Increasing Brand Awareness through Augmented and Virtual Reality

Cindy B. Aronson

School of Computing - Human Computer Interaction, DePaul University

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Harold Streeter, Senior Professional Lecturer

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Abstract

Augmented Reality (AR) and Virtual Reality (VR) technology has evolved over time from its beginnings in science and industry to the consumer equipped with a smartphone device. As the technology improved with faster processing speeds, lower cost, and wider distribution, marketers saw opportunities to connect with their target audience in new and creative ways. The aim of this paper is to show a sampling of the research for both AR and VR and how it improves customer engagement with a brand, helps with purchase decisions, imparts positive brand attitudes, and offers a sense of fun, enjoyment and increased confidence in the shopping process. Many of the studies compare 3D Virtual Reality (VR) with 2D traditional advertising to show that for most dimensions, the 3D VR advertisement is superior in its ability to evoke a more effective and compelling attitude and relationship with a brand. Examples of both marker-based and markerless AR advertising are included which highlight their unique engagement factors. While most of the research is skewed toward a younger demographic, with primarily college students as test subjects, the results can be helpful to marketers who are considering adding AR and VR to their communication strategies. The findings are important to both the fields of human computer interaction (HCI) and marketing because it shows how AR and VR can stimulate various sensory experiences and invite interactions which can influence consumer perceptions, behaviors, and relationships with brands.

Keywords: augmented reality, virtual reality, anthropomorphism, digital marketing, visual commerce, advertising, branding, customer engagement, social media, Technology Acceptance Model (TAM), markerless, marker-based, virtual mirror, e-commerce, enjoyment, immersive virtual reality, presence, flow, brand personality, vividness, brand attitudes, mobile technology, purchase intentions, telepresence, online travel purchase

Increasing Brand Awareness through Augmented and Virtual Reality

Augmented Reality (AR) and Virtual Reality (VR) are technologies that were first introduced in the scientific community for professional use (Arnaldi et al., 2018a; Peddie, 2017b). Worldwide collaborative efforts of research teams from academia, science and industry have helped to evolve the field since the technology was first introduced several decades ago (Arnaldi et al., 2018a; Peddie, 2017b). Virtual reality has been described as a field in which 3D elements and one or more users engage in real-time interactions while immersed in a computer-mediated environment that simulates the natural world by evoking the senses (Arnaldi et al., 2018a; De Gauquier et al., 2019; Hanus & Fox, 2015; Willems et al., 2019; Wu & Lin, 2018). Virtual reality allows for a fully immersive experience, where a user can feel a sense of "presence" in the virtual environment (Kerrebroeck et al., 2017; Wu & Lin, 2018). They can interact with 3D objects by rotating them, "touching" them, and feel a sense of movement within the virtual space (Engelmann et al., 2019; Kerrebroeck et al., 2017). With this technology, a user wears a head-mounted full screen display that typically obstructs their field of vision to the physical world, so that they can become immersed in the virtual one (De Gauquier et al., 2019; Wu & Lin, 2018). Additional hand-held components may be used that track a user's hand and body motions (Arnaldi et al., 2018a).

Augmented reality (AR) can be defined as the practice of displaying digital information within the context of the physical world (Rese et al., 2017; Scholz & Smith, 2016). This hybrid view, combining the "real" with the "virtual", produces an altered world where user's real-time perception of objects, other people or themselves can be enhanced and transformed (Scholz & Smith, 2016). AR technology takes virtual information and places it in the context of the real world to create a "mixed reality" (Del Rowe, 2017; Peddie, 2017b). Mixed reality is part of the continuum between the real and virtual where 3D objects can be interacted with and respond to being manipulated (Arnaldi et al., 2018a). The AR system acquires information from the real environment and processes it in order to combine that data

with virtual objects which are then displayed back to the user (Arnaldi et al., 2018a; Peddie, 2017b; Rese et al., 2017; Scholz & Smith, 2016). Realistic rendering of virtual objects, including shadows cast by them, is required to make the mixed reality believable (Arnaldi et al., 2018a).

AR and VR experiences are multi-sensory and multi-modal. They involve immersing the user's optical, vestibular, kinesthetic and cognitive senses into an altered world, which can impact their behavior and perceptions (Arnaldi et al., 2018a). Although AR and VR share technologies, the main difference between AR and VR is that the actions which take place in VR continue to be simulated, whereas in AR the actions are real (Arnaldi et al., 2018a). For example, in a flight simulator, the virtual airplane never emits actual carbon dioxide into the real atmosphere. Whereas, with AR, the electrician using it to aid in the installation of light switches is affecting a real light fixture that can lighten or darken a real space (Arnaldi et al., 2018a). AR technology can provide such real-time aids because it projects data and overlays content onto real objects and surfaces (Peddie, 2017b). With AR, because users can still see their feet and limbs, and retain their peripheral vision, there is less likelihood of cybersickness, eye pain or dizziness that can sometimes occur with VR (Peddie, 2017b).

The goal of Virtual Reality is to create an artificial environment for the user to execute tasks while believing they are doing so in the real world (Arnaldi et al., 2018a). To do this, VR attempts to trick the brain by exposing it to the same contextual cues that it would receive in the real world (Arnaldi et al., 2018a). The artificial environment completely replaces the actual environment through immersion (Arnaldi et al., 2018a). Sound is also used to help reinforce the perception of reality, and to block out sounds from the real world (Arnaldi et al., 2018a). Different senses have a role to play in VR, such as vision, haptics, proprioception and vestibular (Arnaldi et al., 2018a). Arnaldi et al. (2018a) refers to the "perception, decision, action" loop that the user has with the virtual environment.

Literature Review

Historical Background: From Business to Consumer

Business and Scientific Applications

The foundational period of AR and VR occurred from 1960-1980 and arose as a result of the developing field of computer science in which the first 3D object renderings and interactions were created (Arnaldi et al., 2018a). In 1962, cinematographer, Morton Heilig patented a system called *Sensorama* in which he created an immersive urban environment for a user to ride a motorcycle in which they could experience all of the senses (Arnaldi et al., 2018a). Also notable, the first headset was developed by Ivan Sutherland in 1968 (Kipper & Rampolla, 2012).

The next ten years from 1980-1990 is considered the technological development era focusing on 3D interaction (Arnaldi et al., 2018a). Specifically, NASA Ames Researchers, Michael McGreevy and Scott Fish revitalized the use of the VR display technology and devised the name, "head-mounted display" (HMD) in 1985 (Arnaldi et al., 2018a). The company, VPL Research was established by Jaron Lanier and Jean-Jacques Grimaud. VPL created the "Data Glove" and a redesigned head-mounted display which comprised the first virtual reality application that was sold (Arnaldi et al., 2018a). Lanier was the first to coin the term, "virtual reality" (Arnaldi et al., 2018a).

From 1990-2000 numerous experimental applications became operational. The explosive growth of the video game industry remain a key influence to today's technology (Arnaldi et al., 2018a). Transportation industries such as auto, aeronautics and aerospace began to use VR in the design and training processes (Arnaldi et al., 2018a). Force feedback was used simulation of hepatic surgery (Arnaldi et al., 2018a). Some of AR's earliest uses also included assistance in the repair of photocopier machines and automobiles (Peddie, 2017b).

Industrial maturity spanned from 2000-2010 and focused on training, maintenance and simulations for various sectors (Arnaldi et al., 2018a). AR-assisted surgery provided the surgeon with a 3D visualization of a patient's organs. Data visualization for financial services industry to determine stock trades was created (Arnaldi et al., 2018a). Immersive rooms (CAVE) in commercial and academic

institutions were installed (Arnaldi et al., 2018a). VR application development increased. Researchers in the cognitive sciences began to study VR (Arnaldi et al., 2018a). It was during this time that human factors in application design was incorporated as the knowledge between developers and researchers were being synthesized (Arnaldi et al., 2018a).

Rise of Consumer Use

From 2010 until today, VR and AR have become more accessible to the public. Equipment emerged that would make VR more cost-effective and less unwieldy than earlier versions (Arnaldi et al., 2018a). This was in large part due to smartphone technology and video gaming (Wafa & Hashim, 2016). Systems that captured motion were also rolled out. Software from Apple (ARKit) allowed AR to be run on iPhone and iPad, while Google (ARCore) brought that functionality to Android phones (Del Rowe, 2017). Eric Abbruzzese, Principal Analyst at ABI Research notes that these two software kits expanded AR content to millions of smartphones and tablets at a reasonable cost for marketers who want to create branded content (Del Rowe, 2017). David Berkowitz, Chief Strategy Officer of Sysomos argues that today's devices have enough bandwidth that they can reliably run AR technology without latency effects (Del Rowe, 2017). Also, with the prevalence of unlimited data plans, consumers have less financial restrictions in running AR applications (Del Rowe, 2017). Over the last ten years, a number of socio-economic factors contributed to the transformation of AR and VR (Arnaldi et al., 2018a). Facebook purchased Oculus Rift, leading to its widespread use and distribution. Leap Motion with its sensors to detect user positions was developed.

The following pivotal technologies were also created: 1) Microsoft Kinect Sensor (2010); 2) Google Glass (2013); 3) Samsung Gear VR headset (2015); 4)Microsoft HoloLens headset (2016); 5) Sony PS-VR headset (2016); 6) HTC Valve Vive headset (2016); 7) Apple iPhone (2007) which included a camera, sensors and tactile screen; and 8) Apple tablet. There also was a shift in users, from experts to everyone. A shift in distribution took place from the unknown few suppliers to large well-known

retailers making AR and VR easier to purchase (Arnaldi et al., 2018a).

While accessibility of technology is important, consumers must be willing to use and accept the technology (Rese et al., 2017). Rese et al. (2017) measured and evaluated consumer perception and acceptance of AR technology by employing the Technology Acceptance Model (TAM). Rese et al. (2017) discovered that perceived usefulness on attitude toward using and behavioral intention to use were highly significant for consumers in their acceptance of AR technology.

Applications to marketing and advertising

Shift to the Consumer: Marketers seize an opportunity

Although Augmented and Virtual Reality had their origins in the scientific community for use in professional settings such as education, rehabilitation, manufacturing, medicine, flight training and other industrial uses, as the price of the technology went down, and as the increase in mobile device usage, availability and processing speed went up, AR and VR became more widely available to the general public (Arnaldi et al., 2018a; Wafa & Hashim, 2016). With this increase of smartphone and tablet technology in the hands of consumers, fields such as entertainment, marketing and advertising began to take notice of AR and VR (Nugyen, 2018; Rese et al., 2017). Advertisers and marketers recognized the potential to reach their customers in new and innovative ways via channels that weren't possible before. Augmented and Virtual Reality are technologies that can be leveraged to create memorable user experiences by enabling active engagement with a brand (Hooker et al., 2019). By understanding the research, marketers can make more informed decisions as to whether they want to incorporate these technologies into their communications strategies (Kerrebroeck et al., 2017; Scholz & Smith, 2016).

Visual Commerce

Gartner's Hype Cycle for *Display and Vision in 2019* charts AR in the "Trough of Disillusionment" (Wen, 2019) while another Gartner article states AR and VR is positioned within *What's Hot in Digital Commerce* (Klock, 2019). Specifically, Klock (2019) explained AR, VR and 360-degree video are part of

the Visual Commerce industry, which is comprised of immersive commerce and visual configuration. The visual aspect of shopping and commerce is a critical part of how consumers make buying decisions (Klock, 2019). Visual attributes enable customers to more easily search and find what they're looking for, as well as increase their confidence level that they have chosen the correct product (Klock, 2019). This finding is also corroborated by Willems et al. (2019) who found users who were able to virtually experience a tourist destination using VR in the pre-travel phase, reported higher levels of customer engagement, interactivity and vividness leading to telepresence. This sense of "being there" in the travel experience, was shown to positively impact flow, enjoyment and purchase intentions leading to trip reservations (De Gauquier et al., 2019; Willems et al., 2019).

Visual commerce allows consumers to perform interactions with a brand's products in such a way that is both immersive and visually compelling (Klock, 2019). This higher level of immersion and increased confidence leads to greater customer satisfaction and less burden on the customer service organization (Klock, 2019). In the tourism industry, the ability of a consumer to make informed travel decisions by using only 2D traditional materials is challenging (Willems et al., 2019). Virtual simulations of a destination through VR technology make the intangible more real, and may lessen the uncertainty that goes along with booking a trip (Willems et al., 2019).

This sense of realism also extends to VR online shopping where users can try before they buy in a number of different product categories. Engelmann et al. (2019) confirmed in a study comparing VR with traditional online shops that VR created a greater sense of realism and that users could envision purchasing from a VR store in the future, stressing the importance of being able to rotate the objects around. Rese et al. (2017) confirmed the usefulness of the "virtual mirror" when they studied consumers trying on Mister Spex and Ray Ban eyewear using an AR markerless app. Rese et al. (2017) discovered that retailers in the apparel, accessories and cosmetic industries could utilize that function to help consumers in the decision-making process.

Consumer Engagement

The application of Augmented and Virtual Reality to the fields of marketing and advertising creates vivid experiences for consumers to engage with a brand (Kerrebroeck et al., 2017). By actively participating in the interaction, consumers are more likely to perceive the brand positively resulting in greater brand recognition (De Gauquier et al., 2019). The interaction, whether in a fully immersive world, or augmented one, can provide additional value for the user thereby increasing the likelihood of positive brand awareness, word-of-mouth advertising, entertainment value and ultimately sales. (De Gauquier et al., 2019). VR provides proprioceptor-type stimulation, which allows users to feel as if they are moving around the environment in a natural way. De Gauquier et al. (2019) postulated this level of immersion in VR, compared with the static mouse clicks on a computer screen afforded by 2D advertising, will reinforce positive feelings toward a brand.

Wu et al. (2018) corroborated this evidence by proving that users wearing a head-mounted device (HMD) experienced a significantly greater level of naturalness and presence than those using a tablet or 2D desktop computer when viewing an advertisement. They found that the greater level of presence by using an HMD increased users' positive attitude toward the advertising, the brand, and intention to share or pass the advertisement along to others.

The concept of flow also impacts consumer engagement. It is a mental state which can be attained when a user experiences total involvement, attention and focus in an activity at the exclusion of everything else (Hooker et al., 2019; Willems et al., 2019). With states of flow and presence, time seems to fly by and external environmental factors are not perceived (Hooker et al., 2019). The user experiences a feeling of "being there" and fully engaged in the virtual experience (Willems et al., 2019). Willems et al. (2019) explains that consumers who experience these mental states are more likely to perceive brands positively, learn about products more fully, have greater intentions to purchase, enjoy the virtual experience, and tend to become repeat customers of the brand. Willems et al. (2019) notes

that involvement is one of the main drivers for consumer engagement and indicates that the higher the level of involvement a consumer has with an advertisement, the greater level of attention they pay to it (Willems et al., 2019). Those who are most involved are expected to direct their focus, emotions and behaviors onto the brand they feel most connected with (Willems et al., 2019). Brand loyalty, commitment and trust are the results of consumers who are engaged with a brand (Willems et al., 2019).

Hanus et al. (2015) found that those users who were able to customize a salesperson's avatar reported liking a brand more, with a higher level of purchase intention, than those users who only watched the salesperson's avatar being customized. Hanus et al. (2015) makes a strong correlation between a user actively engaged, taking control, and being autonomous in their interaction, and how that can positively influence their perceptions about a brand.

A Vibrant Media study titled, *Media Planners and Buyers Insperience* reveal media purchasers and planners are adding AR and VR to the mix mainly to better engage with consumers, but also to mitigate the blocking of ads (Martin, 2017). Industries expected to gain the most from AR ads are fashion and fast-moving consumer goods. VR ads are expected to benefit travel, property and construction industries the most. Helen Mussard, VP Global Marketing for Vibrant Media stated that consumers don't want to engage with ads that offer no value or relevance to their lives, as well as ad that are invasive (Martin, 2017). She said that when consumers do take the time to interact with an ad that it has to be pertinent to their lives and worth the time investment. With AR and VR, the consumer controls the interaction with the ad, not the other way around (Martin, 2017).

Mussard claims that Vibrant's pilot campaigns measured to have 600% greater rates of interactions than 2D ads, 700% greater recollection of content, and 2,700% greater level of brand recognition, and 200% greater purchase intentions (Martin, 2017). Mussard further states that the rate of interactions is 85%, which far exceeds the average for the digital advertising industry which is 2.5%.

She says it's important to note that with VR ads, consumers are not just passive observers watching commercials, but active participants who can try makeup on, attend a music concert or visit a resort.

Augmented Reality in Marketing

In 2009 the first AR advertisement was published in *Esquire* magazine's *Augmented Reality* issue which featured different AR experiences launched from a marker Quick Response (QR) code (Peddie, 2017b). After this issue was published, the popularity of AR started to rise quickly. David Bell, a Wharton marketing professor, said that AR can pave the way for advertising locally and allow for marketing that is immersive (Peddie, 2017b). AR has enjoyed increasing media interest and significant investment since then (Nugyen, T. 2018).

When launched in 2016, The Pokemon GO sensation elevated the acceptance level of AR and VR (Klie, 2016) and demonstrated the widespread appeal the technology has for consumers. In its first month it brought in earnings of approximately $35 million from 30 million users (Del Rowe, 2017). Nugyen (2018) states that the Virtual Reality Venture Capital Alliance (VRVCA) estimated there was at least $900 million in global investment funding in 2017 allocated toward AR. According to Jan-Hein Pullens, Chief Technology Officer at roOomy, believes that AR has practical attributes over VR which is that it is not as expensive and cumbersome as VR, and only requires a smartphone. This level of easy access and practicality means it may be a more nimble technology for widespread consumer use (Del Rowe, 2017).

Users access AR through affordances, or entryways such as printed materials, TV screens, displays or other objects in the environment (Scholz & Smith, 2016). AR combines the physical world with an augmented layer that is instantiated by either a user action or a marketer's display (Scholz & Smith, 2016). The goal is to enhance the user's perception of the brand through experiencing it in new and original ways (Scholz & Smith, 2016).

David Berkowitz, who works in social media analytics at Sysomos, explained that businesses have applied AR into their marketing mix (Del Rowe, 2017). One such brand is Oasis which rolled out a limited edition package design in the UK for its bottled fruit juice drink. Each label portrayed a face and customers could use Snapchat to layer their face onto the bottle and enter the images to Oasis' Facebook contest page (Del Rowe, 2017).

Figure 1

Photo of Oasis Fruit Drink Campaign:

Note: Customers can overlay their faces onto the label and post on Oasis' Facebook page.

Marker-based AR

Markers can be QR codes, barcodes or other objects that have been coded. Once scanned, a display of a virtual 3D object appears that is positioned and tracked relative to the marker. Markers are used to locate the camera on the smartphone (Arnaldi et al., 2018a). Markers that have already been defined, such as a QR code, when activated are able to track and find the pose of a device (Peddie, 2017b). Users can interact directly with product packaging, billboards, and other collateral material. If a

consumer has a positive interaction using AR branded experiences, they may develop positive feelings toward the brand (Peddie, 2017b). Examples of marker-based applications include:

- Coca-Cola which engaged consumers by finding surprises on Coca-Cola Christmas bottles and hunting for Santa Claus messages near signage in malls (Peddie, 2017b).
- Movie advertising began in 2009 with Star Trek in an ad called, *Experience the Enterprise*. Movie posters acted as the markers by which users were able to go aboard the *Enterprise* to learn about crewmembers, fire weapons and feel the ship accelerating (Kipper & Rampolla, 2012).

Markerless AR

In markerless apps, the environment being tracked is the consumer. Examples of markerless applications are as follows:

- FaceCake devised a magic mirror that allows users to "try on" cosmetics prior to purchase, as well as post the results to social media.
- Conair created an app that allows users to try new hairstyles virtually and share on social media so others can vote on the style they like best (Peddie, 2017b).
- The EON Interactive Mirror provides clothing retailers with virtual changing rooms that permit shoppers to see how they look not only in the clothes but in the setting in which they will be worn. The Mirror also transcends location where people from all over the world can virtually shop with each other. (Kipper & Rampolla, 2012)

Considerations for using AR

Scholz et al. (2016) recommend that marketers must first define their target audience and the communication objectives they are seeking to achieve. Marketers must also create a mechanism for the user to access the augmented reality. Third, the specifics of what the augmented content is and who controls it must be specified. And lastly, how the augmentation fits into the overall physical and social

contexts must be accounted for.

van Esch et al. (2019) discovered when consumers can receive specific information about a product in close proximity to where they make purchase decisions, a transformation of the retail industry is predicted. This research introduces the concept of anthropomorphism and its impacts on AR. Anthropomorphism is the phenomenon of construing human-like shapes to be present in the environment, and imbuing brands and objects with the characteristics of humans including thought patterns and feelings. This provides an explanation as to why marketers have attempted to "humanize" brands with personality traits, which capitalizes on consumers' desire for social contact and belonging. Anthropomorphism has also been shown to increase a consumer's trust that AR technology will perform as it is intended to (van Esch et al., 2019a).

Virtual Reality in Marketing

Virtual reality is an emerging technology that has gained the attention of marketers such as Volvo, Marriott International, Coca-Cola, Boursin, Adidas, IKEA and The North Face (De Gauquier et al., 2019). This represents a variety of brands from the food, beverage, hospitality, apparel, home goods and automotive industries. Volvo used a Google Cardboard VR app to promote its XC90 limited edition model by simulating a virtual test drive (De Gauquier et al., 2019). Users were able to change the car's different interior combinations while staying in the comfort of their homes. Coca-Cola took consumers on a "virtual sleigh ride with Santa" while Adidas created a VR experience in their New York store featuring an NBA player (De Gauquier et al., 2019). Marriott International created a VR travel campaign that evoked multiple senses through sensory stimuli such as mist and heat. This made the travel destination appear more real, as users could feel a breeze, the warmth of the sun, and natural sounds of the location.(De Gauquier et al., 2019). With its 360-degree rotational capabilities, VR allows consumers more advanced ways to inspect, enlarge, and feel as if they own the product or experience (Kerrebroeck et al., 2017).

Brand Personality

Marketers can bring their brands "to life" by creating brand personalities for their products. A brand personality is built by transferring those personality traits that are unique to humans and applying them to a brand (De Gauquier et al., 2019). This is related to the concept of anthropomorphism, which is described as the phenomenon that occurs when agents that not human are ascribed human characteristics and behaviors (De Gauquier et al., 2019). Marketers can infuse their brand with the type of personality that their target consumer desires to possess, thereby enticing them to engage with the brand (De Gauquier et al., 2019). De Gauquier et al. (2019) researched how the level in which VR conveys the five anthropomorphic brand personality traits that are in the mind of consumers, can result in positive attitudes toward a brand and intentions to purchase. The way a brand makes a consumer feel, sense, think and behave can heighten the brand personality, which can influence consumer satisfaction and loyalty (De Gauquier et al., 2019).

To study the effects of mobile VR advertising, De Gauquier et al. (2019) studied The North Face brand, a high-end outdoor apparel clothier which has appeal to a wide population. The VR condition tested participants using a Google Cardboard-type headset with an Android smartphone to watch the VR app titled, *The North Face: Climb*. The setting for the VR app is Yosemite National Park where participants can feel as if they are rock-climbing. The VR ad portrayed a fully immersive experience with greater complexity than the 2D ad, enabling the proprioceptor-based sensation of falling and sensing height. This allowed participants to feel as if they were using The North Face products in the environment in which they were meant to be used. Results showed participants in the VR condition demonstrated significantly greater positive attitudes toward The North Face brand and significantly increased intentions to purchase than those in the 2D condition. The study also briefly described what marketers should consider before launching a VR campaign. De Gauquier et al. (2019) postulated this level of immersion in VR, compared with the static mouse clicks on a computer screen afforded by 2D

advertising, will reinforce positive feelings toward a brand.

Considerations for using VR

To utilize a VR campaign effectively, marketers must make decisions about goals, story to convey, software and hardware considerations (De Gauquier et al., 2019). To capture consumer attention at the point-of -sale, marketers should consider using the higher resolution premium headsets and systems to invoke a greater sense of presence and experience in the retail stores (De Gauquier et al., 2019). To attract a wider audience to brand and build awareness, marketers should consider creating content that can be viewed at home using less expensive headsets enabled by smartphones, such as Google Cardboard. Brand managers should decide if they want their campaigns to be informational, which succeeds when interactivity is the main feature, or transformational where vividness of immersion is most important (De Gauquier et al., 2019).

Discussion/Future Directions

Arnaldi et al. (2018) offers many predictions about the future of AR and VR, some of which are already occurring. One prediction is that immersive media will become a part of the user's own environment. Areas of the home will be converted into a total immersion space where devices can track user's movements in real-time. TVs will offer more virtual experiences, whether the content comes out of the TV screen and into the actual room where users can interact with the content (Arnaldi et al., 2018a). This would be especially exciting for advertisers to create ads where the user is part of the advertisement. Since the technologies involve monitoring, there is potential for misuse. Companies must protect users' privacy to avoid the danger of hacking a person. (Peddie, 2017b). Privacy issues are also related to facial recognition and paring that with data and include issues of tracking location due to cameras in phones (Kipper & Rampolla, 2012).

The future interfaces are predicted to measure eye movement in real-time, muscle activity and brain activity. Future interfaces are expected to be lighter weight and less cumbersome than older ones,

and allow for the most natural type of interaction that don't require markers. Also, developing wearable interfaces that can become part of the user's clothing is expected in the future (Peddie, 2017b). Objects are expected to also undergo a higher level of haptic realism where not only rigid objects are simulated but those made of fluids and materials that can be re-shaped. Prices are predicted to decrease which will allow greater access to VR and AR technology. Tackling the side-effects of VR, such as "cybersickness" is a continued goal of researchers requiring further study into human perception, physical coordination and cognition (Arnaldi et al., 2018a). Future research also includes how multiple users interact with the same object, each other and the environment.

Conclusion

While AR and VR have evolved over the decades, from professional business applications to consumer use in entertainment and shopping, the technology is still in its adolescence (Nguyen, 2018). There are differing opinions about which technology is considered "better" but that largely depends on the use case, industry sector, marketing objective, budgetary considerations, complexity, and consumer demographics. Some proponents prefer AR because it does not induce cybersickness in the same way that VR can. AR has been viewed as being more practical, less expensive and easier to use (Wafa & Hashim, 2016). AR has experienced adoption in the retail sector with the use of "magic mirrors" and in real-time sales promotion in the grocery store aisle (van Esch et al., 2019b). AR has also enabled customers making big-ticket appliance and furniture purchases to visually see how those items would look in their homes before buying (Peddie, 2017b). But it's important to consider demographics because not all consumers will invest the time and effort to learn AR technology. Typically younger audiences adopt AR more readily than older ones (Del Rowe, 2017). The augmented reality market is predicted to grow to $61.3 billion by 2023, from its value in 2012 of $2.39 billion. That's over a 55% compounded annual rate, from a 2017 report from *Research and Markets* (Del Rowe, 2017).

Those who prefer VR tout its superior immersive qualities, especially in the tourism and

hospitality industries. VR ads that are perceived to be the most immersive are also proven to elicit the greatest positive brand attributes (Willems et al., 2019). However, this poses a very real challenge due to the experience that users have with cybersickness (Arnaldi et al., 2018a). Cybersickness attributed to nausea, headaches, and dizziness remains a barrier to widespread VR use, as does motion sickness that is visually induced (Arnaldi et al., 2018a). Optical problems due to exposure of certain light wavelengths may cause age-related macular degeneration due to blue light (Arnaldi et al., 2018a).

The challenges of VR also include its complex production process and limited distribution of headsets that are required to connect with the content (Arnaldi et al., 2018a). While some businesses can provide consumers access to headsets in the retail environment, other companies may have to rely on consumers purchasing their own hardware and downloading apps.

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