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Could the Virtual Dinosaur See You? Understanding Children's Perceptions of Presence and Reality Distinction in Virtual Reality Environments

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Abstract

Despite the growing interest and use of virtual reality (VR) in American homes, there is a notable gap in empirical studies that examine VR and children. This study identifies two important research concepts in children's research that have been studied across many types of media 1) reality distinction and 2) presence, and applies them to studying VR experiences. Taking a qualitative approach, 6 to 8-year-old children (N=29) participated in a VR experience as an extension of the children's television show called *Dino Dana*. During the child's VR experience where they swam in a pool with dinosaurs, we recorded a computer capture of what the child sees within the VR experience; and a video recording of the child in the VR headset and their behaviors during the VR experience. In addition, children responded to questions before and after their VR experience. We observed several behaviors of how children attempted to test and assess the reality of VR (e.g. holding their breath). Through interviews, we also found that children had certain presence experiences within VR that challenged their understanding of reality, where the dinosaurs were treated as real and evoked social presence. This study builds on our understanding of how VR might impact on young children and their perception of VR experiences, which have important implications for VR researchers, designers, and consumers.

1. Introduction

As virtual reality (VR) is becoming more commercially popular, hardware manufacturers like Oculus and Samsung recommend that children under 13 should not use their devices (Guarino, 2016). Despite this, content creators are still creating VR content geared toward children, whether it is educational content, cartoon avatars, and entertainment, or advertisements (Aubrey, Robb, Bailey, & Bailenson, 2018). Since families with children are often early adopters of technology, VR companies are targeting this audience. Recent surveys show that 1 in 5 families with children under 17-years-old live in a home with a VR headset (Aubrey et al., 2018), and this interest is growing with nearly 70% of 2-15-years-olds in the U.S and U.K. reporting that they are fairly or extremely interest in VR (Yamada-Rice et al., 2017). Given the growing ubiquity and technological advances in commercial VR devices, it is important to understand its impact on children.

Since they were first introduced, virtual environments promised to enable unique kinds of visual and interactive possibilities (Biocca, Harms, & Gregg, 2001; Steuer, 1992). In its earliest forms, scholars studied how virtual environments could affect people's sense of presence, either through projection-based cave systems (Cruz-Neira, Sandin, & DeFanti, 1993) or computer-generated virtual environments (Biocca & Levy, 1995; Heeter, 1995). More recently, there has been a rise in single-user head-mounted displays (HMD), in which the virtual environment is rendered onto a screen in close proximity to a user's eyes. These single-user HMDs offer stereoscopic views and are responsive to head movements, which give the user the impression of being surrounded by a three-dimensional virtual world. Researchers have theorized that the features of single-user HMD may improve educational outcomes (Alhalabi, 2016; Jensen & Konradsen, 2018; Merchant et al, 2014), increase sensations of spatial presence (Baumgartner et al., 2006), and affect behavior change (Ahn, Bailenson, & Park, 2014; Fox, Bailenson, & Binney, 2009; Yee, Bailenson, & Duchenaut, 2009). HMD VR has also been studied extensively in the health context, with researchers utilizing the visual stimulus to treat post-traumatic stress disorder (Difede et al., 2007; Rizzo et al., 2009), depression (Falconer et al., 2016), chronic pain (Li et al., 2011), phobias (Shiban et al, 2016), and mental health (Jerdan et al., 2018).

While many VR studies have been conducted with adult populations, there is a notable gap in empirical studies that examine single-user VR and children (Bailey & Bailenson, 2017; Segovia & Bailenson, 2009). Given the sensory-rich features of VR, one of the concerns for children is that they may become more immersed in VR environments and have difficulty distinguishing VR experiences from real-life memories (Segovia & Bailenson, 2009). VR scholars have specifically called for future research that "will need to examine how the saliency of immersive virtual environments relates to when certain cognitive abilities develop (Bailey & Bailenson, 2017; p. 110)." This study identifies two important research concepts in children's research, which can mediate and explain the impact of media: 1) reality distinction and 2) presence. While other studies have conceptualized the impact of VR as discrete outcomes and variables such as education (Jensen & Konradsen, 2018; Hew & Cheung, 2010) and motivation (Harris & Reid, 2005), this study conceptualizes impact on children in terms of reality and presence. By doing so, we can first begin to understand the impact of VR on perceptions of reality and place those findings into the larger context and trajectory of those constructs. It also allows us to start making key comparisons between VR and other types of media, in terms of how VR might be uniquely different when it comes to children. Lastly, focusing on perceptions of reality distinction and presence can potentially help explain key moderating variables for VR and why certain outcomes may occur, which has practical implications for designers and potential applications (e.g., children's education, health, entertainment).

2. Distinguishing Media from Reality

For decades, scholars across disciplines have studied how children understand and make sense of their media environment. Early research focused on children's perceptions of the reality of media content, particularly television content (Chandler, 1997; Hawkins, 1977; Nikken & Peters, 1988). Starting from the premise that the more children perceive media content to be real, the greater the impact of that content, these studies were concerned that younger children might be particularly susceptible to media influence.

Cognitive-developmental theories have also been applied to understand children's perceptions of media. As children's cognitive skills develop and change throughout various phases of childhood, the ability to distinguish media from reality is a learned skill (Nikken & Peters, 1988). At an early age, children may have more difficulty distinguishing between fantasy and reality. Children start to learn over time that television is different – researchers have found differences in how 5-year-olds and 7-year-olds are able to identify whether a televised event is factual, with 7-year-olds being better able to understand that television is scripted and that characters do not retain those roles in real life (Wright, Huston, Reitz, & Piemyat, 1994). Much of the research in this realm has examined how age affects reality distinction, as well as other factors such as testimony and evidence from others, context, and emotion (Woolley & Ghossainy, 2013). There are also different types of errors that are possible, whether it is believing the non-real to be real such as Santa Claus, or not believing in things that were real e.g., animals who have gone extinct (Figure 1)

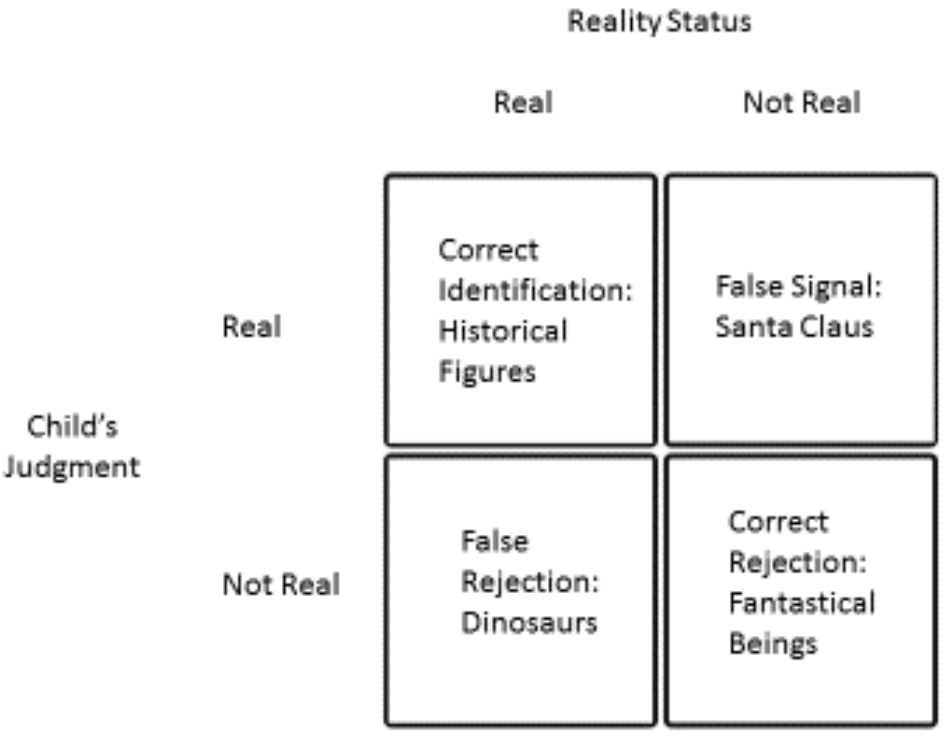

Figure 1: Patterns of Correct and Incorrect Judgments Regarding Reality Status (Adapted from Wooley & Ghossainy, 2013).

Beyond thinking of reality as a binary yes/no state, scholars have further parsed out reality as a multidimensional construct to better understand children's perceptions. Wright and his colleagues (1994) submit that "Reality (or unreality) is not, however, a simple dichotomy or unidimensional

construct. It can be defined at different levels, ranging from the reasonable, if simplistic, to the abstractly metaphysical" (p. 229). Scholars have identified four primary areas of reality. First, the "Magic Window" examines "the degree to which television is seen as portraying real life instead of fiction" (Hawkins, 1977, p. 311). Wright (1994) labeled this dimension as factuality – whether content is "true in the world outside television or are made up and scripted specifically for television" (p. 230). A second key dimension has been recognized as "social expectations" (Hawkins, 1977) or "social realism" (Wright et al., 1994). This concept examines "the degree to which television's characters and events are similar to children's expectations about the real world" (Hawkins, 1977, p. 311). To this extent, children may "judge it (content) as real because they think the people and events are similar to those in the real world" (Wright et al., 1994, p. 230).

Flavell and his colleagues (1990) introduced an image-referent distinction to understand children's perception of television reality through two additional dimensions: Reality and Affordance. The focus centers on how children perceive the images they see as a real object or a picture of an object (reality) and "whether the object on the screen could be acted on" (affordance) (Flavell et al., 1990, p. 402). Affordance is particularly interesting as this concept questions whether visual "objects [can] be touched or come out – whether a person seen on videotape could see, hear, and know about the experimenter's ongoing actions" (Flavell et al., 1990, p. 402). These four dimensions can be summarized as 1) real in the physical world, 2) real according to your expectations, 3) real to you, and 4) real with properties of social actors.

For children, formal features of media content can give certain cues as to the "realness" of what is being seen (Wright et al., 1994). Beyond television, studies have examined pictures and events in books, asking children to classify them as real or pretend (Samuels & Taylor, 1994; Woolley & Cox, 2007). While early research into children and virtual worlds focused on shared computer gaming environments (Lim & Schofield-Clark, 2010; Tuukkanen, Iqbal, & Kankaanranta, 2010), developments in personalized VR systems necessitate additional research into these self-contained VR environments (Bailey & Bailenson, 2017). VR may provide a unique set of cues that can complicate and compound reality distinction issues for children (Bailey & Bailenson, 2017; Segovia & Bailenson, 2009). The 3-D stereoscopic view can supplant their reality with an entirely virtual environment. Secondly, VR could give a heightened sense of presence and interactivity, which offers them different sensory possibilities. Lastly, VR isolates them into this environment, so that they are not getting cues from others in physical space that could help them process other media (e.g., seeing adult reactions to TV).

3. Children, VR, and Presence

The concept of presence may be useful for understanding children's perceptions of VR. Presence, short for telepresence, is defined as: "when part or all of a person's perception fails to accurately acknowledge the role of technology that makes it appear that s/he is communicating with one or more other people or entities" (International Society for Presence Research, n.d.). Presence has multiple dimensions including: 1) social richness 2) realism 3) transportation 4) immersion 5) social actor within medium or 6) medium as social actor (Lombard & Ditton, 1997). Social richness is defined as the extent to which the medium is perceived as sociable, warm, sensitive, or personal when it is used to interact with other people. Realism refers to the extent to which a medium appears perceptually and/or socially realistic. Transportation describes the sensations of being somewhere else, while immersion describes the extent to which the senses are engaged by the mediated environment. Social actor within medium refers to the extent to which the user responds socially to a representation of a person through a medium, while medium as social actor refers to the extent to which the technology itself is perceived as a social actor.

Certain dimensions of presence are especially relevant to studying VR in particular: "Presence as discussed in literature related to immersive VR can most often be characterized by the concept of presence as transportation: people are usually considered 'present' in an immersive VR when they report a sensation of being in the virtual world ('you are there') (Schuemie Van Der Straaten, Krijn, & Van Der Mast, 2001, p. 184)." Heeter (1992) also noted that VR draws sharp contrasts between a personal sense of presence in VR, the social presence of VR characters, and environmental presence and reactions in VR.

While there are many attempts to measure presence (Kim & Biocca, 1997; Lessiter, Freeman, Keogh, & Davidoff, 2000; Slater, 1999; Schubert, Friedmann, & Regenbrecht, 2001; Witmer & Singer, 1998), an analysis of presence research in VR concluded that "measuring presence is done almost exclusively via questionnaires, using them to refine the theories on presence and […] to validate objective measures" (Schuemie et al., 2001; p. 193). Although many studies have utilized these scales to explain how certain technological capabilities trigger various types of social presence (Fox, Bailenson, & Binney, 2009; Schuemie et al., 2001) and spatial presence (Newbutt et al., 2016; Wirth et al., 2007), these self-report scales require a high level of reading comprehension meaning they are used on adults. There has been less work done that explicitly looks at VR, presence, and young children who have more limited reading comprehension than adults (Bailey & Bailenson, 2017; Bracken & Lombard, 2004). Given the possibility that the unique affordances of VR could trigger heightened presence sensations for children (Bailey & Bailenson, 2017), this study poses the following research questions:

RQ1: How do 6-8-year-old children understand and describe a VR experience across various dimensions of reality?

RQ2: How do 6-8-year-old children understand and describe their perception of presence from VR?

4. Method

4.1. Procedure

After obtaining institutional review board approval, we recruited thirty 6 to 8-year-old children to participate in a VR experience through flyers and posts to parenting listservs. Because one child dropped out shortly after putting on the headset, 29 children completed the dinosaur visualization, with 8 of them females. Parents brought their child to a University facility to participate in the study. After acquiring parental and child consent, the child was taken to another room for the VR experience. After a pre-test, children were introduced to the research team and provided instructions regarding the device and experience. Children were informed that they could move and walk while wearing the headset (but not run) and that if they got dizzy, they should close their eyes. Finally, the researcher told the child to raise their hand to indicate if they wanted to stop the VR experience. Children participated in the VR experience for no more than 15 minutes. Then, they were taken to a separate room for a post-test interview.

4.2. VR Experience

The VR experience was created by a company called *Sinking Ship Entertainment*, who also produce a television program called *Dino Dana*. The VR experience consisted of two components: 1) visualization of an open field, and 2) visualization of a swimming pool. The open field visualization consisted of a field of grass with trees, butterflies, and chirping birds. This visualization provided a space in which children could adjust to wearing the VR headset, and we checked if the headset was comfortably fit to their head, that the scene was not blurry, and that the child could hear the sounds in

the VR environment. The swimming pool visualization consisted of a large swimming pool where the child was immersed under water. A school of fish was swimming in the water at all times. In succession, 3 different dinosaurs or prehistoric reptiles swam past the child. Each animal made a sound and completed a short circle around the child. The swimming pool visualization was set on a loop in which the three dinosaurs visited the child twice and lasted no more than 5 minutes.

4.3. Measures

Pre-test Interview. Children were interviewed concerning their current emotional and physical distress/status, their opinion of swimming and dinosaurs, and their enjoyment of using various forms of media. Most questions were asked on a 3-point scale (not at all, some, a lot) with a visual aid of 3 glasses with varying levels of water to represent the different points on the scale. To check their physical status, children were asked to indicate how much their head, eyes, and stomach hurt right now, how dizzy they felt right now, and whether or not they felt hot and sweaty. In terms of emotional status, children were asked to indicate how happy, worried, excited, afraid, and sad they felt right now. Five questions concerning their views on dinosaurs and swimming were asked using this same 3-point scale, including how much they like dinosaurs, swimming, and being in a pool and how much dinosaurs scare and excite them. Children were also asked how much they liked using video games, television, iPad, computer, and smartphone.

Physical Capture. During the child's VR experience, a computer capture of where the child was looking and what they were seeing was recorded. Simultaneously, there was a video recording of the child in the VR headset and their behaviors during the VR experience.

Post-test Interview. Children shared their thoughts through an open-ended semi-structured interview and through close-ended questions. Because the reading comprehension level of the children, we adapted questions from the Temple Presence Inventory (Lombard, Ditton, & Weinstein, 2009) into semi-structured interview questions, which focused on 5 main areas: 1) reality distinction, 2) presence as transportation, 3) presence as richness, 4) social presence of creatures in VR, and 5) emotional response. Our education expert on the team reviewed these questions to ensure the language and questions were age-appropriate.

For reality distinction, researchers asked children questions to differentiate between what was real and what was pretend, and whether the creatures existed in real life. Transportation questions focused on the different places they experienced while in the headset and how they moved from one setting to another. Presence as richness included questions about the child's sense of touch, sound, and movement within the virtual environment. The social presence of creatures involved questions on how they thought the creatures engaged with them, such as did the creatures hear or see the child while in the VR environment. Children's emotional responses (fear, excitement, happiness, worry, and sadness) were also included with particular attention on how they felt during the experience, and what was happening in VR at the time of those feelings.

4.4. Data Analysis

Interviews were transcribed, and research team members coded for key themes of reality (Hawkins, 1977; Flavell et al., 1990; Wright et al., 1994) and presence (Lombard, Ditton & Weinstein, 2009). We coded statements that expressed whether they believed the VR experience was real in the physical world, real according to their expectations, real to them, possessed real physical properties, or were real social actors. We also coded for responses that indicated presence as social richness, presence as transportation, and social presence (Lombard & Ditton, 1997). These statements were triangulated with the data from the recordings of the child during the experience, where many of them often spoke during the experience. We also noted their physical movements in relation to the VR

experience. From this corpus of data, we identified several key themes in how children responded to and explained the perceptions of VR.

5. Findings

5.1. Tests of the New Reality

Most of the children knew that the experience was not real in the physical world, in the sense that they did not leave the room: "Because when I took off the headset I was right where I was in the beginning (P6, 8-year-old Female)." While the research team did not talk to them during the VR experience, there were still people in the room moving their wires to make sure they did not trip and fall or run into walls.

Although most of the children concluded afterwards that the experience was 'pretend,' they were initially unsure. Several of the children would start out by testing the realism of the pool by trying to see their own bodies while wearing the headset. They would look down towards their feet and only see the bottom of the pool. Another tried to test the depth of the environment, by looking down at the bottom of the pool and then reaching his foot forward tapping the floor.

The initial experience of being in water also triggered a physiological response: "It felt like I couldn't breathe under water (P4, 8-year-old Male)." The mismatch between their visual environment cues and the physical environment was a recurring theme: "I do not like being under water. […] And the first thing I thought when I saw that scene is I thought, wait, how am I breathing? I'm under water, how am I breathing? (P17, 6-year-old Male)." Besides not being able to breathe, they also thought that the water would affect their ability to communicate: "In the pool […] I said, 'Don't eat me, don't eat me!' But it's hard to talk in water (P7, 7-year-old Female)."

Children would use these tests to assess the quasi-real space they were transported to, which they recognized as not quite being real. Some were even actively trying to stay tied to the non-VR reality. One child would continually remind herself throughout the experience: "Good thing this isn't real. I would be dead by now. […] Good thing I'm not in real life (P7, 7-year-old Female)." Another child was able to explain that while they did not physically leave, it felt like they did "because my vision is the one I use most to see where I am (P21, 8-year-old Male)."

5.2. Presence as Social Realism and Expectancy Violation

Almost all the children concluded that the VR experience was not real, even though they also reported a high level of social realism in the VR environment. Some concluded that the experience was 'not real' only after seeing things that violated their expectation for reality: "Because the skin was wrong. It had the wrong skin (P3, 7-year-old Male)." Another rationale was that the creatures did not behave like they expected: "It ate only one fish, when it's supposed to be eating a lot (P3, 7-year-old Male)." Others compared those creatures to those they had seen in real life and drew on facts that they had learned: "There was some kind of Apatosaurus I believe. […] but the dead ones are probably extinct (P10, 7-year-old Male)." Children took certain cues from the behavior of the animals and their visual depiction to conclude that the experience was not real.

5.3. Real to Them – Presence as Transportation

Children also demonstrated their subjective experience of reality in the VR experience. Many described presence as transportation into the virtual environment: "It feels like I'm really in a pool with fish inside it (P1, 6-year-old Male)." Their ability to move in the VR space greatly contributed to this feeling: "First thing I wanted to do was actually just walk around and see. When I saw that wall I was […] wondering what it was. (P10, 7-year-old Male)." Most of the children attempted to move in

the environment, with some going so far as to come close to the boundaries of the room. The ability to look up and down also contributed to a sense of transportation: "When I looked down, it looked like it got deeper, and when I look up, it's like it's more I can stand (P26,7-year-old Male)." Most children tracked the dinosaurs with their eyes and tilted their head back to look up as the dinosaur swam over their head.

5.4. Real Physical Properties and Social Presence in VR

Coupled with presence as transportation, children also reported strong feelings of social presence from the creatures, and many believed the creatures could act upon them and vice versa while in the VR experience: "They looked really realistic, and the crocodile was going really close to me, and it opened its mouth. I was like, Oh gosh, is it gonna eat me?" (P4, 8-year-old Male). This fear that they would be eaten was brought up frequently, as children believed that their bodies had also moved into the VR experience. For one, they often reported that the dinosaurs could hear them, and even narrating to themselves: "I shouldn't talk. It will get mad at me (P7, 7-year-old Female)." Several also reported that the dinosaurs could see them: "Yes, some of them were looking at me (P13, 6-year-old Male)."

Their experience of social presence was evident in the physical responses children had to the dinosaurs. Because they could move in the VR experience, children would walk towards the dinosaurs or lean in to get a better look while in the VR experience. Some children would freeze in place when they heard one of the dinosaurs hiss or roar and others would step or jump backwards when they heard a dinosaur snap its jaws shut, often wincing and covering themselves up with their hands. Only four children reached out to try to touch the dinosaurs to see if they possessed physical properties.

The sense of social presence also led to emotions of fear, as they assigned the dinosaurs motivation and intent: "That swimming dinosaur is after me again (P1, 6-year-old Male)." The experience of sound also accentuated the sense of presence as richness: "[I was afraid of] the dinosaur when it went like, 'Roar.' […] I shook, and put my hands in my mouth (P16, 6-year-old Female)." Some moved away because they were worried about touch and smell, indicating a belief in the physical properties of VR: "If the fish touched me, sharks love eating fish, so I'll smell like fish, and the shark might get me (P8, 6-year-old Female)."

6. Discussion

Understanding the impact of VR is not just about assessing its influence on a given field, or a meta-analysis of VR outcome effects. Impact can also be assessed in terms of how it affects concepts in the field. For example, reality distinction and television has been a longstanding interest for children's scholars (see Chandler, 1997 for review). These studies have found certain developmental differences and ways that children understand television, but VR technology has unique visual and sensory features that can extend and complicate longstanding constructs that scholars have used to understand media. Hence, the question of whether and how children perceive VR to be real is an ongoing area of research (Segovia & Bailenson, 2009). By understanding how children perceive the different types of presence and reality possibilities enabled by VR, we can better articulate the issue of impact on children across various development stages (Bailey & Bailenson, 2017).

Children between 6-8 years-old were able to distinguish that it was not real in the world, although some of this may be due to the limitations of the VR technology process. Lombard and Ditton (1997) observe that "for an illusion of nonmediation to be effective, the medium should not be obvious or obtrusive – it should not draw attention to itself and remind the media user that she/he is having a mediated experience." Hence, while television and storybooks might be less immersive than VR, they may prove to be less obtrusive in their presentations of 'reality' (Wooley & Cox, 2007; Wright et al.,

1994). Beyond a binary view of things as real/not real, we observed several behaviors of how children attempted to test and assess the reality of VR. In the absence of external cues, one of the first things they did was to see if their body was still there. They understood that there was a difference between the VR and the physical environment. Given that there have already been studies about VR avatars (Fox, Bailenson, & Tricase, 2013; Yee, Bailenson, & Duchenaut, 2009), how children's perceptions of reality might change if the VR condition included body avatars is an area for future research. Under those conditions, we might theorize that children would have a more difficult time distinguishing reality and that the presence as transportation is higher.

The other tests that children engaged in were those related to their expectations of water, where they would hold their breath for fear of drowning. Children would physiologically react to what they were seeing in the visual environment, and their perception of reality was adjusted when they realized that they could breathe. Using the mismatch between the virtual and the physical to ascertain reality is another component to consider with children, particularly as much of the 'presence' literature has focused on adding sensory stimuli (e.g., tactile, haptic, sound, etc.) to enhance the presence experience (Biocca & Delaney, 1995; Heeter, 1992).

Unlike other media settings where children could rely on the reactions and cues of other people in the environment, assessments of reality in VR are more reliant on the content alone. The perceived social realism (Wright et al., 1994) and how closely the VR is similar to the real world plays an outsized role in assessments of reality and presence. What the precise expectation of reality for young children, however, is still a matter of some debate. Early research that asked 3-5-year-olds to categorize pictures of real and impossible events found that younger children were more likely to claim that both types of events could occur in real life (Samuels & Taylor, 1994). Other similar studies of about whether events in fiction novels could be real also found that performance of assessing reality improved from age 3 on (Woolley & Cox, 2007). Whether they could be as discerning of single-user HMD VR where they are provided visual depictions of certain events occurring, and under what conditions, is still an open question.

Despite most children concluding that the VR experience was 'not real,' children still reported physiological and emotional responses to the stimulus. While the psychological state of presence as immersion has most often been measured by self-report (Heeter, 1995), this was more difficult for children of that age. Hence, observational data from their time using the VR headset provided evidence of their immersion and transportation into the VR space, and how they perceived the social presence of characters in the experience.

The isolation in the single-user VR experience may also heighten a sensation of presence because the complete occlusion of other visual cues ensures a level of attention. While other studies of television and very young children have distinguished between foreground television and background television (Anderson & Pempek, 2005), single-user HMD VR demands foreground attention. It also removes an important resource for assessing reality, as studies have found there are many ways that adult input can affect/mislead children's perceptions (Gelman, 2009). The egocentric view that changes according to their head and body movements also contributes to presence and questions about reality distinction, as early studies found that subjective camera shots can transform the viewer from a spectator to a participant (Zettl, 1990). This is particularly important given that children are more prone to relying on their own experience for understanding the world, whether it is about the shape or location of the earth (Siegal, Butterworth, & Newcombe, 2004) or to reject things as not being real because they have not seen it with their own eyes (Samuels & Taylor, 1994; Wooley & Ghossainy, 2013). Given these technological features and what we know about children's processing of reality, VR may offer unique ways of altering perceptions of what is real because it might literally depict the impossible.

The combination of these technological components of VR caused both physiological responses in children and emotional responses, as they expressed fear and excitement regarding the social creatures. The reporting that the animals could see them is indicative of perception of VR characters as real social actors, similar to early studies that asked whether television characters could see them (Flavell et al., 1990). The experience of social presence complicated the view of reality for certain children, who expressed that while the VR was not 'real in the world,' the creatures may be real in that they 'lived in the machine.'

VR is an important technology to continue testing these concepts with children, given the various ways that VR can supplant/replace certain physical realities and the cognitive development of children (Bailey & Bailenson, 2017). The interplay between how children tested the VR environment by doing things in physical space, how they reacted physically to VR events, and how they believed the VR creatures were social actors all point to a wide range of possibilities for VR to impact reality distinction and presence. By empirically reporting several ways that young children test reality in VR and understand the characters that are shown in VR, this study has implications for designers working on VR for children and children's researchers in terms of how certain VR conditions/manipulations may be more effective than others at blurring reality perceptions and heightening presence outcomes.

7. Conclusion

VR continues to evolve with new iterations and devices. Hence, there is a call for works that assess the impact of VR on fields and people across time, while also recognizing that changes in the technology may yield different types of outcomes. This study attempts to bridge this gap by utilizing the latest iteration of VR technology to understand how it affects important historical concepts regarding children and media (e.g., reality distinction and presence). These types of studies offer a first step for assessing the possibilities of VR, which can extend work that examines VR impact and outcomes (e.g., education, behaviors, motivation, etc.) by examining some of the mechanisms that might contribute to those effects.

As newer digital technologies such as smart speakers, social robots, and virtual reality present new complexities and nuances to reality perception in young children, understanding how they affect reality and presence is a prerequisite to understanding their potential impact. Research suggests that older children (7-15) have difficulty distinguishing between robot dogs and social beings (Kahn et al., 2012) and that children ages 6-10 years viewed smart speakers as being smarter than they were and as being friendly and truthful (Druga, Williams, Breazeal, & Resnick, 2017). Given the rise of VR devices and applications for children (Bailey & Bailenson, 2017; Yamada-Rice et al., 2017), empirical studies assessing how VR technologies can intersect with key developmental capabilities of young children offers an important starting point for both future researchers and VR designers.

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