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Virtual and augmented reality: Advancing research in consumer marketing

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Virtual reality (VR) and augmented reality (AR) technologies are having a profound impact on a variety of marketing practices and are attracting increasing attention from marketing researchers. In this article, we review developments in VR/AR applications and research in the area of consumer marketing. We propose a conceptual framework for VR/AR research in consumer marketing that centers around consumer experiences provided by VR/AR applications along the customer journey and the effectiveness of such applications, and delve into the key concepts and components of the framework. Next, we provide a comprehensive overview of VR/AR applications in current practices and extant research on VR/AR in consumer marketing. Finally, based on this framework, we offer an outlook for future developments of VR/AR technologies and applications, discuss managerial implications, and prescribe directions for research on consumer marketing.

1. Introduction

Virtual reality (VR) is defined as a computer-generated simulation of a situation that incorporates the user, who perceives it via one or more of the senses (currently mostly vision, hearing and touch), and interacts with it in a manner that appears to be real (LaValle, 2017; Sherman & Craig, 2002). VR experiences can be delivered via a variety of hardware, such as head-mounted displays (HMDs), cubic immersive spaces (CAVE), large screens (power walls), mobile devices (smartphones, tablets), or desktop and laptop computers, which are sometimes complemented with other devices for either simulation or tracking. A distinct type of VR is augmented reality (AR), in which digital devices are used to overlay supplementary sensory information (sounds, objects, avatars, graphics, labels, etc.) on the real world. This provides contextual information that enhances appearance, usability, and enjoyment, and delivers an enhanced interactive experience. The distinction between VR and AR is that VR creates a perception of reality completely based on virtual information, while AR enhances the perception of the real world with additional computer-generated information (Carmigniani et al., 2011). Mixed reality (MR) merges both VR and AR. The "Reality-Virtuality continuum" proposed by Milgram and Kishino (1994) is a widely adopted framework that places VR and AR on a technological continuum. Fig. 1 shows examples of AR, VR and MR applications, specifically Hololens, Oculus Quest, and Amazon AR View, respectively. In this article, we refer to all these technologies as VR and use the term AR only when the distinction is needed in a specific context.

The rapid growth of VR applications in marketing has been primarily driven by technological advances in digital displays, motion sensors, computer vision, and computing. These developments have rendered VR much more immersive and engaging for

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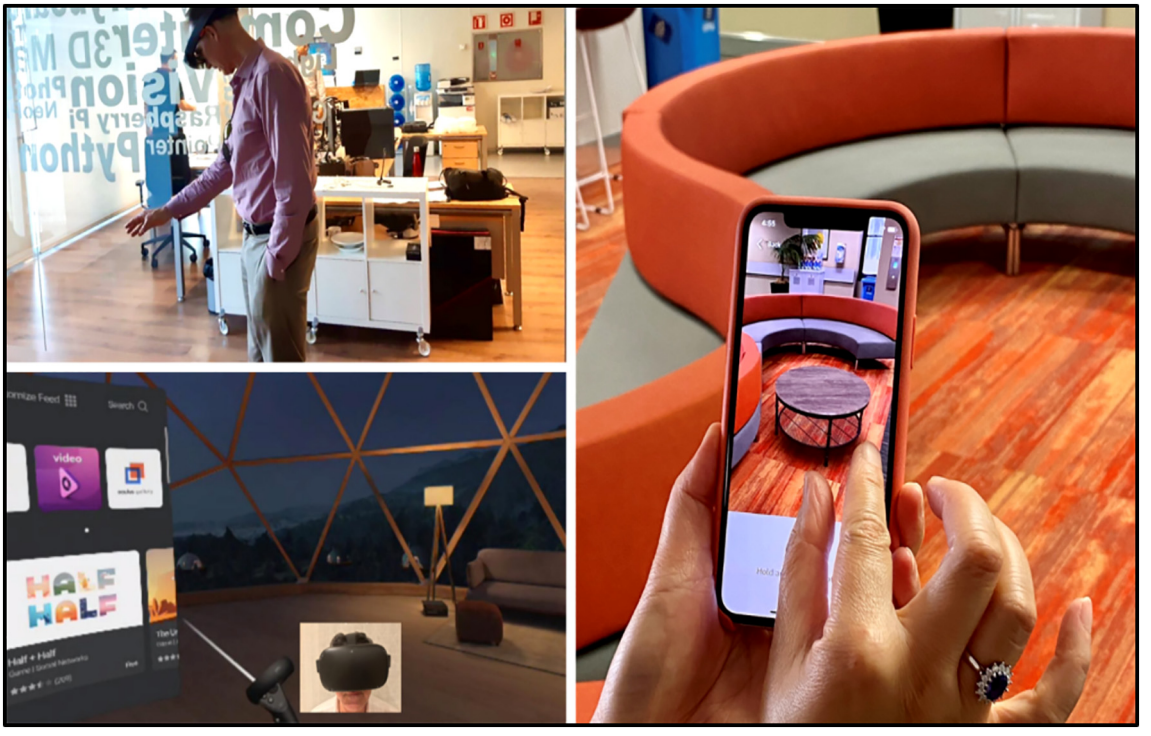

Fig. 1. Illustrations of MR, VR, and AR applications.

users. While the gaming industry has, to date, seen the most extensive developments, medicine, education, travel, entertainment, and marketing are important application areas as well. Gartner (2018) reported that VR is one of the top ten strategic technologies expected to evolve through 2028. The global market size for VR applications is estimated to be currently around US$14 billion, and even conservative estimates predict that it will grow to US$50–60 billion in 3–5 years from now.[1] At the consumer level, as Worldpay (2018) reported, 55% of shoppers globally think that VR and AR will become as popular as smartphones and 62% believe that VR is more fun than shopping online. So far, most of the growth in the VR market comes from AR applications, which abound in areas such as tourism, entertainment, education, real estate, transportation, museums, automotive, and retailing of especially fashion, home furnishing, and beauty products. The rapid growth of AR applications has been propelled by the development toolkits ARKit for iOS devices and ARCore for Android devices.

Several academic fields, especially computer science, engineering, neuroscience, and psychology, have made significant contributions to the development and literature on VR. Marketing scholars too have devoted increasing attention to VR in recent years. A text mining-based review by Loureiro, Guerreiro, Eloy, Langaro, and Panchapakesan (2019) revealed that 150 articles on VR had been published in marketing from 1994 to 2018. This number has linearly increased, up to 62 in the four years between 2015 and 2018, which accounts for 41% of all the papers published between 1990 and 2019 (Loureiro et al., 2019). Despite the already growing attention to VR, there are calls for more research that analyzes the impact of VR in both digital and brick-and-mortar contexts (e.g., Kannan & Li, 2017).

Against this backdrop, the present article aims to assess the current and future impacts of VR in marketing. While VR applications in B2B contexts are prevalent (Boyd & Koles, 2019) and VR is well suited to support business activities such as training and prototyping, consumer-oriented applications are more visible and arguably have the most profound impact on and relevance for the academic marketing field. Therefore, in this article, we focus on VR applications and research in consumer marketing.

The main research questions that we set out to address are the following: 1) How does VR enable and enhance consumer experiences and support tasks in different phases of the customer journey? 2) What is the current state of knowledge on VR in marketing academia and its usage in practice? 3) What is the outlook for VR applications and research in marketing? To answer these questions, we propose a conceptual framework for VR research in consumer marketing centered around consumer experiences, provide overviews of applications in consumer marketing practices and of developments in academic VR research, and prescribe an outlook for future developments in VR technologies and applications as well as directions for future research.

The remainder of the article is organized as follows. In Section 2, we propose an integrated conceptual framework for research on VR in marketing, followed by detailed discussions on the key concepts and components in the proposed framework. In Section 3, we provide an extensive overview of VR applications in consumer marketing practices. In Section 4, we synthesize recent review articles

[1] https://medium.com/vr-first/a-summary-of-augmented-reality-and-virtual-reality-market-size-predictions-4b51ea5e2509.

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about VR in marketing (Burke, 2018; Loureiro et al., 2019; Bonetti, Warnaby, & Quinn, 2018) and then supplement that with our own review of the recent literature. In Section 5, we offer an outlook for future developments in VR technologies and applications, and prescribe directions for consumer marketing research related to and/or impacted by these developments. We end with further discussions on managerial implications in Section 6.

2. Conceptual framework

We propose an integrated framework for consumer marketing research on VR that connects and unifies several academic fields and key constructs related to VR technologies, applications, and their relations to consumer marketing. The framework is depicted in Fig. 2. It serves as the basis for this review article and the directions we propose for future research.

At the center of our proposed framework lies *consumer experience*. We use the term "consumer experience" (CX) synonymous to "customer experience" here, which is defined as "a multidimensional construct focusing on a customer's cognitive, emotional, behavioral, sensorial, and social responses to a firm's offerings during the customer's entire purchase journey" (Lemon & Verhoef, 2016, p. 71). Compared with other digital media, consumer experience with VR is likely to be more impactful and enduring, because VR embodies the following features: (i) simulated multisensory product experiences (vision, touch, hearing, smell), (ii) interactive processes that allow dynamic adjustments in product viewing, trial, and usage, (iii) spatialization and contextualization of product experiences, and (iv) social interactions around virtual products, services, and experiences, by means of avatars or telepresence (Sanchez-Vives & Slater, 2005; Sherman & Craig, 2002). These features provide consumers with complete experiences of augmented, mixed or virtual environments and create the sense that they are present and acting within those environments.

Our framework incorporates the roles of the following concepts which are relevant to consumer experience of VR applications and their effectiveness: (i) immersion which reflects the degree of realism of a VR rendering system resulting from a collection of sensory inputs, and presence which is a consumer's subjective experience of being and behaving in a virtual or augmented reality (Biocca, Harms, & Burgoon, 2003); (ii) attention as a key construct that connects immersion and presence in virtual environments; (iii) consumer experience as a multidimensional response to the virtual environment; (iv) the application context which affects the intended benefits from VR applications (functional or experiential) in enabling or enhancing consumer experiences; (v) stages of the customer journey (pre-purchase, purchase, and post-purchase) along which different features of VR afford engaging experiences; and (vi) effectiveness of VR applications by the application context and along the customer journey as well as its

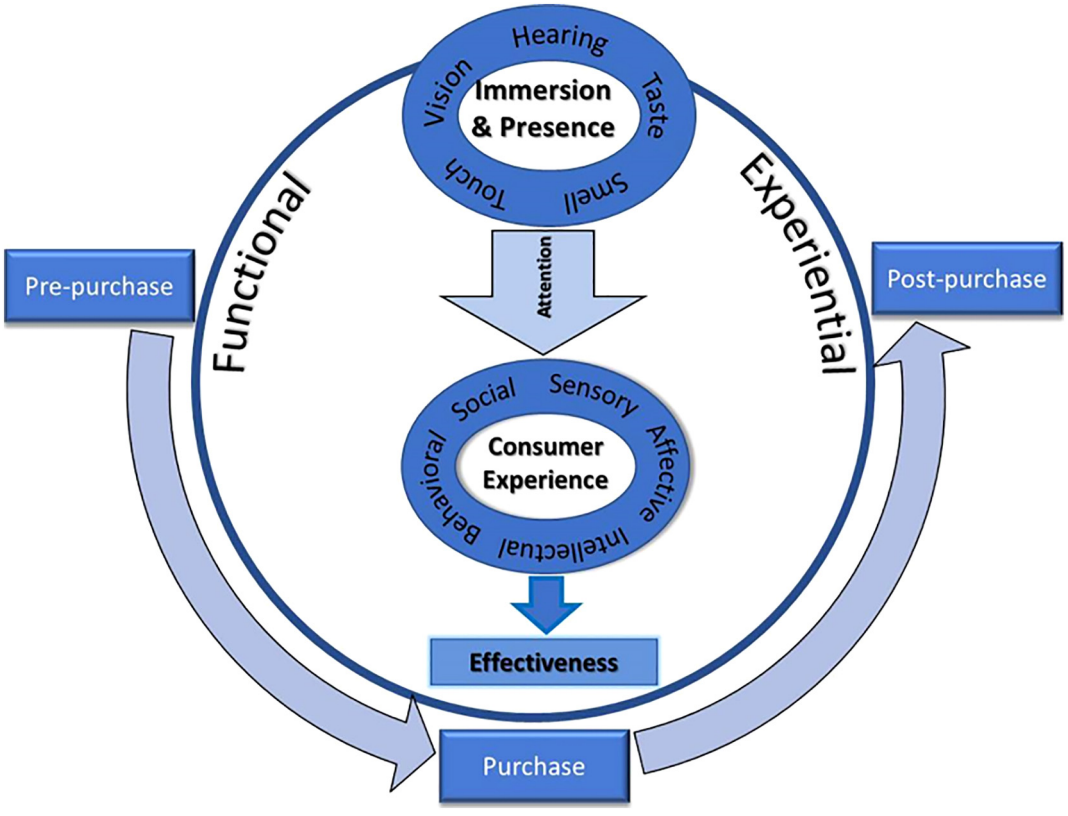

Fig. 2. A conceptual framework for consumer marketing research on VR/AR.

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assessment. We elaborate on these key concepts and their interconnections to consumer marketing research on VR in the following sub-sections.

2.1. Immersion and presence

The research on VR immersion and presence has been conducted primarily in the fields of computer science, engineering, neuroscience, and psychology. Our coverage on the background information and research developments are mainly drawn upon the work of LaValle (2017), Sherman and Craig (2002), and Sanchez-Vives and Slater (2005).

2.1.1. Immersion

Out of the five basic human senses (Krishna, 2010), sight, hearing, and touch are the sensory inputs predominately simulated in virtual environments. The degree of realism of the computer simulation of these sensory inputs to the human brain is called *immersion* (Slater, Usoh, & Steed, 1995; Slater & Wilbur, 1997). Immersion is a result of the technical features of VR systems and devices. Previous research has indeed shown that, as virtual environments become more immersive, they evoke subjective and physiological responses similar to those evoked by corresponding real environments (Meehan, Insko, Whitton, & Brooks, 2002). We next focus on the main technical and perceptual issues in vision, hearing and touch that affect the immersion of VR, and outline challenges in VR development regarding sensory inputs.

The *field of view* (FOV) and the *resolution* of the visual display are two of the key elements of immersion and refer to the effective horizontal and vertical angles through which the virtual environment is seen, respectively the pixel density. *Color resolution* more specifically is determined by the intensity of the red, green, and blue (RGB) values of each pixel. *Depth perception* is a critical element in VR applications as well. The most important depth cue is binocular disparity: for objects less than about 10 m distant, their slightly different projections on the left and right retinas are used to perceive depth. HMDs simulate 3D vision by displaying a different image to each eye (LaValle, 2017). To simulate visual perception when the user moves her/his body or head, called *head-based rendering*, HMDs typically incorporate sensors that track head position, orientation and movement, so that the virtual environment can be rendered congruently with the user's point of view. Handheld AR devices track their position and orientation in space, which enables them to blend virtual and real-world scenes and objects. The number of frames per second that HDMs can deliver is critical in head-based rendering and for generating a high-fidelity illusion of motion. Kang, Shin, and Ponto (2020) show that visual–spatial cues and interactivity enhance consumers perception of informativeness and playfulness of virtual environments, and Li, Daugherty, and Biocca (2008) show that 3-dimensional presentation of products in virtual environments positively affects attitudes and intentions.

Recorded *sounds* can be reproduced with very high fidelity in CAVE (surround or stereo speakers), HMDs and smartphones (headphones). However, simulating sound propagation in real time in virtual environments by modeling the physical processes involved is an extremely challenging task (LaValle, 2017; p. 325). Bialkova and Van Gisbergen (2017) find that higher levels of engagement and presence caused music to have a greater modulating effect on behavior.

Haptics includes the sensation of touch, which is part of a larger system of somatosensory organs throughout the body that senses contact with, and temperature of, the skin, and force, balance, pose (proprioception) and movement (kinesthesis) of body parts, including the arms, hands, and fingers (LaValle, 2017; p. 365). Haptic functions are increasingly becoming part of VR systems, adding the senses of force and touch to virtual environments. In VR games the stylus or controller through which the user interacts with the virtual environment may provide haptic force feedback (Sherman & Craig, 2002; p. 232). Haptic gloves can simulate sense of weight and force via a mechanically controlled exoskeleton, and may have sensors to capture kinesthesis, including bending of the fingers. Motion trackers simultaneously allow hand movements to be recorded and displayed in the virtual environment. A range of haptic inputs can be simulated with vibration motors, for example, the sensation of coming to a hard stop, an opposing force, friction, or texture. Haptic gloves can simulate the sense of touch through embedded vibration and pressure motors. Thermal simulation is possible through heat generating devices placed on the skin. Heller, Chylinski, de Ruyter, Mahr, and Keeling (2019b) show that touch positively affects consumers' willingness-to-pay, and Hadi and Valenzuela (2019) show that haptic feedback with messages improves task performance in virtual environments.

2.1.2. Presence

"Presence" or "telepresence" is a mental state in which the user feels some physical existence in the virtual environment, a sense of "being there" (Sanchez-Vives & Slater, 2005; Steuer, 1992). Presence occurs when, to a certain degree, real sensory input is substituted for virtual sensory input, the user responds similarly to the latter as to the former, and has a sense of being able to take actions that impact the virtual environment (interactivity) (Sanchez-Vives & Slater, 2005). The concept of presence is closely related to that of "flow" or "optimal experience" (Csíkszentmihályi, 1975), which is characterized by focused attention on the task at hand, at the expense of everything else. Hoffman and Novak's (1996) conceptual framework for digital consumer environments recognizes attention as a critical antecedent of flow. They distinguished two forms of flow, goal directed and experiential. Goal directed, or functional flow, is extrinsically motivated, while experiential flow is intrinsically motivated. The experience of flow is thought to result in improved memory, affect and task performance, and reduced perception of consciousness and time. Presence would thus lead to higher effectiveness of VR. *Transference* occurs when task performance and associated cognitive and emotional states are similar to those in the real world (Burke, 2018; Marín-Morales et al., 2018).

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Perhaps surprisingly, the findings to date do not seem to support that the level of realism of the virtual environment directly contributes to sense of presence. Based on a literature review, Schuemie, Van Der Straaten, Krijn, and Van Der Mast (2001) expressed doubts whether presence contributes to better task performance; they report, for example, that users respond to abstract virtual people and their facial expressions in similar ways as they do to real people. Abstract representations may be useful because they reduce the complexity of sensory input, and thus may make certain tasks more efficient, while reducing the computational load of the VR system (Bowman & McMahan, 2007).

2.2. Attention in VR

It is important to understand through which psychological mechanism a sense of presence in a virtual environment emerges. Witmer and Singer (1998) argued that there is a link between the attention users pay to the virtual environment and their sense of presence (see Steuer, 1992, and Hoffman & Novak, 1996, for similar claims). The more attention is focused on the virtual environment the more sensory perception is dominated by it, while sensory input from the real world is inhibited. This leads to a greater sense of presence (Darken, Bernatovich, Lawson, & Peterson, 1999). Empirically, both these early studies and more recent ones (Baka, Stavroulia, Magnenat-Thalmann, & Lanitis, 2018) support that attentive processing plays a crucial role in the experience of presence. Attention is a limited capacity, selective process that supports goal attainment by enhancing the processing of particular sensory input, and suppressing the processing of other, non-selected input, through bottom-up and top-down processes (Lee & Mumford, 2003). Bottom-up processes are mostly involuntary and originate in virtual or real environments; top-down processes are voluntary and driven by the behavioral relevance of sensory inputs and may include memory, goals, emotions and preferences (Pieters & Wedel, 2007). Top-down factors interact with bottom-up inputs to construct an apparently coherent and complete mental representation of the virtual environment. Schlosser (2003) showed that virtual product information that is presented in a way that is congruent with consumers' (browsing or search) goals positively influences attitudes.

2.3. Consumer experience

As mentioned previously, we use the terms “consumer experience” (CX) and “customer experience” interchangeably to refer to a consumer's subjective, dynamic, multidimensional reaction, comprised of cognitive, emotional, behavioral, sensorial, and social responses, to interactions with a firm's offerings and marketing actions across the phases of the customer journey (Becker & Jaakkola, 2020; Bolton et al., 2018; Kuppelwieser & Klaus, 2020; Lemon & Verhoef, 2016). For VR systems, user experience (UX) is an important contributor to the customer experience (CX). User Experience (UX) relates to how a person interacts with products, services, information, persons, and objects through a user interface, including those of VR and AR (Law, Roto, Hassenzahl, Vermeeren, & Kort, 2009; Dix, Finlay, Abowd, & Beale, 2004; Irshad & Rambli, 2014). Natural User Interfaces (NUI) have recently gained popularity and enhance UX. They allow users to interact with digital devices, through touch (Heller et al., 2019b), voice (Saad, Afzal, El-Issawi, & Eid, 2017), and vision (Bigné, Llinares, & Torrecilla, 2016). The integration of eye tracking in HMDs and other VR devices has enabled gaze-based rendering of the virtual environment in response to eye movements. Further, brain-computer interfaces (such as EEG) allow recorded brain activity to be used to control the virtual environment, and unconscious behaviors, such as heart rate, skin temperature and resistance, can be used for the same purpose. Exogenous factors such as the time, the weather, and the presence of others, can also be used as inputs to enhance UX.

While the UX literature has predominantly focused on aesthetics and emotions (Oh, Bellur, & Sundar, 2018; Bargas-Avila & Hornbæk, 2011), in the marketing literature there is consensus that CX is comprised of five key dimensions, for which Hoffman and Novak (2018) coined the acronym BASIS: Behavioral (motor actions), Affective (joy, anger, sadness, fear, surprise, disgust), Sensory (vision, audition, touch, taste, and smell), Intellectual (cognitive) and Social (relational). Consumer product, brand, shopping and consumption experiences elicit these BASIS responses to different degrees (Brakus, Schmitt, & Zarantonello, 2009). As outlined in the conceptual framework, these BASIS responses are influenced by four features of VR: sensory perception, interactive processes, spatial and contextual displays, and collaborative interactions. Such responses have been reflected in dimensions of CX measurement scales (Brakus et al., 2009; Kuppelwieser & Klaus, 2020) and observed in online environments (Novak, Hoffman, & Yung, 2000). They are equally relevant to VR. Due to the dynamic nature of VR, timing is critical for CX measurement (Becker & Jaakkola, 2020). In VR, real time experiences have been tracked through various neurophysiological measurement devices (eye tracking, EEG, EMG, and skin conductance, heart rate variability, body movement, gesture, and voice recording).

The influence of VR on CX has been shown by Flavián, Ibáñez-Sánchez, and Orús (2019); synchronous interaction has been shown to make VR interfaces more engaging (Sundar, Bellur, Oh, Jia, & Kim, 2016; Brodie, Hollebeek, Jurić, & Ilić, 2011; p. 258); a sense of presence has been shown to lead to positive post-consumption behaviors (Wei, Qi, & Zhang, 2019); and consumer product, brand, shopping, and usage experiences have been demonstrated to affect attitudes, preferences, purchase intentions, choice, usage, satisfaction and loyalty (Brakus et al., 2009).

2.4. Application context

A key dimension of the application context that moderates the effect of attention, stimulates presence, and enhances the user experience is whether it involves utilitarian or hedonic products, services, or attributes (Babin, Darden, & Griffin, 1994; Havlena & Holbrook, 1986). Research has shown that utilitarian contexts prime goal-directed flow, while experiential contexts prime experiential flow (Csíkszentmihályi, 1990; Hoffman & Novak, 1996). The process by which this occurs is contextual cueing, where the

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context (products, scenes) activates relevant memories, motives and rules for perception and action (Makovski, 2016). VR applications in a utilitarian context are thus primarily aimed at serving functional benefits, while those in a hedonic context are primarily aimed at delivering experiential benefits. In addition to moderating the relationships between immersion, presence, attention, and consumer experience, the application context is also likely to influence the impact of consumer experience on the effectiveness of VR applications. For example, it is likely that the impact of consumer experience on VR effectiveness is stronger for experientially-oriented VR applications.

2.5. Stages along the customer journey

VR applications can facilitate consumers' experience and decision making in the pre-purchase, purchase, and post-purchase stages of the customer journey. Consumers' motivations, goals, information and benefits sought may evolve along the customer journey (Lemon & Verhoef, 2016). Thus, how they interact with and respond to VR systems may also be moderated by the stage in the customer journey. Recent studies have looked into the influence of VR immersion or presence on user experience or downstream outcomes, usually focusing on certain stages along the customer journey (e.g., Hadi & Valenzuela, 2019; Manis & Choi, 2019; Hilken, de Ruyter, Chylinski, Mahr, & Keeling, 2017; Flavián et al., 2019). Systematic examinations of similarities and differences across the stages would deepen the understanding of how to improve the design and deployment of VR applications along the customer journey.

2.6. VR effectiveness and its assessment

The effectiveness of VR applications in marketing refers to the extent to which VR is successful in supporting, enabling, or enhancing consumer tasks and experiences. The BASIS classification (Hoffman & Novak, 2018) of customer response to CX provides a foundation for assessing the effectiveness of VR applications on consumer experience. We adopt the BASIS terminology to synthesize the assessment of VR effectiveness, and organize specific measures by the key components in our conceptual framework. Immersion and presence can be tracked and measured using a variety of "sensory", "affective", and "behavioral" (especially motor actions) metrics. Attention used to be measured primarily via recall tasks, but has been substantially enhanced by objective measures via eye-tracking techniques (Pieters & Wedel, 2004) and neurophysiological signal monitoring (such as EEG). Consumer experience can be assessed via a variety of affective, cognitive, and social measures, such as emotions, attitude, preference, and bond. The assessment of VR effectiveness is likely to need further modification based on the application context and stages along the customer journey. The consumer behavior and marketing research literature offers rich insights on assessment tools for achieving functional vs. experiential benefits (Havlena & Holbrook, 1986; Hoffman & Novak, 1996), as well as the attitudinal and behavioral outcome measures that are particularly pertinent to different stages of the customer journey (Lemon & Verhoef, 2016). For example, awareness, interest, consideration, and purchase intention are key measures of interest for the pre-purchase stage; purchase frequency, spending, willingness-to-pay are important measures to gauge VR effectiveness at the purchase stage; and satisfaction, engagement, loyalty, and agency reflect how VR influences consumers in the post-purchase stage.

There are four main types of data that can be collected from VR systems and used to assess their effectiveness: objective, digital, neurophysiological, and self-reported data (Alcañiz, Bigne, & Guixeres, 2019). We discuss each type of data and their usage briefly here. First, objective data are technical characteristics of the audio (sound, hearing frequency), video (image, motion), and audiovisual (synchronization) inputs. Akhtar and Falk (2017) provide a comprehensive review of how to assess the quality of these signals. Collectively, these measures reflect the objective degree of immersion of a VR system (Akhtar & Falk, 2017). Alcañiz et al. (2019) argue that the documentation of these technical details in VR experiments is critical for the replicability of VR studies.

Second, voice commands and motion of the head, hands, body, face, and eyes can be digitally recorded through devices such as microphones, motion-trackers, cameras, and haptic devices (Pan & Hamilton, 2018). Li, Daugherty, and Biocca (2001), Sanchez-Vives and Slater (2005), Schuemie et al. (2001), and Tussyadiah, Wang, Jung, and Dieck (2018) provide extensive reviews, which show that body engagement, haptic feedback, spatialized sound, stereopsis, latency, head tracking, motion, animation, frame rates, and field of view are all associated with the experience of presence. These measures allow field metrics such as shopping time, product examination, and product handling times to be easily obtained (Schnack, Wright, & Holdershaw, 2019).

Third, neurophysiological signals, including heart-rate variation, electrodermal reaction, respiratory rate, and voice pitch, can be measured by means of wearables that at the same time are used to facilitate responsiveness of VR to these signals (Egan et al., 2016). Visual attention can be unobtrusively measured through eye movement recording, because eye movements and attention are closely linked (Pieters & Wedel, 2004). Infrared and video cameras in HMDs and CAVE and mobile devices (Bigné et al., 2016) allow for the recording of eye movements while users explore the virtual environment. Facial expressions tracking is enabled in VR by using cameras, but it still is difficult to implement for HMDs because these devices cover the upper half of the face. Classifying facial expressions using video and eye tracking cameras holds promise as well (Hickson, Dufour, Sud, Kwatra, & Essa, 2019; Meißner, Pfeiffer, Pfeiffer, & Oppewal, 2019). EEG has also been used in VR (Marín-Morales et al., 2018), mostly in gaming applications (Kim, Jeon, & Biocca, 2018; Ninaus et al., 2014). VR studies using fMRI have been scarce so far: Ninaus et al. (2014) reported only two VR studies with fMRI, yet they hold promise as a measurement tool for cognitive and affective states (Reggente et al., 2018). Likewise, functional near-infrared spectroscopy (fNIRS) has been recently applied to VR (Kim, Buntain, Hirshfield, Costa, & Chock, 2019). These neurophysiological measurements can be used to assess consumers' attention to the virtual environment, their feelings of presence, their cognitive workload, emotions, and various aspects of their experiences (Schuemie et al., 2001). Presence has thus been

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measured via both behavioral responses (postural sway, eye movements) and physiological measures (heart rate, skin resistance/conductance), sometimes while inducing experimental breaks in the experience as exogeneous variation (Meehan et al., 2002; Sanchez-Vives & Slater, 2005). A review of the literature shows that such behavioral and physiological measures are preferable over survey-based self-reports when collecting the former is feasible (Schuemie et al., 2001).

Fourth, self-reported data from questionnaires and qualitative interviews supplement observational data. Although unobtrusive digital and neurophysiological data will be increasingly used to assess the various dimensions of consumers' responses to VR, self-report data will remain useful in the measurement of consumers' attitudes, preferences, consumer experience, and satisfaction. The combination of these two types of data will enable researchers to assess the immersion-attention-presence-customer-experience chain comprehensively in a wide variety of VR applications in marketing.

3. VR applications in consumer marketing practice

VR technologies have been used to enhance consumer experiences across the customer journey, from awareness, appraisal, decision-making, trial, and repurchase, to consumption and post-consumption evaluations. Appendix 1 provides a select list of about 80 AR, VR, and MR applications in a wide range of consumer product categories, including apparel and fashion, automotive, consumer packaged goods, beauty and fragrance, home goods, jewelry, charities, news and information, restaurants, travel and tourism, and real estate. The list was compiled through Google searches with combinations of the keywords “virtual reality”, “augmented reality”, “marketing”, “retailing”, and “advertising”, and snowballing based on the results of those searches. We do not claim that the list is exhaustive or representative, but it is the most extensive list of marketing applications of VR and AR to date. The applications in Appendix 1 are classified based on their application context (predominantly functional or experiential) and the stage(s) along the customer journey.

In this section, we provide a high-level summary of these VR applications by three major areas of consumer marketing: 1) communications/advertising, 2) selling to consumers, that is, retailing and 3) creating or enhancing the consumption experience. These three areas roughly correspond to the pre-purchase, purchase, and post-purchase stages in the customer journey.

3.1. The pre-purchase stage: VR applications in communication/advertising

A key application area of AR technologies in marketing is advertising, which already had a market size of US$167 million in 2017.[2] AR ads are reported to have higher engagement and click through than standard online ads, elicit positive brand attitudes and stimulate purchase intentions (Grudzewski, Awdziej, Mazurek, & Piotrowska, 2018; Van Kerrebroeck, Brengman, & Willems, 2017). Research shows that VR commercials produced better immediate effects on behaviors than traditional commercials (Leung, Lyu, & Bai, 2020; Li, Daugherty, & Biocca, 2002; Zeng, Cao, Lin, & Xiao, 2020). Packaged goods, apparel, accessories, cosmetics, furniture, gaming, and entertainment companies, such as Coca Cola, Timberland, IKEA, Michael Kors, Sephora, Bobbi Brown, and Pottery Barn, followed suit soon after. While many of the applications are spatial, visual or auditory, the Immersion Corporation produces haptic advertising using vibrations on smartphones. Studies have demonstrated the improved effectiveness of these ads (Hadi & Valenzuela, 2019).

We organize these communications and advertising applications by the benefits provided through AR/VR. (i) Mobile AR ads, placed on a variety of media, especially social media, allow for interactive exploration of products and product enhancement through the provision of information on production, content, design, menus and reviews, and product contextualization (such as for apparel, jewelry, and makeup). Some of these ads blur the lines between advertising and retailing, because they allow consumers to make purchases in the same medium. (ii) Other AR ads allow consumers to interact with print and outdoor media via mobile apps, usually by providing a QR code on the copy which leads the viewer to an AR or VR interface. This makes ads interactive, provides product information and contextualization, and makes exposure and interactions trackable. (iii) Haptic ads that utilize the vibration motor of mobile devices have been explored by several companies to enhance the sensory experience of ads and enhance brand awareness and engagement. (iv) Outdoor digital AR advertising has created awareness, engagement and free publicity via social media sharing, through creative applications on digital screens in public places, such as bus shelters, malls, stores, train stations and so on. Here, virtual objects, products, animals, or people are overlaid on the real world. In some applications, consumers can interact with these virtual objects, and some of these screens enable personalization of content based on facial or emotion recognition. (v) Product placement has been greatly facilitated through AR, with the purpose of contextualizing a product by showing it being used in a (desirable) virtual context. (vi) 360°, 3D, or immersive video ads can be placed in games, virtual stores, and in VR sports broadcasts, in a way that can be targeted to a specific consumer's interactions with the virtual environment.

3.2. The purchase stage: VR applications in retailing and selling

VR and AR applications have been widely used in the retail sector where they have been shown to increase purchase intentions (Yim, Chu, & Sauer, 2017) and revenues (Caboni & Hagberg, 2019). In brick and mortar retailing, AR is transforming stores into showrooms, and is facilitating planned purchases by allowing customers to locate products in the store through reverse

[2] https://arinsider.co/2018/09/04/ar-advertising-2-6-billion-by-2022/.

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image search (such as via apps by Home Depot and IKEA). Some applications (e.g., IKEA Place, Amazon AR View) allow consumers to place products in their homes through smartphones, or through an interactive showroom that offers a HMD-based immersive experience. Along with beacon technology, these applications create new types of consumer interface, such as smart dressing rooms, simulated shelves, virtual product displays, and interactive virtual shelf talkers. VR goes further by creating, personalizing and optimizing shopping and product trials for consumers, improving shopping efficiency, and virtual store redesign, virtual product demonstrations, and virtual walk-throughs.

We summarize the main functions of VR/AR in retailing applications as follows. (i) Mobile AR apps have been used to reduce friction in the buying process in digital channels, by making it possible to try out products at home (furniture, home goods), on the person (jewelry, clothing, cosmetics, apparel, shoes), or on avatars (apparel, fashion), and by enabling virtual walkthroughs (real estate, hotels, museums, tourist sites), thereby reducing the costs associated with returns in online retailing and with personal selling. (ii) Mobile AR apps have also been used by companies (Nike, Timberland) to enhance the consumer experience by facilitating the fitting process in brick-and-mortar stores (apparel, shoes, cosmetics). These applications, which often involve in-store digital screens, smart mirrors, or holograms, are mainly focused on fashion and other luxury products. (iii) Mobile VR and AR apps are used to improve in-store navigation and online product search (home goods) through reverse image search combined with geolocation and/or beacon technology. (iv) Product information and recommendations, discounts, promotions, and product reviews are provided in the store either on interactive digital screens or virtual signage on mobile devices. (v) Virtual pop-up stores, such as the famous example by Yihaodian in China, are a recent development. In these applications, a virtual store is (temporarily) created and tailored to the user using HMDs, outdoor digital screens, or mobile devices. Food and fast-moving consumer packaged goods retailers have been pioneers in this domain. (vi) Virtual retail spaces that simulate stores are being developed by companies such as inversion, through ShelfZone® (Pizzi, Scarpi, Pichierri, & Vannucci, 2019) or ViCoS (Schnack et al., 2019). Customization of assortments and products are beginning to create a new type of virtual mall where the stores, products, locations, time considerations, and other features are chosen by the customer in a single visit (Burke, 2018).

3.3. The post-purchase stage: VR applications for product consumption experiences

For certain consumer product categories, the virtual environment created is itself the product/experience, often through using HMDs or mobile AR applications. Games are a primary example, and e-sports are especially gaining popularity in this domain. VR applications as product offerings are also increasing in travel, arts, and sports/news broadcasting (e.g., applications by Carnival Cruise Line, BBC, and *New York Times*). Some museums (e.g., the Smithsonian) offer virtual tours of selected collections or exhibitions so that viewers can have an immersive experience without visiting the physical places.

The most widespread applications in this domain involve supplementing and enhancing product creation and consumption experiences. We organize them by the benefits provided by VR and/or AR. (i) Some applications allow for product customization or co-creation through AR in the home or other out-of-store settings (such as for fashion, jewelry and cosmetics). (ii) The in-store/on-premises product experience can be enhanced, which is primarily achieved through mobile AR applications, such as for travel, automotive, and real estate applications. In addition, the product consumption experience can be enhanced through gamification (consumer products), usage training (electronics and appliances), or contextualizing usage (travel, charity events), for which HMDs have been mostly used. (iii) VR and AR applications can enhance post-consumption experience and evaluation by providing additional contextual information or re-experiencing the consumption process (travel, performing arts).

3.4. Future challenges

VR applications in consumer marketing are becoming mainstay, and consumers have come to expect and rely on them. While companies could find a unique point of differentiation through the application of VR not too long ago, it has become a must-have to successfully compete in many industries. Yet, there remain two key challenges in the further diffusion and adoption of these technologies. The first are privacy concerns, which relate to reluctance of consumers to share personal data and photos with companies, and their concerns over sharing and use of that information for other purposes. Second, adoption may be impeded because consumers are not sufficiently familiar with the technology, may experience sickness during VR usage, or fail to see its benefits. The latter may be caused by a poor user experience because of imperfections in the rendering of size, color, or spatial placement of products. Addressing privacy issues upfront is good business practices and may help adoption of VR (Wedel & Kannan, 2016), and VR sickness and rendering imperfections will need to be resolved with high priority as the technology advances.

4. Synthesis of prior research on VR in marketing

In this section, we first summarize several prior review articles on VR. Recently, several excellent review articles were published, in particular, those by Alcañiz et al. (2019), Berg and Vance (2017), Bonetti et al. (2018), Feng and Mueller (2019), and Loureiro et al. (2019). We then provide our own analysis of the recent literature to supplement the previous review articles and to offer a synthesis of recent research on VR in marketing based on our proposed conceptual framework.

Alcañiz et al. (2019) traced the chronology of academic research on VR back to roughly four phases. In the first phase, in the 1980s, the incipient research mostly used 2D, and later 3D, desktop displays with keyboard/mouse input to simulate virtual environments, identified factors that affected adoption and usage of 2D virtual stores, and assessed effects on attitudes, knowledge and intentions toward brands. Then, in the second phase, the 1990s saw the emergence of studies that used mobile AR interfaces,

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mostly still using desktop VR but also the first HMD interfaces, to explore the usage of AR, and to assess the cost savings that VR could bring to retailing. In the third phase, in the 2000s, AR research expanded through the increasing use of HMDs and researchers looked at VR as a communication channel, at virtual product sales, at consumer responses to VR retailing, and at applications in marketing research. Most recently, in phase four, which began around 2015, immersive HMD and 3-dimensional interfaces have been used in consumer behavior studies carried out both in the lab and in-store to assess consumer response to virtual environments. Nevertheless, the authors concluded that only in the last two phases, a few studies have used truly immersive visual interfaces and HMDs as yet.

Loureiro et al. (2019) used text mining to review and analyze research on VR, focusing on marketing applications. They analyzed 150 articles from 115 journals. We summarize their main findings by the key topics identified by them. 1. Research on the *virtual setting* (23 articles) has studied the effects of ambient factors (colors, lighting, music), layout (equipment, furniture), design (symbols, style), information, and the social context (privacy, employees, customers, avatars), for supermarkets, restaurants, museums, and hotels, on the customer experience, amount of time spent shopping, ease of navigation, the search sequence, the number of products and brands examined and bought, and amount of money spent. 2. Research on *manufacturing and new product development* (29 articles) looked into the use of VR to simulate the design of prototypes, to optimize manufacturing and marketing, increase product quality, and reduce time-to-market and uncertainty about consumer acceptance. Studies also examined how VR might contribute to radical and incremental innovations and company-consumer co-creation processes. 3. Research on *service configuration* frequently used eye movement recording to investigate various visual stimuli and decision tasks, for example, examining the effects of packaging design and product presentation on attention, perceptions and brand choices. In addition, studies in this research stream investigated how consumers might contribute to service configurations. 4. Research on *interactions* (21 articles) has investigated co-creation of consumption experiences using VR, for example, by examining the opportunities of using VR in pre-visit, visit, and post-visit experiences. Research on avatars revealed that their effectiveness is related to their congruity with the user, while accurate real-time rendering of the avatars also critically affected their effectiveness. 5. One of the larger research streams is that of *experiential marketing* (31 articles), which studied the effects of immersion and presence on consumer behavior. Two of the most studied factors were the rendition quality of the virtual environment (immersion) and consumers' perception of navigating in it (presence). It was found that providing more information enhanced the sense of presence, which led to a positive perception of the virtual environment. Furthermore, vividness of rendering was associated with more positive attitudes toward advertising and brands which led to higher purchase intentions. 6. Finally, research on *advertising and social media* showed positive effects of VR advertising on brand affect, brand knowledge, brand attitudes, and purchase intentions, in particular for experience-based products. Some of these effects were attributed to an increased sense of presence on the part of the consumer.

To summarize, the review by Loureiro et al. (2019) showed that VR technology can positively influence consumers through advertising, simulating products or packages, and testing new products, during the *pre-purchase stage*. In the *purchase stage*, it revealed that brands may influence the effects of price, product attributes, product information, sales force, and convenience, on consumer behaviors through the integration of VR technology into marketing activity. The authors conclude that neither academics nor practitioners have paid much attention to application of VR in the *post-purchase stage*, with co-creation being an emerging exception (Loureiro et al., 2019). The impact on VR effectiveness of the virtual setting, which includes immersion and presence, and VR-enabled consumer experiences, which are central in our conceptual framework, have also been two major domains of the extant research.

We next present our own analysis and synthesis of recent research on VR in the marketing academic field. We searched the Scopus and WOS databases for articles on VR/AR in nine marketing journals,[3] published in 2002 to February 2020, which roughly corresponds to the third and fourth phases of VR research chronicled by Alcañiz et al. (2019). This search resulted in 38 papers. Twenty of these were published in *JBR*, most of which in a special issue on VR in 2019. A text mining analysis of the abstracts revealed the following keywords, in the order of appearance frequency: VR, consumer, product, AR, experience, technology, decision, interactivity, brand, social, and purchase. A word-cloud depiction of the abstracts is presented in Fig. 3. Based on a content analysis, we classify these papers based on our conceptual framework, by the application context (functional versus experiential), the stage of customer journey (pre-purchase, purchase, and post-purchase), and the key relationships investigated, including between immersion (I), presence (P), user experience (UX), consumer experience (CX), and effectiveness (E) (see Table 1). A given paper may appear in multiple cells in this classification when applicable. We excluded a few review, conceptual, B2B, or game theoretic articles.

Table 1 highlights several interesting aspects of VR and AR research in the recent phases of its development. There has been a significant research focus on the pre-purchase stage, especially in application contexts with an experiential orientation, and many of the relationships between concepts in our framework have been empirically assessed. For example, Wang and Chen (2019) found that perceived control of VR videos promoted interest in and consideration of brands. Yim and Park (2019) revealed that consumers with an unfavorable perception of their body image evaluate AR try-on technology more favorably. Hershfield et al. (2011) show that participants plan to save more for retirement if they interacted with their virtual future selves. Steinhoff, Arli, Weaven, and Kozlenkova (2018) investigated how AR may improve consumer social engagement and relationships. Importantly, Laurell, Sandström, Berthold, and Larsson's (2019) analysis of social media content revealed that poor technical performance impedes consumers' acceptance of HMD VR applications.

[3] The journals are the *International Journal of Research in Marketing*, *Journal of Business Research*, *Journal of Consumer Research*, *Journal of Consumer Psychology*, *Journal of Marketing Research*, *Journal of Retailing*, *Journal of Interactive Marketing*, *Journal of the Academy of Marketing Science*, and *Marketing Science*.

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Fig. 3. Word-cloud based on text mining of recent research on VR/AR (2002−2020).

With regard to the purchase stage, most relationships between concepts in our conceptual framework also have been empirically investigated. For example, with respect to the relationship between immersion and VR effectiveness in application contexts with a functional orientation, Li et al. (2008) showed that (3D) virtual product visualization enhances brand attitudes and purchase intentions, while Martínez-Navarro, Bigné, Guixeres, Alcañiz, and Torrecilla (2019) showed that VR may affect consumers' purchase intention via creating a sense of presence and certain emotions evoked by the virtual environment. Heller et al. (2019b) found that haptic controls have greater impact on consumers' willingness to pay than voice controls because the former lead to stronger perception of tangibility. Relatedly, Hadi and Valenzuela (2019) showed that haptic feedback in marketing messages improves task performance by improving the sense of social presence. In application contexts with an experiential orientation, Schlosser (2003) showed that interactivity increases purchase intentions because it elicits rich mental images of product use. Tanner, Ferraro, Chartrand, Bettman, and Van Baaren (2008) demonstrated that mimicry of avatars' behaviors enhances product

Table 1
Recent research on VR/AR (2002–2020): a classification based on our conceptual framework.

Application context	Functional		Experiential		
Customer Journey	Pre-purchase	Purchase	Pre-purchase	Purchase	Post-purchase
Research Focus					
I→E[1]	Manis and Choi (2019); Ketelaar et al. (2018); (Wilkström, Carlell, & Frostling-Henningsson, 2002); Schlosser (2003); Hadi and Valenzuela (2019).	Kang et al. (2020); Heller, Chylinski, de Ruyter, Mahr, and Keeling (2019a); Esmark Jones, Barney, and Farmer (2018); Li et al. (2008).	Laurell et al. (2019); Manis and Choi (2019); Steinhoff et al. (2018); (Wilkström, Carlell, & Frostling-Henningsson, 2002); Schlosser (2003).	Kang et al. (2020); Kandaurova and Lee (2019); Hilken et al. (2017).	
P → E	Hadi and Valenzuela (2019).	Martínez-Navarro et al. (2019); Pizzi et al. (2019).	Hyun and O'Keefe (2012).	Hilken et al. (2017).	
I,P → UX	(Rauschnabel, He, & Ro, 2018)		Flavián et al. (2019); Jung et al. (2019).	Flavián et al. (2019); Jung et al. (2019).	Flavián et al. (2019).
UX → E	Mathwick and Rigdon (2004)	Meißner et al. (2019).	Mathwick and Rigdon (2004).		
CX → E	Yim and Park (2019); Yim et al. (2017).	Cowan and Ketron (2019); Heller et al. (2019b); Hilken et al. (2017); Yim et al. (2017); Bigné et al. (2016); Sarantopoulos et al. (2019).	Wang and Chen (2019); Deng, Unnava, and Lee (2019); Hershfield et al. (2011).	Carrozzi et al. (2019); Deng et al. (2019); Cowan and Ketron (2019); Tanner et al. (2008); Rapp, Ahearne, Mathieu, and Rapp (2010).	Hudson et al. (2019).

[1] I: Immersion; P: Presence; UX: User Experience; CX: Consumer Experience; E: Effectiveness.

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preferences. Kandaurova and Lee (2019) found that virtual (compared to video) contents increase the intention to provide time and money for a social cause. Hilken et al. (2017) showed that AR-based service augmentation enhances consumers' value perceptions and facilitates their decisions by increasing the sense of spatial presence.

To conclude, Table 1 reveals that, while much research has focused on testing the relationships between immersion, presence, consumer experience, and effectiveness in the pre-purchase and purchase stages of the customer journey, few studies have yet focused on the post-purchase stage, especially for functional application contexts (thus this column is omitted in Table 1). Nonetheless, for experiential contexts, Flavián et al., 2019 provided a conceptual framework of CX, and Hudson, Matson-Barkat, Pallamin, and Jegou (2019) found that immersion mediates VR effects on satisfaction and loyalty in the context of a seascape exploration experience. This analysis confirms the conclusion of Loureiro et al. (2019) about the lack of research on VR applications in the post-purchase stage and highlights an opportunity for future research which we will articulate in the next section.

5. Future developments in VR applications and opportunities for consumer marketing research

In this section, we first offer an outlook for future developments of VR technologies and applications. We then identify areas of future research concerning VR in consumer marketing, based on our conceptual framework, reviews of VR applications and the academic literature, and this outlook for the future.

5.1. Future developments of VR technologies and applications

Trends in VR application will occur along three main dimensions: the VR *technology*, *consumers* adopting and using it, and *companies* developing and selling them, as depicted in Fig. 4.

In terms of *VR technologies*, two directions of innovation are particularly relevant and will continue to advance. First, with the development of multimedia applications (Cruz-Neira, Reiners, & Springer, 2010), VR will increasingly become a multisensory experience. In the development of HMDs, there is a trend toward all-in-one devices, enhanced by vision technologies and technologies that enable users to deploy their hands for control. It is expected that wearable AR glasses and HMDs will converge into mixed reality glasses in the coming years (Nreal). In addition, more sensors will become integrated into VR, including those in VR globes, olfactory technologies, VR motion chairs, and 360° motorized treadmills (omnifinity.se). Thus, VR will increasingly become a multisensory experience that goes beyond sight and hearing, and will incorporate haptics, motion, olfaction, and gustation (Murray et al., 2017). Second, technologies for measuring neurophysiological signals will be integrated into a wider array of VR systems (Marín-Morales et al., 2018; Meißner et al., 2019; Schuemie et al., 2001). These technologies involve recording eye movements (Fove, HTC Vive, Pupil Labs, Varjo), EMG (emteq), EEG (Emotiv EPOC or B-Alert x10), fNIRS (Artinis), heart rate variability, respiratory rate, electro-dermal activity, and posture and gestures.

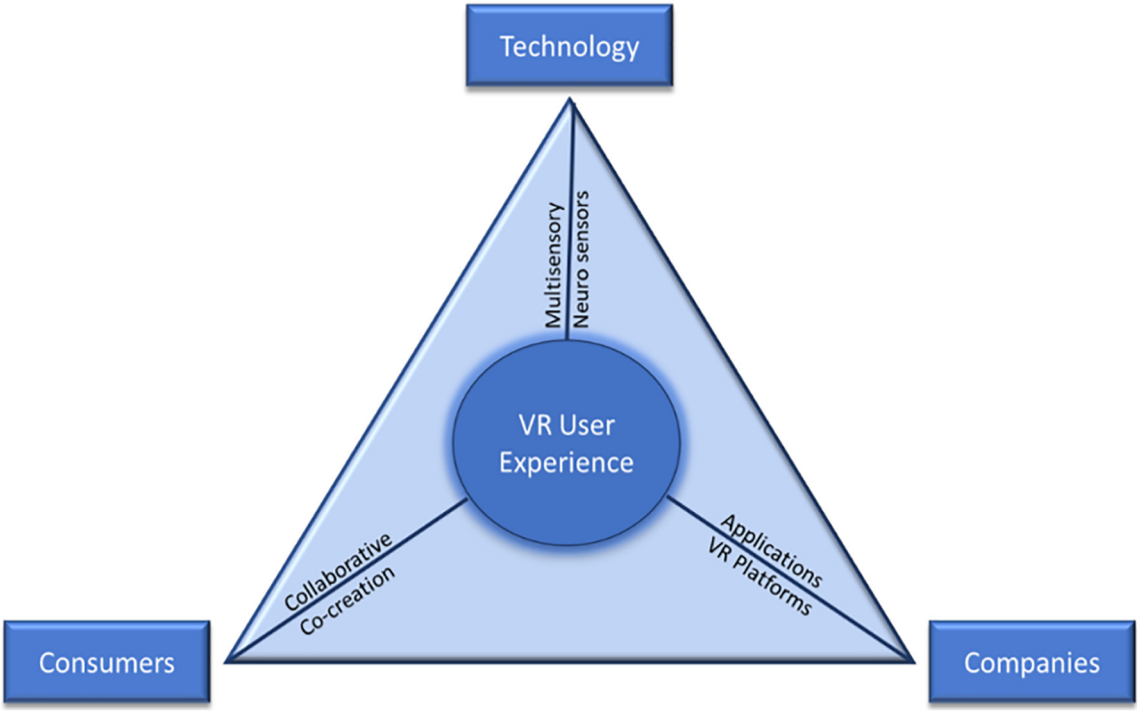

Fig. 4. Dimensions concerning the future of consumer VR experiences.

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Once technical performance has reached levels that do not pose barriers toward VR acceptance or usage, customer adoption of VR will continue to be triggered by three evolving forces. The first is the fun-to-function evolution. As our review has shown, an increasing number of AR apps are being developed for commercial usage, such as try-on apps for clothing and cosmetics, space simulation for interior design, experience-based education, and brand communication in services. This is causing a shift from hedonic to utilitarian motives in the adoption and use of VR that will promote its further spread (Martínez-Navarro et al., 2019). Second, VR adoption will be stimulated by the ease-of-use afforded by natural user interfaces and multi-interaction modalities (Blach, 2008), including voice interfaces, gesture and posture recognition, and human-thought tracking.[4] For instance, the Orbulus app, which takes users to the desired destination when they gaze at an option for a sufficiently long time, and the CTRL-labs armband that records nerve activity to enable movement of virtual or real objects, are gaining popularity. Third, consumers' desires for interactivity and the experience of telepresence will speed up VR adoption. These may involve joint activities carried out by multiple individuals or avatars in a virtual context, such as shopping with friends or experts, or watching movies or sports with friends, supporters, or coaches.

Companies are adopting roles as developers or sellers, so that some division of labor may emerge in consumer VR markets. On the one hand, sellers, focusing on stand-alone VR, are deploying VR to enable customers to interact with their products and services (the Dolphin Swim Club's therapeutic virtual swimming sessions with dolphins). On the other hand, developers are introducing general VR platforms that provide multiple applications (Yerbabuena, NextVR) or subscription services for VR content (Viveport Infinity). VR-arcades and CAVEs that create professional grade multisensory VR experiences, now common in gaming, may extend their applications to the public for news, arts, sports and entertainment applications. This will continue to increase the breadth of VR experiences.

Some form of open architecture might emerge that will be compatible with most VR devices and applications. VR and AR development kits (ARKit for Apple iPhone, ARCore for Google Android) may become available to *consumers*, who then will create their own virtual experiences and virtual environments. More platforms will be developed on which firm- and user-generated VR applications co-exist (e.g., the online gaming platform Roblox.com). Consumers will play an increasingly large role in producing user-generated VR content that augments companies' product and service offerings, and may create virtual experiences that can be re-lived by themselves and experienced and augmented by others. Consumers will be able to interact within these applications in collaborative VR experiences. One of the VR research and development priorities will be on new ways of connecting customers with products and services, and with avatars, robots, and other customers in joint virtual spaces through multisensory interactions.

5.2. Areas for future research on VR in consumer marketing

Based on our conceptual framework, reviews of VR applications and the academic literature, and analyses of future developments of VR, we posit several areas for research on VR in consumer marketing that future research endeavors should focus on. We discuss how innovative VR applications will prompt researchers to revisit existing marketing concepts and questions, give rise to new research questions, measure VR effectiveness, examine the response of consumers to VR, assess the impact of VR application in various marketing domains, and study how VR itself can be utilized to facilitate research developments.

5.2.1. Area 1: Revisiting consumer behavior theories in VR contexts

Developments in VR practices may lead researchers to revisit existing consumer behavior concepts and theories. Theoretical advances can be made by conceptually and empirically assessing the impact of core VR features (such as immersion, presence, interactivity, and contextualization) on consumer psychology and behaviors. Consumer information processing models should be revisited to examine their applicability to VR, including studying what mechanisms mediate consumer responses to VR features, and which VR features may be incorporated into these models as moderators. Concepts such as sensory perception and integration, learning and memory, embodiment, mental simulation, and the attentional and emotional influences on consumer decision-making would need to be elucidated and tested in virtual contexts (cf., Bagozzi, Gopinath, & Nyer, 1999; Li et al., 2008).

Important questions in this research area are: (1) How is context-relevant knowledge acquired in virtual environments? (2) What bottom-up or top-down processes drive attention in virtual contexts? (3) How do embodiment and a sense of presence facilitate learning and decision making? (4) What are the psychological and social consequences of VR engagement? Escapism, self-image, stress, anxiety, and social interactions are particularly worthy of further research (Jung, Yu, Seo, & Ko, 2019). (5) How does the application context (functional vs. experiential) moderate these effects? In addition, how does the application context moderate goal setting and pursuit (Locke & Latham, 1990; Schlosser, 2003) at different stages of the customer journey? (6) Another worthy topic is whether and how virtual contexts moderate dual-process formation of attitudes and behaviors (Chaiken, 1980; Evans, 1984; Kahneman, 2003; Petty & Cacioppo, 1986). The roles of constructs such as tangibility, imagery, embodiment, fluency, spatial presence, self-presentation, the (future) self, and attachment deserve re-examination in the VR contexts (Chicchi-Giglioli, Pravettoni, Sutil Martín, Parra, & Alcañiz-Raya, 2017; Heller et al., 2019b; Hilken et al., 2017; Schau & Gilly, 2003; Schlosser, 2003). Future research should also address joint action, task sharing, and action coordination in virtual environments (Miller et al., 2019).

[4] https://medium.com/fast-company/facebooks-vision-of-glasses-that-read-your-thoughts-isn-t-just-a-dream-f78ee1d3b3ff.

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In terms of conceptual advancement, the concept of customer experience should be further developed to encompass virtual experiences, and particularly virtual brand experiences (Schmitt, 1999). Important open questions are: (1) How much does fidelity of the virtual environment matter for consumer experiences? (2) What are the roles of immersion, attention, and presence in influencing virtual consumer experiences and what is their impact on the effectiveness of VR applications in marketing? (3) How are brand perceptions, and consumer interactions and relationships with brands influenced through virtual or augmented reality? In addition, one would need to better understand customer expectations of VR service delivery and the quality of virtual service interactions (Parasuraman, Berry, & Zeithaml, 1985), how expectations about virtual objects, people and interactions are formed and updated, and how consumers can be engaged to contribute to virtual service configurations and their evaluative reviews. More research illuminating which specific features of VR drive social exchanges between buyers and sellers, the influence of types of avatars and virtual reference groups would also be valuable. The hypothesis that anthropomorphism of avatars in the VR context may improve engagement and social interactions should be tested and its boundary conditions investigated (Steinhoff et al., 2018). Similarly, the Uncanny Valley phenomenon that was discovered in human-robot interactions (Mori, 1970), and its effect on sense of presence and the user experience should be investigated for avatars in VR as well. Finally, the findings by Miller et al. (2019) that nonverbal behavior and social connectedness are altered in the presence of virtual contents provide an important starting point for further research.

At the same time, VR presents opportunities to test existing and develop new concepts and theories, because it allows participants to be placed in virtual conditions that can more easily illicit real experiences via various manipulations, instead of asking participants to imagine those situations. For example, the effects of specific sensory inputs can be isolated and manipulated with VR, and VR presents a means to experimentally investigate the effect of sensory integration on consumer behaviors. In addition, operationalizing and experimentally manipulating experiences in virtual reality would be a powerful research tool with high external validity.

5.2.2. Area 2: Development of measurement approaches and models for VR-generated data

Neurophysiological data collected in or via VR applications, especially body, hand, face, eye, and brain tracking (EEG) data (Alcañiz et al., 2019), will become widely available and offer the potential to dynamically measure many processes involved in consumer decision-making. It is, however, not yet sufficiently clear what specific measures should be used to comprehensively capture the sense of presence, consumer experience, and the effectiveness of VR. In-depth consumer psychology research on sensory perception, multisensory integration, emotions, attention, fluency and flow, and presence will play a critical role in advancing assessment of consumer responses to VR. Developing that body of knowledge further is an important avenue for future research.

The rich and multidimensional data sources made available through VR will necessitate the development and application of marketing analytics methods (Wedel & Kannan, 2016). A wide range of marketing research techniques need to be extended and adapted for these new data, including those for handling unobserved heterogeneity (such as mixture and hierarchical Bayes models), methods for image, speech, text, and video analyses (such as Artificial Intelligence, and machine learning and neuronetwork models), and estimation methods involving large-scale data or computation (such as the Markov Chain Monte Carlo, Particle Filters, and Variational Inference techniques). The application and adaptation of social media and web analytics to VR data is also a rich domain for new research.

5.2.3. Area 3: Examining consumer response to VR applications

A deeper understanding of consumer responses to specific features and functions in VR applications is needed to assist development and adoption of VR, including but not limited to responses to products, experiences, people, advertisements, store environments, shelf displays, promotions and pricing in virtual environments. Moreover, the impact of these VR features on the consumer experience in each stage of the customer journey needs to be elucidated. Although prior research has already addressed some of these issues (as indicated in Table 1), the effect of virtual product/brand presentations on consumer engagement, attitudes, purchase intentions, and purchase outcomes, and dynamic patterns in them remain important future research territories (Pizzi et al., 2019). For example, much is still unknown about how consumers interact with brands, form and develop relationships with brands, and attribute value and meaning to brands in virtual environments. Beyond conventional outcome variables, such as choice and satisfaction, research should identify and incorporate intermediary constructs, and their measurements, that drive/mediate downstream outcome variables in virtual contexts. Along this direction, we expect the following intermediary constructs to play a central role: *attention* to features and objects in the virtual environment measured by eye movement recording, *emotional responses* measured by facial recognition, and *neurophysiological activities* measured by devices such as wearables and EEG (Bigné et al., 2016).

While the visual aspects of VR have received most research interest, studies have just begun to explore how simulation through haptic devices affects consumer experiences and its impact on consumer attitudes, intentions, and behaviors (Hadi & Valenzuela, 2019), which will continue to be a fertile research area. Central questions in this domain include but are not limited to: (1) What level of presence is required for the optimal consumer experience and in what specific application contexts? (2) How do antecedents (visual, auditory, haptic) of a VR system drive the sense of presence, consumer experience, and VR effectiveness in different stages of the customer journey? (3) What unique features of virtual stores, ads, and brands elicit favorable consumer responses? (4) How to increase consumer adoption of and engagement with VR, and their impact on enjoyment, purchase intention, satisfaction, and loyalty? The post-purchase stage deserves particular attention given a dearth of

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prior research. For example, an area of interest is how VR can be used to address dissatisfaction and mitigate post-purchase regret (Zeelenberg & Pieters, 2004).

Much of the extant research has focused on how VR interfaces constrain the consumer, inhibit the sense of presence, and how they enable the consumer, for example by facilitating virtual interactions with objects and avatars. However, Hoffman and Novak (2018) pointed out that little or no research has studied if, and how, consumers enable or constrain the virtual environment through their interactions with it, which is worth future inquiry especially given the emergence of user-generated virtual environments.

5.2.4. Area 4: Studying VR impact in marketing domains

The marketing domains that are most likely to be affected by VR are product design and aesthetics, advertising, shopper marketing, multichannel retailing, social interactions, and co-creation of products and experiences. In these domains, VR is both an enabling technology and a new channel. In the pre-purchase phase, acceptance of VR technology is critical. The literature on user acceptance of information technology has already looked into VR adoption (Fetscherin & Lattemann, 2008; Manis & Choi, 2019), but acceptance of specific features, such as haptics and motion, still needs further research. Although the work on VR is nascent, research on VR acceptance in the tourism industry has been particularly active (Yung & Khoo-Lattimore, 2017), and it has shown the influence of immersion, enjoyment, and perception of usefulness on intentions to use VR and on product purchases (Disztinger, Schlögl, & Groth, 2017; Pantano & Corvello, 2014; Tussyadiah et al., 2018). Research on mobile AR adoption (Kourouthanassis, Boletsis, Bardaki, & Chasanidou, 2015) finds that functional properties of AR tourism apps evoke feelings of pleasure and arousal. These findings would need to be replicated in other VR application domains, especially those in functional vs. experiential contexts.

In the domain of retailing, there are two broad areas of topics that are particularly important: VR as an enhancement technology within an existing channel, and VR as an emerging new sales channel. Much of extant research has focused on the first area. As discussed previously, the experience with and impact of VR applications in the post-purchase stage has as yet seen the least research. Important questions to be addressed in the first area include: (1) What is the impact of functional vs. experiential VR experience on consumers' shopping and purchase behaviors (such as browsing, shopping cart conversion vs. abandonment, purchase frequency, spending, etc.), and how does it vary by product or service categories? (2) How does VR influence and (hopefully) enhance retailer's other merchandising activities such as assortment, promotion, shelf display, and space allocation? (3) How does VR experience during the shopping and purchase process influence consumption and post-purchase evaluations? (4) How much value is added to manufacturers by VR applications in retailing, such as AR advertising or virtual try-on functions? Although VR as a sales channel is still a nascent phenomenon (for examples, VR video game consoles that are used to sell new games; the Chinese online grocer Yihaodian that has tested AR virtual stores[5]), the technology for it to grow is already here. Therefore, we expect the VR retail channel to be an exciting new research area with many interesting topics to be explored. As the practice gains traction, future research should provide a comprehensive picture of cross-channel implications of adding a VR channel, transcending the boundaries between current channels, and how it impacts advertising, promotion, showrooming, and attribution. *E*-commerce practitioners need to know whether the VR channel cannibalizes or creates synergy for other channels. A central topic for research will be the quantification of the incremental value of a VR channel. In addition, researchers need to revisit channel migration issues, because switching between virtual channels and among virtual and other digital channels can be almost frictionless.

VR technologies can also be used to establish VR marketplaces through which a large number of merchants interact and transact with consumers. The replication and extension of research on online digital B2C exchanges to VR in consumer markets seems called for (Martínez-Navarro et al., 2019). For example, the idea of mobile ad-exchanges could be extended to virtual contexts, and it is a worthy topic to investigate issues related to marketplaces for virtual product placements.

The extended interactivity with products, stores, objects, people, and avatars presented by VR affords consumers with more opportunities to express individual differences, which leads to the question of how one can best personalize products, marketing content and marketing actions in virtual environments. Teng (2010) already showed that customization in VR gaming enhances user loyalty both directly and indirectly via enhanced immersion and satisfaction. Research on personalization in the VR context should analyze the influence of chatbots and avatars, and investigate source credibility, customer trust, engagement, attachment, and emotional and social bonds in virtual environments. VR technologies open up new routes for personalization of pricing and promotions (Zhang & Wedel, 2009), morphing products, experiences and contexts (Hauser, Liberali, & Urban, 2014; Urban, Liberali, MacDonald, Bordley, & Hauser, 2013), and adaptive personalization of messaging, products and experiences (Chung, Rust, & Wedel, 2009; Chung, Wedel, & Rust, 2016). The viability and effectiveness of these personalization methods need to be investigated. Moreover, product reviews, social-media posts (such as likes, shares, comments), contextual product information, and co-created and self-customized products in virtual environments provide rich data sources for research on new ways to personalize various marketing actions and offerings.

[5] https://insideretail.asia/2012/10/17/yihaodian-goes-virtual/.

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Finally, financial issues related to VR adoption have been almost ignored so far. What is the ROI of investing in VR applications? What kind of returns can be expected? How is implementation of VR technologies linked to financial performance of the firm? Analogous to the framework of VR applications for B2B marketing by Boyd and Koles (2019), an interesting direction for future research is to develop frameworks to assess the financial impact of VR targeted toward consumers.

5.3. Research opportunities enabled by VR

VR constitutes a tool that can help advance research in areas including, but not limited to, new product development, multimedia advertising, branding, and multichannel marketing. Pan and Hamilton (2018) provided an in-depth discussion on how to utilize VR technologies to study human social interactions (see also Miller et al., 2019), and discussed challenges in its application for that purpose, which include the Uncanny Valley, embodiment, presence and ethics. Similarly, VR seems a useful tool to study multisensory integration.

Feng and Mueller (2019) analyzed the content of AR advertising videos on YouTube, and Van Berlo, van Reijmersdal, Smit, and van der Laan (2019) analyzed the processing of branded VR content. These are initial studies in a domain where VR is expected to yield deeper insights into product design, advertising, and branding. For example, VR can be used in research to improve physical attributes of products, ads, and stores. It can also be used to investigate the mutual influences between virtual and physical environments. While obtaining comprehensive data on the customer journey in traditional settings is notoriously difficult (Lemon & Verhoef, 2016), the entire customer journey can be tracked in simulated VR environments, with possible manipulations on different touchpoints (outdoor, contextual pop-up, ads, and stores), media, channel specifics, and marketing actions (advertising, sales promotions, product recommendations). This would enable an experimental 360° view of consumer responses to multiple media and channels, which provides a tremendous opportunity to study media responses, channel migration, cross-channel spillovers, and synergy versus cannibalization. Such data would also contribute to developing better attribution assessments and new or improved measures of advertising effectiveness across media.

In many marketing domains, virtual and augmented reality allow for relatively cost-effective experimentation (Burke, 2018). Whereas field experiments often are used to address minor tactical issues due to their high costs and potential risks to companies, experiments conducted in VR, AR, or MR environments can offer similar realism yet are more cost-efficient, confidential, and can be easily scaled up to address high-dimensional, major tactical or even strategic marketing problems, such as product assortments, product positioning, branding and re-branding, personalization of marketing contents, product-line pricing, and store layout and design. In lab experiments, VR may also prove to be useful to place participants in simulated, rather than imagined, situations. An example is the recent research by Sarantopoulos, Theotokis, Pramatari, and Roggeveen (2019), who used a virtual reality experiment to show that organizing product categories by consumption goals rather than physical characteristics enhances visualization of the consumption process, which increases purchases and spending.

VR/AR technologies can also be used by companies to assess the impact of marketing programs on downstream outcome measures such as store traffic and sales. For brick-and-mortar and online retailers who already adopted VR in their business operations, field experiments or quasi-experiments conducted via their VR infrastructure could be particularly useful methods for this purpose. In addition, controlled field experiments can be conducted at relatively low cost and high speed in realistic settings via VR, and detailed behavioral data can be collected unobtrusively. Burke (2018) reported, for example, that practitioners use virtual store simulations because they offer the benefits of facilitating planning, collaboration, and relationship management.

6. Concluding remarks

The rapid developments in VR technologies have stimulated many applications in business practice, which in turn has drawn increasing research attention from marketing scholars. Despite that growing interest, the emerging literature on VR in marketing is still relatively sparse, disconnected, and lacking significant overarching research frameworks, consensus measurement instruments, and a body of generalizable and replicable findings. In this article, we have proposed a conceptual framework for consumer marketing research on VR, provided a review of VR applications in marketing practice, synthesized the academic literature, prescribed an outlook for future developments in practice, and identified opportunities for advancing consumer marketing research on VR. We hope that measurement tools, experiments using VR and AR, and data analytical techniques will test, corroborate, and expand upon the relationships between the concepts in our framework.

Multiple factors give rise to optimism over the potential for VR. First, large companies continue to make major investments in VR/AR for mass-market applications, and continuous innovations arise from start-ups; VR, thus, is likely to become an integral component of the marketing landscape. Second, academic and research institutions are increasingly being equipped with VR, and there is a steady growth in marketing and consumer research on VR, or using VR. Our hope is that this article will provide marketing researchers with insights that may help them identify and address important research questions, and practitioners with an overview of the competitive landscape, untapped application opportunities, and a framework that help them assess the effectiveness of deploying VR in different application contexts and stages along the customer journey. We have discussed implications for practitioners throughout this paper. These key managerial implications are summarized in Table 2, organized by the topics discussed in this paper.

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Table 2
Summary of managerial implications by topics discussed in this paper.

Topic in our article	Managerial implications
VR Applications in Practice	• Current applications have primarily focused on the pre-purchase and purchase stages of the customer journey. More development is needed to target the post-purchase stage. • VR technology companies need to give priority in improving 1) rendition quality of all sensory dimensions and 2) minimizing user sickness. • Companies need to address VR privacy and security issues upfront.
• Pre-purchase stage: advertising/selling	• As virtual try-ons and walk-throughs becoming more mainstream, companies need to focus on creating a point of differentiation in their VR applications.
• Purchase stage: retailing	• Currently VR features are usually embedded within mobile retail apps. Opportunities exist to create stand--alone virtual stores.
• Post-purchase stages: consumption experiences	• Companies can utilize VR applications in the post-purchase stage to enhance consumption experiences, strengthen relationships, and build long-term customer loyalty.
Conceptual Framework	
• Immersion and presence	• Higher level of immersion (realism) does not necessarily increase presence or task performance. Companies could reduce the complexity of sensory input yet achieve higher VR effectiveness and cost efficiency at the same time.
• Attention	• Consumers' attention is a critical link between immersion and presence. Companies can utilize eye-tracking and other brain-computer interfaces to measure attention and improve the designs of VR applications to enhance their ability to attract and retain attention, which in turn would contribute to greater VR effectiveness.
• Consumer experience	• Companies should focus on creating multisensory (vision, sound, touch, smell) virtual product/brand experiences that embrace interactive telepresence.
• Application context	• Managers should give priority to implementing VR applications for hedonic and experiential products, as the impact of CX on VR effectiveness tends to be stronger for such products.
• Stages along the customer journey	• The design and deployment of VR should be tailored to the different stages in the customer journey by presenting information congruent with consumers' goals and facilitating the specific behaviors in each stage.
• Assessment of VR effectiveness	• Companies should enhance capabilities of tracking and utilizing metrics of consumers' multisensory input and behaviors to improve the effectiveness of VR in a continuous fashion.
Directions for Future Research	
• Revisiting CB theories	• VR technologies and application designs can be further improved based on insights gained via research on VR and consumer information processing, self-portrayal, social interactions, co-creation, escapism, nostalgia, and anthropomorphism.
• VR measurement, analytics, consumer response to VR	• Companies need to invest in capabilities to harness dynamic and unstructured data generated by VR applications and pay attention to integrating neurophysiological measurements.
• VR impact in marketing domains	• VR will allow companies to connect customers with other customers and avatars, as well as products and services via interconnected virtual spaces. • VR offers unique opportunities for real-time personalization of pricing, promotions, products, messaging, experiences, and contexts. • Enhancing familiarity and confidence with its use is key to consumers' adoption of VR. • VR investment decisions should be based on accurate assessment of the incremental value of a given VR technology or application.
• Research enabled by VR	• Companies can utilize VR for experimentation with and testing of product design, assortment, product positioning, branding, product-line pricing, store layout and design, multimedia communications, and multi-channel marketing.

We expect that future research along the directions identified in this article will provide a plethora of consumer marketing insights that are valuable for VR practices and managerial decisions, ranging from enhancing VR technologies and designs to guiding deployments and assessments of VR applications in a wide range of industries, application contexts, and at different stages of the customer journey. While the focus of this article has been consumer marketing research on VR, we would like to acknowledge the importance of studying social issues concerning VR, including ethical issues on privacy and discrimination, and race identity and self-identity in virtual environments.

Due to the complex, multidimensional nature of future research questions, they invite the initiation of multidisciplinary research teams that combine expertise from different backgrounds, specifically computer science, engineering, psychology and business. Such collaborations, and those with industry practitioners, could address broader and more strategic research questions, and yield research outcomes that will be more robust and relevant to business practices. New technological advancements will emerge in the future which may challenge certain elements in our proposed conceptual framework. Nonetheless, it is our hope that the fundamentals laid out in this paper will continue to provide useful guidance to future research in a rapidly evolving environment, and that it is helpful in identifying new research opportunities in VR for marketing academics.

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Appendix A

Company	VR	Industry	Device	Application	Marketing	Benefit	Journey	YouTube
Immersion, Hap2you	AR	Advertising	Mobile	Haptic mobile ads	Advertising	Exper	prepurchase	https://www.youtube.com/watch?v=5l20EDlVqug
Michael Kors, Pottery Barn, Sephora, NYX Professional Makeup, Bobbi Brown, Nike, Kia	AR	Advertising	Mobile	Interaction with ads on Facebook, Snapchat and Blippar platforms	Advertising	Funct/Exper	prepurchase	https://www.youtube.com/watch?v=VVLGZS3u2jA ; https://www.youtube.com/watch?v=VVLGZS3u2jA ; https://www.youtube.com/watch?v=V36c4ryFgAM
GAP	AR	Apparel	Mobile	Virtual mannequin fitting	Retailing	Funct	prepurchase	https://vimeo.com/198481246
Rixo	AR	Apparel	Hologram	Virtual runway model	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=pn-k2BERxxM
Zara	AR	Apparel	Mobile In-store	Virtual runway model	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=b1lyn4t5Y0Y
Timberland	AR	Apparel	AR Mirror	Virtual fitting	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=5TZmQPdhpak
Nike	AR	Apparel	In-store	Shoe fit visualization and customization	Retailing Product	Funct	purchase	https://www.youtube.com/watch?v=Xf3VdMENFKs
Stockholm Art Week, Becks	AR	Art	Mobile	Explore Art through city	Experience	Exper	postpurchase	https://www.youtube.com/watch?v=mYQshH7ptew
INDE	AR		Hologram	Explore	Product Experience	Exper	prepurchase	https://www.youtube.com/watch?v=shQwp30ZTBM
GM	AR	Automotive	Digital billboard	Customization of advertising based on facial expressions	Advertising	Exper	prepurchase	https://www.youtube.com/watch?v=Kj7Dm_i-OoM
BMW	AR	Automotive	Mobile	Car visualization in context and customization	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=jMIkpbvv-QE
Axe, Disney	AR	Beauty & Fragrance	Outdoor screen	advertising	Advertising	Exper	prepurchase	https://www.youtube.com/watch?v=Hd_2Y29_FLU ; https://www.youtube.com/watch?v=UIHwHqaY3SY
Jo Malone, Macys	AR	Beauty & Fragrance	In-store screen	Fragrance visualization	Retailing	Exper	prepurchase	https://www.youtube.com/watch?v=ziHpjkzBo08
Wanna Nails, Sally Hansen	AR	Beauty & Fragrance	Mobile	Show nail polish on hands, social media, gamification	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=1pWfFsX9lEM
Zeni	AR	Fragrance	Mobile	Virtual glasses fitting	Retailing Product	Funct	purchase	https://www.youtube.com/watch?v=Aikck5AwlTs
Toms	AR	Charities	Mobile Outdoor	Virtual travel experience	Experience Product	Exper	postpurchase	https://www.with.in/watch/toms-virtual-giving-trip/ https://www.youtube.com/watch?v=uG2HiraKM-Y ; https://www.youtube.com/watch?v=DnN_MKQwd6k
WWF	AR	Charity	Screen In-store	Interaction with wildlife	Experience Product	Exper	postpurchase	
Unilever	AR	CPG	mobile	Game	Experience Product	Exper	purchase	https://www.blippar.com/work/magnum
The Dutch Lady	AR	CPG	Mobile	Childrens game	Experience Product	Exper	prepurchase	https://www.youtube.com/watch?v=z0ki1OSuUvE&t=61s
Absolut	AR	CPG	Mobile Digital (Bus Shelter)	Product production info	Experience	Exper	postpurchase	https://www.youtube.com/watch?v=ewE05pwWwI8
Pepsi	AR	CPG	Screen In-store	Advertising	Advertising	Exper	prepurchase	https://www.youtube.com/watch?v=Go9rf9GmYpM
Johnson & Johnson	AR	CPG	screen	Product info triggered by touch and cross selling	Retailing Product	Funct	purchase	https://vimeo.com/340179213
Heinz (Blippar)	AR	CPG	Mobile	Product information, receipes	Experience Product	Funct	prepurchase	https://www.youtube.com/watch?v=0I3CdW8zPa0
Animojis, Clips, ARStickers,	AR	Entertainment	Mobile	Avatar, video, picture rendering	Experience	Exper	Purchase	https://www.youtube.com/watch?v=d9TaZjMc1hw

(continued on next page)

(continued)

Company	VR	Industry	Device	Application	Marketing	Benefit	Journey	YouTube
The Walking Dead	AR	Entertainment	Bus Shelter Screen	Trailer fragments, advertising	Advertising	Exper	prepurchase	https://www.youtube.com/watch?v=B7FzWUhgqck
Kith, Ihaodien, IKEA	AR	Fashion	Mobile	Pop-up store	Retailing	Exper	Purchase	https://www.youtube.com/watch?v=UudV1VdFtuQ
Kate Spade	AR	Fashion	In-store screen	Handbag visualization and customization	Retailing	Funct	prepurchase, purchase	https://www.youtube.com/watch?v=xtkLvxUJw6I
LaCoste	AR	Fashion	Mobile	Shoe fit visualization, interact with in-store displays and signage	Retailing	Funct	purchase	https://www.youtube.com/watch?v=JcMOyMudH88
Pokemon Go, Ingress, PuzzlAR, The Machines, Lego AR studio	AR	Gaming	Mobile	Variety of games	Product Experience	Exper	purchase, postpurchase	https://www.youtube.com/watch?v=SWtDeeXtMZM ; https://www.youtube.com/watch?v=-EbTk3toFgY ; https://www.youtube.com/watch?v=ZIF2w-wULcw ; https://www.youtube.com/watch?v=QYJo3YUdgCA ; https://www.youtube.com/watch?v=cHvcD2FrKew
Home Depot, Dulux	AR	Home goods	Mobile	Visualize interior colors	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=yETvPdW9J4s ; https://www.youtube.com/watch?v=ownZIyP4V_Q ; https://www.youtube.com/watch?v=4lMFxJ4PDXY
Lowe's	AR	Home goods	Mobile	In-store navigation, reverse image search	Retailing	Funct	purchase	https://www.youtube.com/watch?v=LZ0IoPyUvSg ; https://www.youtube.com/watch?v=ar63AS1sRwE
Macys, Houzz, Amazon, Ikea, Pottery Barn, Bobs discount Furniture, iStaging, Wayfair, Mity, Target	AR	Home goods	Mobile	Visualize furniture in home	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=E_f88nf_BL8 ; https://www.youtube.com/watch?v=NKdS9xyj6co; https://www.youtube.com/watch?v=77ZJ3jw6EkA; https://www.youtube.com/watch?v=4jrhw_ZRjV4; https://www.youtube.com/watch?v=G-_p_FrhwgQ ; https://www.youtube.com/watch?v=-W4KtSTrnJ4; https://www.youtube.com/watch?v=K2HWltnJAYA; https://www.youtube.com/watch?v=_sMRevzMF3w; https://www.youtube.com/watch?v=uNUcVPjnysE; https://www.youtube.com/watch?v=6ZWuNgPjo_Q
NFR	AR	Home goods	Mobile	Virtual store visit	Retailing	Funct	purchase	https://www.youtube.com/watch?v=UQcJSZPpNhA
Diamond Hedge, Jura, bella luce	AR	Jewelry	Mobile	Show rings on hands, show watches, pricing info	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=KvZQXqcX1Do ; https://www.youtube.com/watch?v=LySvUOmL4Dw ; https://www.youtube.com/watch?v=R_F1LvK5gCk
BBC Civilizations	AR	News & Information	Mobile	Explore and interact with ancient artifacts	Product Experience	Exper	postpurchase	https://www.youtube.com/watch?v=0FDdp0TpESs
Wikitude, layar, top Gear Mags, Hector & Karger	AR	News & Information	Mobile	Interact with magazines, newspapers, brochures, find nearby restaurants, ATMs, historical sites	Product Experience	Funct	postpurchase	https://www.youtube.com/watch?v=rjmZE0VkJWM
Quartz	AR	News & Information	Mobile	Product placement	Advertising	Funct	prepurchase	https://www.youtube.com/watch?v=urqpdMrp3_Q
MYPad3, Matterport, Sotheby's International Realty, Realtor.com	AR	Real Estate	Mobile	New home search and exploration	Product Experience	Exper	prepurchase, purchase	https://www.youtube.com/watch?v=xPOT3UsGj2w ; https://www.mypad3d.com/ ; https://www.youtube.com/watch?v=uMgtHxRULUk ; https://www.youtube.com/watch?v=c0jUhnCRizI ; https://www.youtube.com/watch?v=4jDITypfWgs
Pizza Hut	AR	Restaurants	Mobile	Interactive menu, gamification	Product Experience	Exper	postpurchase	https://www.youtube.com/watch?v=NzLQWw3S2z4
Toys R US	AR	Toys	In-store	Game	Product Experience	Exper	purchase	https://www.youtube.com/watch?v=7V4KsmKQP1Q
Disney	AR	Toys	Mobile	Digital coloring book	Product Experience	Exper	postpurchase	https://www.youtube.com/watch?v=SWzurBQ81CM

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Blippar	AR	Travel, Entertainment	Mobile	Object, logo, car, landmark recognition	Advertising, Product Experience	Exper	postpurchase	https://www.youtube.com/watch?v=AgRdutPZNug
Beijing Airport, Amsterdam-Schiphol	AR	Travel, Entertainment	Outdoor screen	Flight information based on face recognition	Retailing	Funct	postpurchase	https://www.youtube.com/watch?v=7VBv28w0bEQ ; https://www.youtube.com/watch?v=wHgFrc86rkY
Dubai Airport	AR	Shopping	Mobile	Virtual store visit	Retailing	Funct	purchase	https://www.youtube.com/watch?v=5OHd0xGC87M
Top Shop, Uniqlo, Kinnect, Cisco, Lily	AR	Apparel	In-store screen	In-store virtual fitting mirror, color substitution	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=L_cYKFdP1_0 ; https://www.youtube.com/watch?v=MjltyZx15O4 ; https://www.youtube.com/watch?v=Mr71jrkzWq8 ; https://www.youtube.com/watch?v=XM9ZOWPeiAk ; https://www.youtube.com/watch?v=zBKtZvy5r1A
Sephora, Bourjois, Tilbury, YouCam Makeup, Makeup, Inkhunter	AR	Beauty & Fragrance	In-store screen, mobile	Visualize makup combinations, tatoos, social media sharing	Retailing	Funct	purchase	https://www.youtube.com/watch?v=2dTvMR7TVck ; https://www.youtube.com/watch?v=gc-lzjvaaXM ; https://www.youtube.com/watch?v=qFn39e9AnUI; https://www.youtube.com/watch?v=5_vBVEiZBSk ; https://www.youtube.com/watch?v=Qg5V2s1BC7I ; https://www.youtube.com/watch?v=5_vBVEiZBSk ; https://www.youtube.com/watch?v=p_Q7eA-C6X0
North Face	VR	Apparel	In store HMD	Virtual outdoor travel experience	Retailing	Exper	prepurchase	https://www.youtube.com/watch?v=FSfkE4emoBE
Lexus	VR	Automotive	In-store HMD	Virtual race track experience	Retailing	Exper	prepurchase	https://www.youtube.com/watch?v=HC3NDv4kXc0
Volvo, Audi, BMW, Seat, Ford	VR	Automotive	In-store HMD	Virtual tour of car	Product Experience	Funct	prepurchase	https://www.youtube.com/watch?v=Ahxc9GsqKHo ; https://www.youtube.com/watch?v=HEkGRUkqjTA ; https://www.youtube.com/watch?v=kt3e-90JTQ4 ; https://www.youtube.com/watch?v=1ugOFZoCGF0 ; https://www.seat.com/company/news/cars/virtual-reality-car-manufacturing.html ; https://www.youtube.com/watch?v=IdPtw0rCapw
Airwalk, Helsinki Design Week 2019	VR	Fashion	Mobile	Pop-up store	Retailing	Exper	purchase	https://www.youtube.com/watch?v=6QAgxBtkoGY ; https://www.youtube.com/watch?v=INuaa5AGDUw
Topshop, Coca Cola, Pepsi Max	VR	Fashion	HMD	Pop-up store	Retailing	Exper	purchase	https://www.youtube.com/watch?v=lUal_Lrhec0 ; https://www.youtube.com/watch?v=1YEBjfyAFP4 ; https://www.youtube.com/watch?v=S89NTOTf97w
Swarovski	VR	Fashion	HMD	Visualization of products in home and purchase	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=uFNFU4wgyNI
Alibaba- Macy's	VR	Retailing	HMD	Shopping	Retailing	Exper	prepurchase, purchase	https://www.youtube.com/watch?v=-HcKRBKlilg
IKEA	VR	Retailing	HMD	Shopping	Retailing	Exper	prepurchase, purchase	https://www.youtube.com/watch?v=5_znFPj5Lis&t=47s
American Express	VR	Finance	HMD	Virtual tennis game against Sharapova	Advertising	Exper	prepurchase	https://www.youtube.com/watch?v=RaDwt9hHYes
Santander bank, Finovate	VR	Finance	HMD	Tour visit	Retailing	Exper	prepurchase	https://www.youtube.com/watch?v=gPWYo277xv0 ; https://www.youtube.com/watch?v=w1mDD-_rb7s
Lenovo	VR	Gaming	HMD	Star Wars	Product Experience	Exper	Purchase	https://www.youtube.com/watch?v=3WduF2UyvJc
Adidas	VR	Shoes	HMD	Test concept	Retailing	Exper	prepurchase, purchase	https://www.youtube.com/watch?v=5IhyBc3XwDc
Lowe's	VR	Home goods	In-store HMD	Consumer education and skill development	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=OlYltG1RKuI
NYT	VR	News & Information	Mobile	Virtual situational experience	Product Experience	Exper	postpurchase	https://www.youtube.com/watch?v=rcsev4e9DoI ; https://www.youtube.com/watch?v=49vZHEIhp_8
Fox Sports	VR	News & Information	HMD	Watch sports in VR	Product Experience	Exper	purchase	https://www.youtube.com/watch?v=5c32vzqanPk
Engel & Völkers', Halstead	VR	Real Estate	In store	New home search and	Retailing	Exper	prepurchase,	https://www.youtube.com/watch?v=wFfd0doAhH0 ; https://www.

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(continued)

Company	VR	Industry	Device	Application	Marketing	Benefit	Journey	YouTube
Properties, Altlas Bay VR			HMD	exploration			purchase	youtube.com/watch?v=nlwyoVn8RLI ; https://www.youtube.com/watch?v=-BDSyWqW03M
Carnival (AT&T)	VR	Travel	In-Store HMD	Cruise and travel destination experience	Product Experience	Exper	prepurchase, purchase	https://www.youtube.com/watch?v=4sSd-GBADwA
Invrsion	VR	Retailing	HMD	Store navigation and eye tracking	Retailing	Funct	prepurchase	https://www.youtube.com/watch?v=-6iDn1OxpTo
Carrefour- KFC	VR	Retailing	HMD	Store simulation	Retailing	Exper	prepurchase, purchase	https://www.youtube.com/watch?v=cS8rboRYzr8
Vera Bradley	VR	Retailing	HMD	Store navigation	Retailing	Exper	prepurchase	https://www.youtube.com/watch?v=iBnj2TnXHwo
Tesco	VR	Retailing	HMD	Store navigation	Retailing	Exper	prepurchase	https://www.youtube.com/watch?v=08S86X_5Crs
ShopperMX	VR	Retailing	HMD	Store layout and design	Retailing	Exper	purchase	https://www.youtube.com/watch?v=njoP87yek5I
Amadeus	VR	Travel	HMD	Travel agency	Retailing	Exper	prepurchase, purchase	https://www.youtube.com/watch?v=Ax0BmO3DrTc
Notre Dame Cathedral	VR	Travel	HMD	Reconstruction	Product Experience	Exper	postpurchase	https://www.youtube.com/watch?v=JKnZmue656k
Oreo	VR	Food	HMD	Product ingredients	Product Experience	Experience	prepurchase	https://www.youtube.com/watch?v=ENau7AkayN8
Hololens 2	MX	Live demo	HMD	Gaming, utilities, avatar	Product Experience	Experience	prepurchase	https://www.youtube.com/watch?v=uIHPPtPBgHk&t=13s
Museum Rotterdam	MX	Museum	HMD	Construction	Development	Funct	prepurchase	https://www.youtube.com/watch?v=pHjjqKLFMXM
Magic Leaps	MX	Entertainment	HDM	Daily Life	Experience	Funct	prepurchase, purchase	https://www.youtube.com/watch?v=GmdXJy_IdNw

References

Akhtar, Z., & Falk, T. H. (2017). Audio-visual multimedia quality assessment: A comprehensive survey. *IEEE Access*, *5*, 21090–21117.
Alcañiz, M., Bigne, E., & Guixeres, J. (2019). Virtual reality in marketing: A framework, review and research agenda. *Frontiers in Psychology*, *10*, 1530.
Babin, B. J., Darden, W. R., & Griffin, M. (1994). Work and/or fun: Measuring hedonic and utilitarian shopping value. *Journal of Consumer Research*, *20*(4), 644–656.
Bagozzi, R. P., Gopinath, M., & Nyer, P. U. (1999). The role of emotions in marketing. *Journal of the Academy of Marketing Science*, *27*(2), 184–206.
Baka, E., Stavroulia, K. E., Magnenat-Thalmann, N., & Lanitis, A. (2018). An EEG-based evaluation for comparing the sense of presence between virtual and physical environments. *Proceedings of Computer Graphics International 2018* (pp. 107–116). ACM.
Bargas-Avila, J. A., & Hornbæk, K. (2011). Old wine in new bottles or novel challenges? A critical analysis of empirical studies of user experience. *CHI*, 1–10 May 7–12, 2011. Vancouver, BC, Canada.
Becker, L., & Jaakkola, E. (2020). Customer experience: Fundamental premises and implications for research. *Journal of the Academy of Marketing Science*. https://doi.org/10.1007/s11747-019-00718-x article in press.
Berg, L. P., & Vance, J. M. (2017). Industry use of virtual reality in product design and manufacturing: A survey. *Virtual Reality*, *21*(1), 1–17.
Bialkova, S., & Van Gisbergen, M. S. (2017, March). When sound modulates vision: VR applications for art and entertainment. *2017 IEEE 3rd Workshop on Everyday Virtual Reality (WEVR)* (pp. 1–6). IEEE.
Bigné, E., Llinares, C., & Torrecilla, C. (2016). Elapsed time on first buying triggers brand choices within a category: A virtual reality-based study. *Journal of Business Research*, *69*, 1423–1427.
Biocca, F., Harms, C., & Burgoon, J. K. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence Teleoperators and Virtual Environments*, *12*(5), 456–480.
Blach, R. (2008). Virtual reality technology — An overview. *Product Engineering* (pp. 21–64). Dordrecht: Springer.
Bolton, R. N., McColl-Kennedy, J. R., Cheung, L., Gallan, A., Orsingher, C., Witell, L., & Zaki, M. (2018). Customer experience challenges: Bringing together digital, physical and social realms. *Journal of Service Management*, *29*(5), 776–808.
Bonetti, F., Warnaby, G., & Quinn, L. (2018). Augmented reality and virtual reality in physical and online retailing: A review, synthesis and research agenda. *Augmented reality and virtual reality* (pp. 119–132). Cham: Springer.
Bowman, D., & McMahan, R. (2007). Virtual reality: How much immersion is enough? *Computer*, *40*, 36–43.
Boyd, D. E., & Koles, B. (2019). Virtual reality and its impact on B2B marketing: A value-in-use perspective. *Journal of Business Research*, *100*, 590–598.
Brakus, J. J., Schmitt, B. H., & Zarantonello, L. (2009). Brand experience: What is it? How is it measured? Does it affect loyalty? *Journal of Marketing*, *73*(3), 52–68.
Brodie, R. J., Hollebeek, L. D., Jurić, B., & Ilić, A. (2011). Customer engagement: Conceptual domain, fundamental propositions, and implications for research. *Journal of Service Research*, *14*(3), 252–271.
Burke, R. R. (2018). Virtual reality for marketing research. In L. Moutinho, & M. Sokele (Eds.), *Innovative research methodologies in management* (pp. 63–82). Palgrave Macmillan.
Caboni, F., & Hagberg, J. (2019). Augmented reality in retailing: A review of features, applications and value. *International Journal of Retail & Distribution Management*, *47*(11), 1125–1140.
Carmigniani, J., Furht, B., Anisetti, M., Ceravolo, P., Damiani, E., & Ivkovic, M. (2011). Augmented reality technologies, systems and applications. *Multimedia Tools and Applications*, *51*(1), 341–377.
Carrozzi, A., Chylinski, M., Heller, J., Hilken, T., Keeling, D. I., & de Ruyter, K. (2019). What's mine is a hologram? How shared augmented reality augments psychological ownership. *Journal of Interactive Marketing*, *48*, 71–88.
Chaiken, S. (1980). Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *Journal of Personality and Social Psychology*, *39*(5), 752.
Chicchi-Giglioli, I. A., Pravettoni, G., Sutil Martín, D. L., Parra, E., & Alcañiz-Raya, M. A. (2017). A novel integrating virtual reality approach for the assessment of the attachment behavioral system. *Frontiers in Psychology*, *8*, 959.
Chung, T. S., Rust, R. T., & Wedel, M. (2009). My mobile music: An adaptive personalization system for digital audio players. *Marketing Science*, *28*(1), 52–68.
Chung, T. S., Wedel, M., & Rust, R. T. (2016). Adaptive personalization using social networks. *Journal of the Academy of Marketing Science*, *44*(1), 66–87.
Cowan, K., & Ketron, S. (2019). A dual model of product involvement for effective virtual reality: The roles of imagination, co-creation, telepresence, and interactivity. *Journal of Business Research*, *100*, 483–492.
Cruz-Neira, C., Reiners, D., & Springer, J. P. (2010). An affordable surround-screen virtual reality display. *Journal of the Society for Information Display*, *18*(10), 836–843.
Csíkszentmihályi, M. (1975). *Beyond boredom and anxiety.* San Francisco, USA: Jossey-Bass.
Csíkszentmihályi, M. (1990). *Flow: The psychology of optimal experience.* Harper & Row.
Darken, R. P., Bernatovich, D., Lawson, J., & Peterson, B. (1999). Quantitative measures of presence in virtual environments: The roles of attention and spatial comprehension. *CyberPsychology and Behavior*, *2*(4), 337–347.
Deng, X., Unnava, H. R., & Lee, H. (2019). "Too true to be good?" When virtual reality decreases interest in actual reality. *Journal of Business Research*, *100*, 561–570.
Disztinger, P., Schlögl, S., & Groth, A. (2017). Technology acceptance of virtual reality for travel planning. *Information and Communication Technologies in Tourism*, *2017*, 255–268.
Dix, A., Finlay, J., Abowd, G. D., & Beale, R. (2004). *Human-computer interaction* (3rd ed.). Essex, England: Pearson Education Limited.
Egan, D., Brennan, S., Barrett, J., Qiao, Y., Timmerer, C., & Murray, N. (2016). An evaluation of heart rate and ElectroDermal activity as an objective QoE evaluation method for immersive virtual reality environments. *2016 Eighth International Conference on Quality of Multimedia Experience (QoMEX)* (pp. 1–6). IEEE.
Esmark Jones, C. L. E., Barney, C., & Farmer, A. (2018). Appreciating anonymity: An exploration of embarrassing products and the power of blending in. *Journal of Retailing*, *94*(2), 186–202.
Evans, J. (1984). Heuristic and analytic processes in reasoning. *British Journal of Psychology*, *75*(4), 451–468. https://doi.org/10.1111/j.2044-8295.1984.tb01915.x.
Feng, Y., & Mueller, B. (2019). The state of augmented reality advertising around the globe: A multi-cultural content analysis. *Journal of Promotion Management*, *25*(4), 453–475.
Fetscherin, M., & Lattemann, C. (2008). User acceptance of virtual worlds. *Journal of Electronic Commerce Research*, *9*(3), 231–242.
Flavián, C., Ibáñez-Sánchez, S., & Orús, C. (2019). The impact of virtual, augmented and mixed reality technologies on the customer experience. *Journal of Business Research*, *100*, 547–560.
Gartner (2018). Top 10 strategic technology trends for 2019. https://www.gartner.com/en/doc/3891569-top-10-strategic-technology-trends-for-2019, Accessed date: 21 April 2019.
Grudzewski, F., Awdziej, M., Mazurek, G., & Piotrowska, K. (2018). Virtual reality in marketing communication—The impact on the message, technology and offer perception—Empirical study. *Economics and Business Review*, *4*(3), 36–50.
Hadi, R., & Valenzuela, A. (2019). Good vibrations: Consumer responses to technology-mediated haptic feedback. *Journal of Consumer Research*. https://doi.org/10.1093/jcr/ucz039.
Hauser, J. R., Liberali, G., & Urban, G. L. (2014). Website morphing 2.0: Switching costs, partial exposure, random exit, and when to morph. *Management Science*, *60*(6), 1594–1616.
Havlena, W. J., & Holbrook, M. B. (1986). The varieties of consumption experience: Comparing two typologies of emotion in consumer behavior. *Journal of Consumer Research*, *13*(December), 394–404.
Heller, J., Chylinski, M., de Ruyter, K., Mahr, D., & Keeling, D. I. (2019a). Let me imagine that for you: Transforming the retail frontline through augmenting customer mental imagery ability. *Journal of Retailing*, *95*(2), 94–114.
Heller, J., Chylinski, M., de Ruyter, K., Mahr, D., & Keeling, D. I. (2019b). Touching the untouchable: Exploring multi-sensory augmented reality in the context of online retailing. *Journal of Retailing*, *95*(4), 219–234.

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Hershfield, H. E., Goldstein, D. G., Sharpe, W. F., Fox, J., Yeykelis, L., Carstensen, L. L., & Bailenson, J. N. (2011). Increasing saving behavior through age-progressed renderings of the future self. *Journal of Marketing Research*, *48*(SPL), S23–S37.
Hickson, S., Dufour, N., Sud, A., Kwatra, V., & Essa, I. (2019). Eyemotion: Classifying facial expressions in VR using eye-tracking cameras. *2019 IEEE Winter Conference on Applications of Computer Vision (WACV)* (pp. 1626–1635). IEEE.
Hilken, T., de Ruyter, K., Chylinski, M., Mahr, D., & Keeling, D. I. (2017). Augmenting the eye of the beholder: Exploring the strategic potential of augmented reality to enhance online service experiences. *Journal of the Academy of Marketing Science*, *45*(6), 884–905.
Hoffman, D. L., & Novak, T. P. (1996). Marketing in hypermedia computer-mediated environments: Conceptual foundations. *Journal of Marketing*, *60*(July), 50–68.
Hoffman, D. L., & Novak, T. P. (2018). Consumer object experience in the internet of things: An assemblage theory approach. *Journal of Consumer Research*, *44*(6), 1178–1204.
Hudson, S., Matson-Barkat, S., Pallamin, N., & Jegou, G. (2019). With or without you? Interaction and immersion in a virtual reality experience. *Journal of Business Research*, *100*, 459–468.
Hyun, M. Y., & O'Keefe, R. M. (2012). Virtual destination image: Testing a telepresence model. *Journal of Business Research*, *65*(1), 29–35.
Irshad, S., & Rambli, D. R. B. A. (2014). User experience of mobile augmented reality: A review of studies. *3rd International Conference on User Science and Engineering*, 125–130.
Jung, J., Yu, J., Seo, Y., & Ko, E. (2019). Consumer experiences of virtual reality: Insights from VR luxury brand fashion shows. *Journal of Business Research*. https://doi.org/10.1016/j.jbusres.2019.10.038.
Kahneman, D. (2003). A perspective on judgement and choice. *American Psychologist*, *58*(9), 697–720.
Kandaurova, M., & Lee, S. H. M. (2019). The effects of virtual reality (VR) on charitable giving: The role of empathy, guilt, responsibility, and social exclusion. *Journal of Business Research*, *100*, 571–580.
Kang, H. J., Shin, J. H., & Ponto, K. (2020). How 3D virtual reality stores can shape consumer purchase decisions: The roles of informativeness and playfulness. *Journal of Interactive Marketing*, *49*, 70–85.
Kannan, P. K., & Li, H. A. (2017). Digital marketing: A framework, review and research agenda. *International Journal of Research in Marketing*, *34*(1), 22–45.
Ketelaar, P. E., Bernritter, S. F., van Woudenberg, T. J., Rozendaal, E., Konig, R. P., Hühn, A. E., ... Janssen, L. (2018). "Opening" location-based mobile ads: How openness and location congruency of location-based ads weaken negative effects of intrusiveness on brand choice. *Journal of Business Research*, *91*, 277–285.
Kim, G., Buntain, N., Hirshfield, L., Costa, M. R., & Chock, T. M. (2019). Processing racial stereotypes in virtual reality: An exploratory study using functional near-infrared spectroscopy (fNIRS). *International Conference on Human-Computer Interaction* (pp. 407–417). Cham: Springer.
Kim, G., Jeon, J., & Biocca, F. (2018). MIND brain sensor caps: Coupling precise brain imaging to virtual reality head-mounted displays. *International Conference on Augmented Cognition* (pp. 120–130). Cham: Springer.
Kourouthanassis, P., Boletsis, C., Bardaki, C., & Chasanidou, D. (2015). Tourists responses to mobile augmented reality travel guides: The role of emotions on adoption behavior. *Pervasive and Mobile Computing*, *18*, 71–87.
Krishna, A. (2010). *Sensory marketing: Research on the sensuality of products*. New York: Routledge.
Kuppelwieser, V. G., & Klaus, P. (2020). Measuring customer experience quality: The EXQ scale revisited. Journal of Business Research (article in press), https://doi.org/https://doi.org/10.1016/j.jbusres.2020.01.042.
Laurell, C., Sandström, C., Berthold, A., & Larsson, D. (2019). Exploring barriers to adoption of virtual reality through social media analytics and machine learning—An assessment of technology, network, price and trialability. *Journal of Business Research*, *100*, 469–474.
LaValle, S. M. (2017). *Virtual reality*. Cambridge: Cambridge University Press. http://vr.cs.uiuc.edu/.
Law, E. L.-C., Roto, V., Hassenzahl, M., Vermeeren, A. P. O. S., & Kort, J. (2009). *Understanding, scoping and defining user experience: A survey approach. CHI 2009, April 4–9, 2009*. Boston: MA, USA, 719–728.
Lee, T. S., & Mumford, D. (2003). Hierarchical Bayesian inference in the visual cortex. *Journal of the Optical Society of America*, *20*(7), 1434–1448.
Lemon, K. N., & Verhoef, P. C. (2016). Understanding customer experience throughout the customer journey. *Journal of Marketing*, *80*(6), 69–96.
Leung, X. Y., Lyu, J., & Bai, B. (2020). A fad or the future? Examining the effectiveness of virtual reality advertising in the hotel industry. *International Journal of Hospitality Management*. https://doi.org/10.1016/j.ijhm.2019.102391 In press.
Li, H., Daugherty, T., & Biocca, F. (2001). Characteristics of virtual experience in electronic commerce: A protocol analysis. *Journal of Interactive Marketing*, *15*(3), 13–30.
Li, H., Daugherty, T., & Biocca, F. (2002). Impact of 3-D advertising on product knowledge, brand attitude, and purchase intention: The mediating role of presence. *Journal of Advertising*, *31*(3), 43–57.
Li, H., Daugherty, T., & Biocca, F. (2008). The role of virtual experience in consumer learning. *Journal of Consumer Psychology*, *13*(4), 395–407.
Locke, E. A., & Latham, G. P. (1990). *A theory of goal setting & task performance*. Englewood Cliffs, NJ: Prentice Hall ISBN 978-0139131387. OCLC 20219875.
Loureiro, S. M. C., Guerreiro, J., Eloy, S., Langaro, D., & Panchapakesan, P. (2019). Understanding the use of virtual reality in marketing: A text mining-based review. *Journal of Business Research*, *100*, 514–530.
Makovski, T. (2016). What is the context of contextual cueing? *Psychonomic Bulletin & Review*, *23*(6), 1982–1988.
Manis, K. T., & Choi, D. (2019). The virtual reality hardware acceptance model (VR-HAM): Extending and individuating the technology acceptance model (TAM) for virtual reality hardware. *Journal of Business Research*, *100*, 503–513.
Marín-Morales, J., Higuera-Trujillo, J. L., Greco, A., Guixeres, J., Llinares, C., Scilingo, E. P., & Valenza, G. (2018). Affective computing in virtual reality: Emotion recognition from brain and heartbeat dynamics using wearable sensors. *Scientific Reports*, *8*(1), 13657.
Martínez-Navarro, J., Bigné, E., Guixeres, J., Alcañiz, M., & Torrecilla, C. (2019). The influence of virtual reality in e-commerce. *Journal of Business Research*, *100*(July), 475–482.
Mathwick, C., & Rigdon, E. (2004). Play, flow, and the online search experience. *Journal of Consumer Research*, *31*(2), 324–332.
Meehan, M., Insko, B., Whitton, M., & Brooks, F. P. (2002). *Physiological measures of presence in stressful virtual environments, Proc. ACM Siggraph. 2002*. (pp. 645–652). ACM Press, 645–652.
Meißner, M., Pfeiffer, J., Pfeiffer, T., & Oppewal, H. (2019). Combining virtual reality and mobile eye tracking to provide a naturalistic experimental environment for shopper research. *Journal of Business Research*, *100*(July), 445–458.
Milgram, P., & Kishino, A. F. (1994). Taxonomy of mixed reality visual displays. *IEICE Transactions on Information and Systems*, *E77–D*(12), 1321–1329.
Miller, M. R., Jun, H., Herrera, F., Yu, V. J., Welch, G., & Bailenson, J. N. (2019). Social interaction in augmented reality. *PLoS One*, *14*(5), e0216290. https://doi.org/10.1371/journal.pone.0216290.
Mori, M. (1970). Bukimi no tani [the uncanny valley]. *Energy*, *7*, 33–35.
Murray, N., Ademoye, O. A., Ghinea, G., Qiao, Y., Muntean, G. M., & Lee, B. (2017). Olfactory-enhanced multimedia video clips datasets. *2017 Ninth International Conference on Quality of Multimedia Experience (QoMEX)* (pp. 1–5). IEEE.
Ninaus, M., Kober, S. E., Friedrich, E. V., Dunwell, I., De Freitas, S., Arnab, S., ... Bellotti, F. (2014). Neurophysiological methods for monitoring brain activity in serious games and virtual environments: A review. *International Journal of Technology Enhanced Learning*, *6*(1), 78–103.
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.
Oh, J., Bellur, S., & Sundar, S. S. (2018). Clicking, assessing, immersing, and sharing: An empirical model of user engagement with interactive media. *Communication Research*, *45*(5), 737–763.
Pan, X., & Hamilton, A. F. D. C. (2018). Why and how to use virtual reality to study human social interaction: The challenges of exploring a new research landscape. *British Journal of Psychology*, *109*(3), 395–417.
Pantano, E., & Corvello, V. (2014). Tourists' acceptance of advanced technology-based innovations for promoting arts and culture. *International Journal of Technology Management*, *64*(1), 3–16.
Parasuraman, A., Berry, L. L., & Zeithaml, V. A. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing*, *49*(4), 41–50.
Petty, R., & Cacioppo, J. (1986). The elaboration likelihood model of persuasion. *Advances in Experimental Social Psychology*, *19*, 123–181.

Please cite this article as: M. Wedel, E. Bigné and J. Zhang, Virtual and augmented reality: Advancing research in consumer marketing, International Journal of Research in Marketing, https://doi.org/10.1016/j.ijresmar.2020.04.004

Pieters, R., & Wedel, M. (2004). Attention capture and transfer in advertising: Brand, pictorial, and text-size effects. *Journal of Marketing, 68*(2), 36–50.
Pieters, R., & Wedel, M. (2007). Goal control of attention to advertising: The Yarbus implication. *Journal of Consumer Research*, *34*(2), 224–233.
Pizzi, G., Scarpi, D., Pichierri, M., & Vannucci, V. (2019). Virtual reality, real reactions?: Comparing consumers' perceptions and shopping orientation across physical and virtual-reality retail stores. *Computers in Human Behavior*, *96*, 1–12.
Rapp, A., Ahearne, M., Mathieu, J., & Rapp, T. (2010). Managing sales teams in a virtual environment. *International Journal of Research in Marketing*, *27*(3), 213–224.
Rauschnabel, Philipp, He, Jun, & Ro, Young (2018). Antecedents to the adoption of augmented reality smart glasses: A closer look at privacy risks. *Journal of Business Research*, *92*, 374–384. https://doi.org/10.1016/j.jbusres.2018.08.008 In this issue.
Reggente, N., Essoe, J. K. Y., Aghajan, Z. M., Tavakoli, A. V., McGuire, J. F., Suthana, N. A., & Rissman, J. (2018). Enhancing the ecological validity of fMRI memory research using virtual reality. *Frontiers in Neuroscience*, *12*.
Saad, U., Afzal, U., El-Issawi, A., & Eid, M. (2017). A model to measure QoE for virtual personal assistant. *Multimedia Tools and Applications*, *76*(10), 12517–12537.
Sanchez-Vives, M. V., & Slater, M. (2005). From presence to consciousness through virtual reality. *Nature Neuroscience Reviews*, *6*(4), 332–339.
Sarantopoulos, P., Theotokis, A., Pramatari, K., & Roggeveen, A. L. (2019). The impact of a complement-based assortment organization on purchases. *Journal of Marketing Research*, *56*(3), 459–478.
Schau, H. J., & Gilly, M. C. (2003). We are what we post? Self-presentation in personal web space. *Journal of Consumer Research*, *30*(3), 385–404.
Schlosser, A. E. (2003). Experiencing products in the virtual world: The role of goal and imagery in influencing attitudes versus purchase intentions. *Journal of Consumer Research*, *30*(2), 184–198.
Schmitt, B. (1999). Experiential marketing. *Journal of Marketing Management*, *15*(1–3), 53–67.
Schnack, A., Wright, M. J., & Holdershaw, J. L. (2019). An exploratory investigation of shopper behaviour in an immersive virtual reality store. *Journal of Consumer Behaviour*. https://doi.org/10.1002/cb.1803.
Schuemie, M. J., Van Der Straaten, P., Krijn, M., & Van Der Mast, C. A. (2001). Research on presence in virtual reality: A survey. *Cyberpsychology & Behavior*, *4*(2), 183–201.
Sherman, W. R., & Craig, A. B. (2002). *Understanding virtual reality: Interface, application, and design.* San Francisco, CA: Morgan Kaufmann Publishers Inc.
Slater, M., Usoh, M., & Steed, A. (1995). *Taking steps: The influence of a walking metaphor on presence in virtual reality, ACM Transactions on Computer Human Interaction (TOCHI) special issue on VirtualReality.* (September 1995).
Slater, M., & Wilbur, S. (1997). A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments. *Presence*, *6*(6), 603–616.
Steinhoff, L., Arli, D., Weaven, S., & Kozlenkova, I. V. (2018). Online relationship marketing. *Journal of the Academy of Marketing Science*, 1–25.
Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of Communication*, *42*(4), 73–93.
Sundar, S. S., Bellur, S., Oh, J., Jia, H., & Kim, H. S. (2016). Theoretical importance of contingency in human-computer interaction: Effects of message interactivity on user engagement. *Communication Research*, *43*(5), 595–625.
Tanner, R. J., Ferraro, R., Chartrand, T. L., Bettman, J. R., & Van Baaren, R. (2008). Of chameleons and consumption: The impact of mimicry on choice and preferences. *Journal of Consumer Research*, *34*(6), 754–766.
Teng, C. I. (2010). Customization, immersion satisfaction, and online gamer loyalty. *Computers in Human Behavior*, *26*(6), 1547–1554.
Tussyadiah, I. P., Wang, D., Jung, T. H., & Dieck, M. C. (2018). Virtual reality, presence, and attitude change: Empirical evidence from tourism. *Tourism Management*, *66*, 140–154.
Urban, G. L., Liberali, G., MacDonald, E., Bordley, R., & Hauser, J. R. (2013). Morphing banner advertising. *Marketing Science*, *33*(1), 27–46.
Van Berlo, Z. M. C., van Reijmersdal, E. A., Smit, E. G., & van der Laan, L. N. (2019). Inside advertising: The role of presence in the processing and consolidation of branded VR content. In T. Jung, M. C. tom Dieck, & P. A. Rauschnabel (Eds.), *Augmented reality and virtual reality: Changing realities in a dynamic world*. Basel, Switzerland: Springer Nature Switzerland AG.
Van Kerrebroeck, H., Brengman, M., & Willems, K. (2017). When brands come to life: Experimental research on the vividness effect of virtual reality in transformational marketing communications. *Virtual Reality*, *21*(4), 177–191.
Wang, Y., & Chen, H. (2019). The influence of dialogic engagement and prominence on visual product placement in virtual reality videos. *Journal of Business Research*, *100*, 493–502.
Wedel, M., & Kannan, P. K. (2016). Marketing analytics for data-rich environments. *Journal of Marketing*, *80*(6), 97–121.
Wei, W., Qi, R., & Zhang, L. (2019). Effects of virtual reality on theme park visitors' experience and behaviors: A presence perspective. *Tourism Management*, *71*, 282–293.
Wilkström, Solveig, Carlell, Camila, & Frostling-Henningsson, Maria (2002). From real world to mirror world representation. *Journal of Business Research*, *55*, 647–654. https://doi.org/10.1016/S0148-2963(00)00205-8 In this issue.
Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence*, *7*(3), 225–240.
Worldpay (2018). Is your business ready? Available at https://www.worldpay.com/global/insight/articles/2017-05/virtual-reality-is-your-business-ready. Accessed on April 21, 2019.
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.
Yim, M. Y. C., & Park, S. Y. (2019). "I am not satisfied with my body, so I like augmented reality (AR)": Consumer responses to AR-based product presentations. *Journal of Business Research*, *100*, 581–589.
Yung, R., & Khoo-Lattimore, C. (2017). New realities: A systematic literature review on virtual reality and augmented reality in tourism research. *Current Issues in Tourism*, 1–26.
Zeelenberg, M., & Pieters, R. (2004). Beyond valence in customer dissatisfaction: A review and new findings on behavioral responses to regret and disappointment in failed services. *Journal of Business Research*, *57*(4), 445–455.
Zeng, G., Cao, X., Lin, Z., & Xiao, S. H. (2020). When online reviews meet virtual reality: Effects on consumer hotel booking. *Annals of Tourism Research*, *81*. https://doi.org/10.1016/j.annals.2020.102860 in press.
Zhang, J., & Wedel, M. (2009). The effectiveness of customized promotions in online and offline stores. *Journal of Marketing Research*, *46*(April), 190–206.

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