]), and high ($\beta = 0.466$; 95% CI [0.269 to 0.721]). These results indicated that the indirect effect was diminished as the level of sport involvement increases (see Fig. 2). Taken together, *hypothesis 4* was tenable.

With regard to *hypothesis 5*, the results revealed that rivalry did not have a significant impact on flow experience ($\beta = 0.01$, $p = .56$).

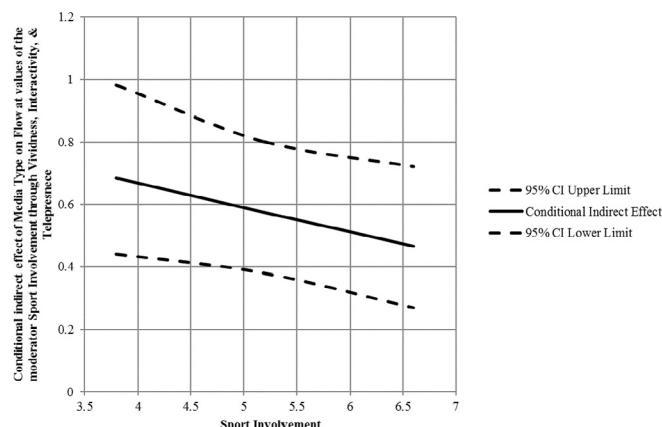


Fig. 2. The Conditional Indirect Effects of Media Type on Flow depending on Sport Involvement.

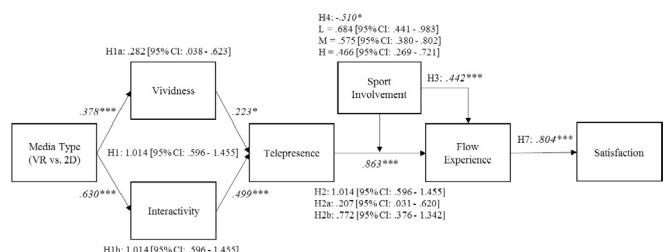


Fig. 3. The Direct, Indirect, and Conditional Indirect Effects. Note. * $p < .05$, ** $p < .01$, *** $p < .001$; L: Low Involvement, M: Medium Involvement, H: High Involvement; Italicized: Standardized Coefficients.

Hence, *hypothesis 5* was not supported. Additionally, the moderated mediation was not statistically significant ($\beta = -0.06$, $p = .67$). Therefore, *hypothesis 6* was not supported. Lastly, flow experience was found to positively influence satisfaction ($\beta = 0.80$, $p < .001$). Accordingly, *hypothesis 7* was supported. The overall results are shown in Fig. 3.

5. Discussion

5.1. The process mechanism related to user experiences in VRS

Drawing on telepresence theory, flow theory, and ELM principles, we demonstrated that in the context of sport media consumption, VR technology significantly enhances telepresence through increased vividness and interactivity. Our results indicated that VR technology provides consumers with greater vividness and interactivity than traditional (e.g., 2-D screen) media, and that these two attributes significantly enhance their telepresence. These findings support the basic tenet of the telepresence theory, that telepresence is function of vividness and interactivity (Steuer, 1992), as well as the conclusions of the existing literature on the effects of VR technology on telepresence (Hecht & Reiner, 2006; Lok, 2004; Nah et al., 2011; Riva et al., 2007).

The results also showed that media artifacts amplified sport media consumers' flow experience through telepresence. This finding has very important theoretical implications, because it supports the argument that telepresence should be conceptualized as an antecedent of flow experience (Hoffman & Novak, 1996; Novak et al., 2000; Shin, 2018; Zaman et al., 2010). Specifically, the result is consistent with Zaman et al.'s (2010) study, which demonstrated telepresence was a key determinant of flow experience in the usage of internet-based communication technologies. The current study showed a strong direct effect of telepresence on flow experience ($\beta = 0.86$, $p < .001$), as well as the substantial indirect effects of media type on flow experience through telepresence. These results support the Person-Artifact-Task (PAT) model (Finneran & Zhang, 2003) by suggesting that media artifact is a major determinant of flow experience in media usage. We can therefore conclude that telepresence is a key determinant of flow experience in VRS contexts.

5.2. The dual role of sport involvement in flow experience

We found that sport involvement positively influenced flow experience. When a viewer is highly involved in professional basketball, he or she experiences a flow state during sport media consumption. This finding is consistent with a key assumption of flow theory, which is that an individual's knowledge (experience) or skills should be above a threshold in a target activity in order for them to experience a flow state. As might be expected, given that the level of sport involvement affects an individual's knowledge of or ability to appreciate a target sport, highly involved sport fans experience a flow state to a greater extent than viewers who are less involved.

It is also noteworthy that the level of sport involvement moderated

the indirect effect of media type on flow experience via vividness, interactivity, and telepresence. The indirect effect was stronger for less involved viewers than for highly involved sport fans. This finding implies that the benefits of VR technologies designed to enhance viewer experience are greater for individuals who are less interested in a target sport. A possible explanation for the finding is that highly involved sport fans are motivated to engage in their viewing experience regardless of the media format. Furthermore, sport-related information (e.g., the quality of the target game) significantly influences highly involved sport fans' viewing experiences, while non-sport-related information (e.g., media vividness, interactivity, and telepresence) significantly influences less involved fans' viewing experiences. This interpretation is supported by the elaboration likelihood model (ELM; Petty & Cacioppo, 1986), which posits that high-involvement groups focus on central cues, whereas low-involvement groups focus on peripheral cues. Taken together, these factors indicate that sport involvement level is an important boundary condition for the indirect effect of media artifacts on flow experience through vividness, interactivity, and telepresence in VRS contexts.

5.3. Insights related to the game factor determining flow experience

We hypothesized that game rivalry is an important determinant of flow experience, as well as a boundary condition for the indirect effect of media artifacts on flow experience. However, our results did not show significant effects of rivalry on flow experience. An alternative explanation of the null effects is a possible relationship between rivalry and social identity. According to social identity theory (Tajfel, 1974), individuals tend to affiliate with a particular group to enhance their self-esteem. Such affiliation becomes more salient in rivalry games (Luellen & Wann, 2010). Kilduff et al. (2010) argue that rivalry exists when an individual imposes greater importance on the outcomes of a competition against a specific opponent, since those outcomes influence the individual's social identity. Therefore, in order for rivalry to significantly influence flow experience, a decent level of affiliation with a target team is a necessary condition. In the current study, however, the target participants were undergraduate students at a major public university in the southeastern United States, and the teams in the stimuli were located in the northeast (Brooklyn, Boston, and New York) and southwest (Phoenix). As a result, the participants may not have had a strong enough affiliation with the teams used in the stimuli.

5.4. Flow and user satisfaction in VRS

Lastly, flow experience was found to substantially elevate user satisfaction in the context of VRS ($\beta = 0.80, p < .001$). This finding is consistent with the existing literature on the positive effect of flow experience on satisfaction in diverse contexts (Chang, 2013; Chang & Zhu, 2012; Kim, 2011, 2016; Reid, 2004; Shin, 2006; Xin Ding et al., 2010). The finding implies that flow experience is a very important diagnostic cue in the evaluation of the overall viewing experience. Accordingly, we conclude that flow experience is a robust predictor of satisfaction in the context of VRS and sport media consumption.

6. Implications

6.1. Theoretical implications

The current study makes several meaningful theoretical contributions to the literature on media and flow experience. First, the results extend the insights offered in existing studies by highlighting the dynamic effects of the selected media factor (media type) on media user experiences. Since VRS is a new and emerging pattern of sport media consumption, the specific mechanisms by which user experiences (i.e., flow and satisfaction) are affected by the selected factors in that medium remain uninvestigated. While the existing literature has

suggested the importance of flow experience in VR (Shin, 2018), there is little empirical evidence to demonstrate how each medium influences sensory perception (visual vividness and interactivity), mediated perception (telepresence), flow, and satisfaction differently. The current study pinpointed how VRS amplifies user experiences more than traditional media formats by testing a holistic process model containing parallel and serial mediation (media type [VRS vs. 2-D screen] → media attributes [vividness and interactivity] → telepresence → flow).

Second, the current study contributes to the literature by identifying a personal factor (sport involvement) that has an impact on flow experience in sport media consumption. Researchers working in the area of sport spectatorship have mainly focused on the concept of team identification (psychological attachment to the favorite team) as a determinant of flow experience (Chang, Wann, & Inoue, 2018; Kwon & Lee, 2015; Lee et al., 2017). As a result, little academic attention has been paid to the role of sport involvement as an enhancer of flow experience. A major difference between team identification and sport involvement is the target entity to which sport viewers are attached (target team vs. target sport). The results of the current study imply that sport media consumers experience flow states when they are highly involved in the target sport, even if their favorite teams are not competing.

Furthermore, the current study demonstrates the dual role of sport involvement in flow experience. We found that sport involvement does not only affect flow experience directly, but also functions as a boundary condition for the entire process through which VRS enhances flow experience. Specifically, the results showed that VRS provides greater vividness and interactivity, and further, that these two media attributes significantly enhance telepresence, which is a strong determinant of flow experience. However, such benefits were found to be diminished for highly-involved sport fans. These findings are particularly important, because the majority of the media literature has either focused on the direct effects of media technologies on flow experience or on their simple mediation effects. Therefore, the results of conditional indirect effect test provide a new theoretical insight into the process mechanism of user experiences in VRS by demonstrating that parallel and serial mediation, and their conditional effects, depend on the personal factor of sport involvement.

In addition, our results illuminate the theoretical relationship between telepresence and flow experience. As noted, the scholarship on the theoretical relationship between telepresence and flow is inconclusive; there is some question as to whether (tele)presence is a component (e.g., Pace, 2004; Shin, 2006; Skadberg & Kimmel, 2004) or an antecedent of flow (Hoffman & Novak, 1996; Novak et al., 2000; Shin, 2018; Zaman et al., 2010). The current study provides an empirical demonstration of their discriminant validity, and highlights its mediating role in the relationship between media artifact and flow experience.

Lastly, our study introduces the concept of VRS to the literature on sport media. Since watching sporting events using VR is a new form of consumption, scholars have not yet developed a conceptual vocabulary for it. Recent works on sport media have mainly focused on social media (Abeza, O'Reilly, Séguin, & Nzindukiyimana, 2015), and little attention has been paid to VRS. . Therefore, the current study offers a conceptual foundation of VRS to the media literature and creates future research opportunities for developing theoretical foundation in this interesting venue.

6.2. Practical implications

Our research also has several practical implications. First, the results suggest that sport organizations and sport media content providers should aggressively adopt VRS as a primary product content in the major spectator sport industry. Such a tool may help expand the existing market and attract new markets by providing a higher level of telepresence, and thus enhancing the immersive viewing experience.

Currently, professional sport leagues and teams are experimenting with VRS, but only the NBA provides a VR league pass as a real product (\$49.99 for 27 games in the 2017–2018 season). Therefore, VRS still offers numerous and substantial business opportunities for sport organizations.

Second, VR technology can be further developed in ways that amplify telepresence. The results of the current study suggest that VR can enhance fans' flow experience via telepresence. They thus imply that telepresence is a key factor in maximizing the benefits of VR technology in VRS. One possible way to amplify telepresence in VRS is to enhance media interactivity by enabling users to freely select camera angles. Consumers cannot do so in the current version of VRS. Another way to magnify telepresence is to enhance media vividness by providing a higher-resolution display. The VRS used in the current study is not much more superior to that of traditional media. Recently, some companies have started developing VR headsets delivering 2880 × 1600 resolution (Roettgers, 2018). Creating such higher interactivity and vividness in VRS may further enhance telepresence, resulting in a more engaging spectator experience.

Third, the findings of the current study can help in developing effective strategies to attract different types of viewers to this emerging market. Our research revealed that the effect of VR technology on flow experience was stronger for less involved viewers than highly involved ones. This suggests that offering VRS to less involved or new sport viewers could be an effective strategy for enhancing their sport media consumption and loyalty. Therefore, marketers need to actively promote VRS when targeting people who are less interested in sport products.

7. Limitations and suggestions for future research

While the theoretical and practical contributions of the current study are considerable, it does have some limitations. We outline those limitations here in order to illuminate avenues for future research. First, we did not uncover any significant effects of the game factor (rivalry) on flow experience. As discussed in the previous section, rivalry is likely to work when it is present as "subjective rivalry," which is related social identity. Therefore, scholars should carefully examine the role of subjective rivalry on consumers' flow experience in VRS contexts. Furthermore, it is necessary to identify other situational factors (target matches/playoff games vs. regular season games) that may influence sport media consumers' VRS flow experience.

Second, the purpose of the study was to examine the impact of VRS on the "state of flow" rather than the "process of flow." Therefore, we measured consumers' flow experiences in the short term. As a result, we do not know how long the participants' flow experience lasts and how the identified determinants impact flow experience throughout an entire game. It is possible that individuals move in and out of flow experience in an activity (ebb and flow; Pearce, Ainley, & Howard, 2005). In future studies, researchers should measure flow experience in ways that can capture the process of flow, in order to fully understand the changes that happen to sport media consumers during their viewing experiences.

Third, the current study excluded skills and situational challenges as determinants of flow experience in the context of sport media consumption. This was because the main focus of our research was on examining the specific mechanism through which VRS (the media factor) amplifies flow experience. Additionally, we were interested in identifying a new personal factor (sport involvement) and situational factor (rivalry) that have effects on flow experience in sport media consumption. As suggested by flow theory, we acknowledge that skills as a personal factor and situational challenges are major determinants of flow experience in media usage contexts (Jin, 2011, 2012). However, the balance between skills and situational challenges may have two facets in sport media consumption. First, skills may represent viewers' knowledge of or experiences through which to understand the media

content (sport contests), and challenges may represent the perceived difficulty of appreciating the target media content. Second, due to the fact that sport spectatorship is a vicarious experience (Funk, Mahony, Nakazawa, & Hirakawa, 2001), skills may reflect the performance of viewers' favorite teams, whereas situational challenges may represent the performances of opponents. Therefore, in our study, we incorporated rivalry concept instead. Further examination of the balance between skills and situational challenges and their impact on flow experience is another important research avenue in sport media consumption.

Lastly, the concept of flow experience has been found to predict diverse (media) consumer behaviors, including attitudes (Korzaan, 2003; Lu, Zhou, & Wang, 2009), positive affect (Chiang, Sunny, Chao-Yang, & Liu, 2011; Novak et al., 2000), psychological well-being (Rogatko, 2009), and diverse behavioral intentions (Agarwal & Karahanna, 2000; Sharkey, Acton, & Conboy, 2012; Shin & Kim, 2008; Zhou, 2013). In contrast to the positive outcomes of flow experience, flow experience may result in negative outcomes such as pathological Internet use (Bridges & Florsheim, 2008) and addictive behavior (Chou & Ting, 2003). Therefore, future research needs to investigate both positive and negative outcomes of flow experiences to clearly understand user experiences in the context of VRS.

We conclude that VRS substantially enhances user experiences, and that such experiential benefits are greater for those who are less involved in the target sport. We also conclude that flow experience is a very important concept for explaining user satisfaction in the context of sport media consumption. Despite its limitations, the current research not only makes theoretical contributions to the consumer behavior and media literature by offering new insight into the holistic processes of flow experience and user satisfaction in VRS, but it also provides practical suggestions for media providers and VRS developers.

References

- Abeza, G., O'Reilly, N., Séguin, B., & Nzindukiyimana, O. (2015). Social media scholarship in sport management research: A critical review. *Journal of Sport Management*, 29(6), 601–618.
- Agarwal, R., & Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly*, 24(4), 665–694.
- Batra, R., & Ray, M. L. (1986). Situational effects of advertising repetition: The moderating influence of motivation, ability, and opportunity to respond. *Journal of Consumer Research*, 12(4), 432–445.
- Bhattacherjee, A., & Sanford, C. (2006). Influence processes for information technology acceptance: An elaboration likelihood model. *MIS Quarterly*, 30(4), 805–825.
- Brady, M. K., Knight, G. A., Cronin, J. J., Hult, T. M., & Keillor, B. D. (2005). Removing the contextual lens: A multinational, multi-setting comparison of service evaluation models. *Journal of Retailing*, 81(3), 215–230.
- Bridges, E., & Florsheim, R. (2008). Hedonic and utilitarian shopping goals: The online experience. *Journal of Business Research*, 61(4), 309–314.
- Butler, M. R. (2002). Interleague play and baseball attendance. *Journal of Sports Economics*, 3(4), 320–334.
- Cauberghe, V., Geuens, M., & De Pelsmacker, P. (2011). Context effects of TV programme-induced interactivity and telepresence on advertising responses. *International Journal of Advertising*, 30(4), 641–663.
- Celsi, R. L., & Olson, J. C. (1988). The role of involvement in attention and comprehension processes. *Journal of Consumer Research*, 15(2), 210–224.
- Chang, C. C. (2013). Examining users' intention to continue using social network games: A flow experience perspective. *Telematics and Informatics*, 30(4), 311–321.
- Chang, Y., Wann, D. L., & Inoue, Y. (2018). The effects of implicit team identification (iTeam ID) on revisit and WOM intentions: A moderated mediation of emotions and flow. *Journal of Sport Management*, 32, 1–14.
- Chang, Y. P., & Zhu, D. H. (2012). The role of perceived social capital and flow experience in building users' continuance intention to social networking sites in China. *Computers in Human Behavior*, 28(3), 995–1001.
- Chen, H. (2006). Flow on the net—detecting Web users' positive affects and their flow states. *Computers in Human Behavior*, 22(2), 221–233.
- Chiang, Y.-T., Sunny, S. J., Chao-Yang, C., & Liu, E. Z.-F. (2011). Exploring online game players' flow experiences and positive affect. *TOJET: The Turkish Online Journal of Educational Technology*, 10(1), 106–114.
- Chou, T. J., & Ting, C. C. (2003). The role of flow experience in cyber-game addiction. *CyberPsychology and Behavior*, 6(6), 663–675.
- Cooper, L. F., & Tuthill, C. E. (1952). Time distortion in hypnosis and motor learning. *The Journal of Psychology*, 34(1), 67–76.
- Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety*. San Francisco: Jossey-Bass.

- Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal performance*. New York: Cambridge University.
- Csikszentmihalyi, M. (1991). *Flow: The psychology of optimal experience*. New York: HarperCollins.
- Csikszentmihalyi, M., Abuhamdeh, S., & Nakamura, J. (2014). Flow. *Flow and the foundations of positive psychology* (pp. 227–238). Boston, MA: Springer.
- Digi-Capital (2016). *Augmented/Virtual Reality revenue forecast revised to hit \$120 billion by 2020*. <https://www.digi-capital.com/news/2016/01/augmentedvirtual-reality-revenue-forecast-revised-to-hit-120-billion-by-2020/#.WqICSSPwYWo>, Accessed date: 8 March 2018.
- Ellis, G. D., Voelkl, J. E., & Morris, C. (1994). Measurement and analysis issues with explanation of variance in daily experience using the flow model. *Journal of Leisure Research*, 26(4), 337–356.
- Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, 41(4), 1149–1160.
- Ferguson, C. J., Olson, C. K., Kutner, L. A., & Warner, D. E. (2014). Violent video games, catharsis seeking, bullying, and delinquency: A multivariate analysis of effects. *Crime & Delinquency*, 60(5), 764–784.
- Finneran, C. M., & Zhang, P. (2003). A person-artefact-task (PAT) model of flow antecedents in computer-mediated environments. *International Journal of Human-Computer Studies*, 59(4), 475–496.
- Finneran, C. M., & Zhang, P. (2005). Flow in computer-mediated environments: Promises and challenges. *Communications of the Association for Information Systems*, 15(1), 82–101.
- Fortin, D. R., & Dholakia, R. R. (2005). Interactivity and vividness effects on social presence and involvement with a web-based advertisement. *Journal of Business Research*, 58(3), 387–396.
- Funk, D. C., & James, J. (2001). The psychological continuum model: A conceptual framework for understanding an individual's psychological connection to sport. *Sport Management Review*, 4(2), 119–150.
- Funk, D. C., Mahony, D. F., Nakazawa, M., & Hirakawa, S. (2001). Development of the sport interest inventory (SII): Implications for measuring unique consumer motives at team sporting events. *International Journal of Sports Marketing & Sponsorship*, 3(3), 38–63.
- Ghani, J. A. (1995). Flow in human computer interactions: Test of a model. In J. Carey (Ed.). *Human factors in information systems: Emerging theoretical bases* (pp. 291–311). Norwood, NJ: Ablex.
- Ghani, J. A., Supnick, R., & Rooney, P. (1991). *The experience of flow in computer-mediated and in face-to-face groups: Vol. 91*, (pp. 229–237). ICIS.
- Gregory, C. K., Meade, A. W., & Thompson, L. F. (2013). Understanding internet recruitment via signaling theory and the elaboration likelihood model. *Computers in Human Behavior*, 29(5), 1949–1959.
- Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (Sixth ed.). Upper Saddle River, NJ: Pearson Education Inc.
- Havard, C. T., Gray, D. P., Gould, J., Sharp, L. A., & Schaffer, J. J. (2013). Development and validation of the sport rivalry fan perception scale (SRFPS). *Journal of Sport Behavior*, 36(1), 45–64.
- Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: Guilford Publications.
- Hecht, D., & Reiner, M. (2006). Field dependency and the sense of object-presence in haptic virtual environments. *CyberPsychology and Behavior*, 10(2), 243–251.
- Hendrix, C., & Barfield, W. (1996). The sense of presence within auditory virtual environments. *Presence: Teleoperators and Virtual Environments*, 5(3), 290–301.
- Hernon, P., & Whitman, J. R. (2001). *Delivering satisfaction and service quality: A customer-based approach for libraries*. Chicago, IL: American Library Association.
- Hoffman, D. L., & Novak, T. P. (1996). Marketing in hypermedia computer-mediated environments: Conceptual foundations. *The Journal of Marketing*, 60(3), 50–68.
- Hoffman, D. L., & Novak, T. P. (2009). Flow online: Lessons learned and future prospects. *Journal of Interactive Marketing*, 23(1), 23–34.
- Huang, M. H. (2003). Designing website attributes to induce experiential encounters. *Computers in Human Behavior*, 19(4), 425–442.
- Hyun, M. Y., Lee, S., & Hu, C. (2009). Mobile-mediated virtual experience in tourism: Concept, typology and applications. *Journal of Vacation Marketing*, 15(2), 149–164.
- Jang, H., Kim, W., Lee, A., & Hur, T. (2012). Is it possible to flow through watching? Focusing on the observational flow and watching TV. *Korean Journal of Social and Personality Psychology*, 30(5), 561–587.
- Jang, E. W., Ko, Y. J., Wann, D., & Kim, D. (2017). Does spectatorship increase happiness? The energy perspective. *Journal of Sport Management*, 31, 333–344.
- Jin, S. A. A. (2011). I feel present. Therefore, I experience flow: A structural equation modeling approach to flow and presence in video games. *Journal of Broadcasting & Electronic Media*, 55(1), 114–136.
- Jin, S. A. A. (2012). Toward integrative models of flow: Effects of performance, skill, challenge, playfulness, and presence on flow in video games. *Journal of Broadcasting & Electronic Media*, 56(2), 169–186.
- Kelley, C. A., Gaidis, W. C., & Reingen, P. H. (1989). The use of vivid stimuli to enhance comprehension of the content of product warning messages. *Journal of Consumer Affairs*, 23(2), 243–266.
- Khalifa, M., & Shen, N. (2004). System design effects on social presence and telepresence in virtual communities. *Proceedings of the international conference on information systems* (pp. 547–558). (Washington).
- Kilduff, G. J., Elfenbein, H. A., & Staw, B. M. (2010). The psychology of rivalry: A relationally dependent analysis of competition. *Academy of Management Journal*, 53(5), 943–969.
- Kim, M. (2011). Analysis of relations among flow, viewing satisfaction and intention to revisit that were perceived by professional baseball spectators. *The Korean Journal of Physical Education*, 50(4), 213–223.
- Kim, D. (2016). The relationship among viewing environment, immersion, and viewing satisfaction according to Pro Volleyball spectators' characteristics. *The Korean Journal of Sport*, 14(4), 279–288.
- Kim, T., & Biocca, F. (1997). Telepresence via television: Two dimensions of telepresence may have different connections to memory and persuasion. *Journal of Computer-Mediated Communication*, 3(2) JCMC325.
- Kimiecik, J. C., & Stein, G. L. (1992). Examining flow experiences in sport contexts: Conceptual issues and methodological concerns. *Journal of Applied Sport Psychology*, 4(2), 144–160.
- Kim, D., Kim, A. C., Kim, J. Y., & Ko, Y. J. (2018). Symbiotic relationship between sport media consumption and spectatorship: The role of flow experience and hedonic needs fulfillment. *Journal of Global Sport Management* (in press).
- King, B. (2010). What makes fans crazy about sports? Retrieved January 10, 2018, from: <http://www.sportsbusinessdaily.com/Journal/Issues/%0A2010/04/20100419/SBJ-In-Depth/What-Makes-Fans-Crazy-%0AAbout-Sports.aspx>.
- Kirmani, A., Sood, S., & Bridges, S. (1999). The ownership effect in consumer responses to brand line stretches. *Journal of Marketing*, 63(1), 88–101.
- Ko, Y. J., Chang, Y., Jang, W., Sagas, M., & Spengler, J. O. (2017). A hierarchical approach in predicting sport consumption behavior: Personality and need perspective. *Journal of Sport Management*, 31, 213–228.
- Koufaris, M. (2002). Applying the technology acceptance model and flow theory to online consumer behavior. *Information Systems Research*, 13(2), 205–223.
- Ko, Y. J., Zhang, J. J., Cattani, K., & Pastore, D. L. (2011). Assessment of event quality of major spectator sports. *Managing Service Quality*, 21, 304–322.
- Korzaan, M. L. (2003). Going with the flow: Predicting online purchase intentions. *Journal of Computer Information Systems*, 43(4), 25–31.
- Kwon, W., & Lee, H. (2015). How does stadium atmosphere affect spectator behavior, flow, and revisit intentions? Implications from embodied cognition theory and environmental psychology. *Korean Journal of Sport Management*, 20(4), 67–80.
- Laurel, B. (1991). *Computers as theatre* Addison-Wesley. Reading, MA: Addison-Wesley.
- Lee, K. M. (2004). Presence, explicated. *Communication Theory*, 14(1), 27–50.
- Lee, H. W., Gipson, C., & Barnhill, C. (2017). Experience of spectator flow and perceived stadium atmosphere: Moderating role of team identification. *Sport Marketing Quarterly*, 26(2), 87–98.
- Lok, B. C. (2004). Toward the merging of real and virtual spaces. *Communications of the ACM*, 47(8), 48–53.
- Lu, Y., Zhou, T., & Wang, B. (2009). Exploring Chinese users' acceptance of instant messaging using the theory of planned behavior, the technology acceptance model, and the flow theory. *Computers in Human Behavior*, 25(1), 29–39.
- Ludvigsen, M., & Veeraswamy, R. (2010). Designing technology for active spectator experiences at sporting events. *Proceedings of the 22nd conference of the computer-human interaction special interest group of Australia on computer-human interaction* (pp. 96–103). ACM.
- Luellen, T. B., & Wann, D. L. (2010). Rival salience and sport team identification. *Sport Marketing Quarterly*, 19(2), 97–106.
- Madrigal, R. (2006). Measuring the multidimensional nature of sporting event performance consumption. *Journal of Leisure Research*, 38(3), 267–292.
- Mantovani, G., & Riva, G. (1999). "Real" presence: How different ontologies generate different criteria for presence, telepresence, and virtual presence. *Presence*, 8(5), 540–550.
- Martín, S. S., Camarero, C., & José, R. S. (2011). Does involvement matter in online shopping satisfaction and trust? *Psychology and Marketing*, 28(2), 145–167.
- Mathwick, C., & Rigdon, E. (2004). Play, flow, and the online search experience. *Journal of Consumer Research*, 31(2), 324–332.
- Michaelidou, N., & Dibb, S. (2006). Product involvement: An application in clothing. *Journal of Consumer Behaviour*, 5(5), 442–453.
- Mittal, B. (1989). Measuring purchase-decision involvement. *Psychology and Marketing*, 6(2), 147–162.
- Nah, F. F. H., Eschenbrenner, B., & DeWester, D. (2011). Enhancing brand equity through flow and telepresence: A comparison of 2D and 3D virtual worlds. *MIS Quarterly*, 35(3), 731–747.
- Novak, T. P., Hoffman, D. L., & Yung, Y. F. (2000). Measuring the customer experience in online environments: A structural modeling approach. *Marketing Science*, 19(1), 22–42.
- Pace, S. (2004). A grounded theory of the flow experiences of Web users. *International Journal of Human-Computer Studies*, 60(3), 327–363.
- Park, C., & Moon, B. (2003). The relationship between product involvement and product knowledge: Moderating roles of product type and product knowledge type. *Psychology and Marketing*, 20(11), 977–997.
- Pearce, J. M., Ainley, M., & Howard, S. (2005). The ebb and flow of online learning. *Computers in Human Behavior*, 21(5), 745–771.
- Petty, R. E., & Cacioppo, J. T. (1981). Issue involvement as a moderator of the effects on attitude of advertising content and context. *Advances in Consumer Research*, 8, 20–24.
- Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. *Communication and persuasion* (pp. 1–24). New York: Springer.
- Reid, D. (2004). A model of playfulness and flow in virtual reality interactions. *Presence: Teleoperators and Virtual Environments*, 13(4), 451–462.
- Riva, G., Mantovani, F., Capdeville, C. S., Preziosa, A., Morganti, F., Villani, D., et al. (2007). Affective interactions using virtual reality: The link between presence and emotions. *CyberPsychology and Behavior*, 10(1), 45–56.
- Roettgers, J. (2018). HTC unveils new higher resolution Vive Pro VR headset, wireless adapter. Retrieved March 1, 2018, from <https://variety.com/2018/digital/news/htc-vive-pro-1202657222/>.
- Rogatko, T. P. (2009). The influence of flow on positive affect in college students. *Journal of Happiness Studies*, 10(2), 133–148.

- Senecal, S., Gharbi, J. E., & Nantel, J. (2002). The influence of flow on hedonic and utilitarian shopping values. *Advances in Consumer Research*, 29, 483–484.
- Sharkey, U., Acton, T., & Conboy, K. (2012). Optimal experience in online shopping: the influence of flow. *ECIS 2012* (pp. 108). Barcelona Spain.
- Sheridan, T. B. (1992). Musings on telepresence and virtual presence. *Presence: Teleoperators and Virtual Environments*, 1(1), 120–126.
- Sherry, J. L. (2004). Flow and media enjoyment. *Communication Theory*, 14(4), 328–347.
- Shih, C. F. (1998). Conceptualizing consumer experiences in cyberspace. *European Journal of Marketing*, 32(7/8), 655–663.
- Shin, N. (2006). Online learner's 'flow'experience: An empirical study. *British Journal of Educational Technology*, 37(5), 705–720.
- Shin, D. (2017a). How does immersion work in augmented reality games? A user-centric view of immersion and engagement. *Information, Communication & Society*, 1–18.
- Shin, D. (2017b). The role of affordance in the experience of virtual reality learning: Technological and affective affordances in virtual reality. *Telematics and Informatics*, 38, 1826–1836.
- Shin, D. (2018). Empathy and embodied experience in virtual environment: To what extent can virtual reality stimulate empathy and embodied experience? *Computers in Human Behavior*, 78, 64–73.
- Shin, D., & Biocca, F. (2018). Exploring immersive experience in journalism. *New Media & Society*, 20(8), 2800–2823.
- Shin, D., & Kim, W. Y. (2008). Applying the technology acceptance model and flow theory to cyworld user behavior: implication of the web2. 0 user acceptance. *CyberPsychology & Behavior*, 11(3), 378–382.
- Siekpe, J. S. (2005). An examination of the multidimensionality of flow construct in a computer-mediated environment. *Journal of Electronic Commerce Research*, 6(1), 31–43.
- Skadberg, Y. X., & Kimmel, J. R. (2004). Visitors' flow experience while browsing a web site: Its measurement, contributing factors and consequences. *Computers in Human Behavior*, 20(3), 403–422.
- Slater, M., Usoh, M., & Steed, A. (1994). Depth of presence in virtual environments. *Presence: Teleoperators and Virtual Environments*, 3(2), 130–144.
- Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of Communication*, 42(4), 73–93.
- Stride, C. B., Gardner, S. E., Catley, N., & Thomas, F. (2016). *Mplus code for mediation, moderation and moderated mediation models (1–80)*. Retrieved from: <http://www.offbeat.group.shef.ac.uk/FIO/mplusmedmod.htm>.
- Sun, S. (2008). An examination of disposition, motivation, and involvement in the new technology context computers in human behavior. *Computers in Human Behavior*, 24(6), 2723–2740.
- Szymanski, D. M., & Hise, R. T. (2000). E-satisfaction: An initial examination. *Journal of Retailing*, 76(3), 309–322.
- Tainsky, S., & Jasielec, M. (2014). Television viewership of out-of-market games in league markets: Traditional demand shifters and local team influence. *Journal of Sport Management*, 28(1), 94–108.
- Tajfel, H. (1974). Social identity and intergroup behaviour. *Information (International Social Science Council)*, 13(2), 65–93.
- Tyler, B. D., & Cobbs, J. (2017). All rivals are not equal: Clarifying misrepresentations and discerning three core properties of rivalry. *Journal of Sport Management*, 31(1), 1–14.
- Tyler, B. D., Morehead, C. A., Cobbs, J., & DeSchriver, T. D. (2017). What is rivalry? Old and new approaches to specifying rivalry in demand estimations of spectator sports. *Sport Marketing Quarterly*, 26(4), 204–222.
- Van Noort, G., Voorveld, H. A. M., & Van Reijmersdal, E. A. (2012). Interactivity in brand web sites: Cognitive, affective, and behavioral responses explained by consumers' online flow experience. *Journal of Interactive Marketing*, 26(4), 223–234.
- Xin Ding, D., Hu, P. J.-H., Verma, R., & Wardell, D. G. (2010). The impact of service system design and flow experience on customer satisfaction in online financial services. *Journal of Service Research*, 13(1), 96–110.
- Yim, M. Y. C., Chu, S. C., & Sauer, P. L. (2017). Is augmented reality technology an effective tool for e-commerce? An interactivity and vividness perspective. *Journal of Interactive Marketing*, 39, 89–103.
- Yoshida, M., & James, J. D. (2010). Customer satisfaction with game and service experiences: Antecedents and consequences. *Journal of Sport Management*, 24(3), 338–361.
- Zaichkowsky, J. L. (1985). Measuring the involvement construct. *Journal of Consumer Research*, 12(3), 341–352.
- Zaichkowsky, J. L. (1994). The personal involvement inventory: Reduction, revision, and application to advertising. *Journal of Advertising*, 23(4), 59–70.
- Zaman, M., Anandarajan, M., & Dai, Q. (2010). Experiencing flow with instant messaging and its facilitating role on creative behaviors. *Computers in Human Behavior*, 26(5), 1009–1018.
- Zeltzer, D. (1992). Autonomy, interaction, and presence. *Presence: Teleoperators and Virtual Environments*, 1(1), 127–132.
- Zhou, T. (2012). Understanding users' initial trust in mobile banking: An elaboration likelihood perspective. *Computers in Human Behavior*, 28(4), 1518–1525.
- Zhou, T. (2013). The effect of flow experience on user adoption of mobile TV. *Behaviour & Information Technology*, 32(3), 263–272.