Employing Disability Simulations and Preliminary Virtual Reality Technology to Foster Cognitive and Affective Empathy towards Individuals with Disabilities

Introduction

Disabilities account for the largest minority in the country. Moreover, 95% of all children (ages 6-21) in the U.S. are currently integrated into regular education classrooms and this number increased from 33% in 1990-191 to 62% in 2013-2014 (National Center for Education Statistics, 2016). Thus, the need to optimally accommodate children with disabilities in the most sensitive and effective fashion is and will continue to be increasingly integral to their academic and social success. Unfortunately, despite this large number and increase of individuals with disabilities in regular education classrooms, most schools are unfortunately ill-equipped to adequately accommodate individuals with disabilities in the mainstream classroom. Research suggests that simply including children with disabilities in the classroom does not ensure that typical children will have positive attitudes, intentions and an interest in socializing with their new classmates with disabilities. Rather, high quality interventions that effectively educate typical children about disabilities and encourage children to befriend individuals with disabilities are paramount to enhancing the cognitive attitudes, behavioral intentions and socialization of typical children towards their peers with disabilities (Silton, 2015; Vignes et al., 2009). Conversely, if programs are not developed to promote acceptance, empathy and social integration, then children with disabilities will be less accepted by their typically developing peers in the classroom (Favazza, Phillepson, & Kumar, 2000).

Timing of understanding disabilities

While preschool children already appear capable of understanding visible disabilities (e.g. physical and sensory disabilities), they seem to be less discerning of less visible disabilities, like mental retardation (Conant & Budoff, 1983) and psychological disturbances (Smith & Williams, 2001). Some research studies suggest that young children may not only possess inaccurate information about less visible disabilities but may even possess more negative attitudes towards children with less obvious disabilities (Maras & Brown, 2000). It has been suggested that young children may experience a lack of clarity about their peers with cognitive disabilities (e.g. mental retardation, autism), since many of these peers with disabilities do not rely on overt, adaptive equipment, like a wheelchair, a hearing aid, glasses or a walking stick. In contrast, Goodman (2001) discovered that third graders perceived retardation as a trait, interpreted abstractly to be both predetermined and incontrovertible, based on personal effort. Similarly, Goodman (1989) discovered that eight to nine year olds possessed an accurate conceptualization of learning disabilities, perceiving them as a trait that is abstract and irreversible. Interestingly, these distinctions in conceptualization of disability may relate to the more negative perceptions of third and fourth grade children towards children with disabilities compared to the more positive perceptions of their younger preschool and kindergarten counterparts (Diamond et al., 1997; Goodman, 1989). A number of studies have shown that as typical children age, they rate their peers with both physical and intellectual disabilities less positively, suggesting that there is a negative relationship between age and attitudes (Campbell, Ferguson, Herzinger, Jackson, & Marino, 2004; Bell & Morgan, 2000; Morgan &Wisely, 1996). Unfortunately, this negative relationship between age and attitudes in elementary school children can result in painful bullying in and outside of the classroom.

Negative Attitudes and Bullying Towards Individuals with Disabilities

Research consistently reveals that students with disabilities are not only a more frequent target of negative attitudes (Nowicki & Sandieson, 2002), but are less accepted, exhibit less social participation, have fewer friends, socialize less often, and report more loneliness than their typical peers (Bossaert, Colpin, Pijl & Petry, 2011). While any individual might be a target of bullying, the following student profiles are at a greater risk of becoming victims of bullying: students with disabilities and mental health problems, smaller students, and students who are lesbian, gay, bisexual, transgender and questioning (LGBTQ) (Lieberman & Cowan, 2011). In particular, children with disabilities are two to three times more likely to be victims of bullying compared to their typical peers (Holmquist, 2011) and bullying experienced by individuals with disabilities tends to be more chronic in nature and a direct result of their disability (Wall et al., 2009). Hoover and Stenhjem (2003) suggest that the lack of participation of children with disabilities in general education classes, mainstream educational clubs and organizations, and athletic programs perpetuates a lack of understanding and interaction among students with and without disabilities. Peer interactions and relationships are critical ingredients for developing social skills during childhood (Asher & Coie, 1990). Aligned with this notion, various research studies suggest the importance of having learning standards focus on the development of social skills and social competence skills as opposed to focusing solely on the acquisition of academic competencies like literacy and mathematics in the classroom (Scott, Little, Kagan & Freelow, 2006; National Research Council, 2001).

Therefore, this literature review will begin by discussing the constructs and measurement of empathy and theory of mind (ToM), two key constructs which are not only crucial ingredients for social and peer development, but are key reasons why constructing simulations- for typical individuals to experience what disability is like- is so critical. Developing disability simulations via the computer and via virtual reality technology allow the user to empathize (emotionally) and to harness Theory of Mind (ToM) skills (to cognitively take the perspective) of an individual with a disability. These constructs of empathy and Theory of Mind (ToM) will thus be crucial in understanding the impetus behind the innovative use of disability simulations and Virtual Reality Technology (VRT) to enhance the typical users' understanding, cognitive attitudes and behavioral attitudes and intentions towards children with disabilities.

The review will then highlight the key characteristic symptoms, strengths and limitations associated with five disabilities that are commonly found in regular education classrooms: Autism, Attention Deficit Hyperactivity Disorder (ADHD), Visual Impairment, Hearing Impairment and Physical Impairment. Next, the review will introduce Affect/Effort Theory to suggest how a focus on strengths associated with disabilities rather than solely a focus on limitations may motivate typical children to put forth more effort in taking interest and befriending their peers with disabilities. The lion's share of the review will focus on how disability simulation through Virtual Reality Technology may be a particularly creative and active approach towards fostering knowledge, positive attitudes and intentions towards peers with disabilities. The authors will highlight the strengths, limitations and best practices to consider for VRT disability simulation.

Empathy

Empathy is composed of both affective (appropriateness of emotional responses) and cognitive (inference of mental states; theory of mind) dimensions (Baron-Cohen & Wheelwright, 2004). Empathizing is the drive to decode another individual's emotions and thoughts and to respond in kind with an appropriate emotion; it offers a key into making sense of and predicting another individual's behavior (Wakabayashi et al., 2007). Aligned with this definition, Zhou et al. (2002) presented Eisenberg & Fabes' (1998) definition of empathy as "the affective reaction that stems from the apprehension or comprehension of another's emotional state or condition, that is identical or very similar to what the other person is feeling or would be expected to feel.

Measuring Empathy

The Interpersonal Reactivity Index (IRI) is one measure used to assess empathy. The IRI is a 28-item instrument which includes measures of both cognitive and affective dimensions of empathy (Davis, 1980). Some items are reverse scored as per the IRI scoring instructions. The total IRI score is measured by adding all 28 items. Higher scores indicate greater empathy. A sample cognitive item is, "I believe that there are two sides to every question and try to look at them both." A sample affective item is, "I often have tender, concerned feelings for people less fortunate than me." Items are measured using a Likert-style scale with 0="does not describe me well" to 4="describes me very well." This measure is both reliable and valid (Davis, 1980).

ToM (Theory of Mind).

Theory of Mind (ToM) describes the ability to attribute mental states to oneself or to another individual and therefore often overlaps with empathy. ToM, or the ability to infer the mental states of others, is identified as an essential tool for social and behavioral functioning, including the ability to take the perspective of others, to empathize (Batson et al., 1987), and to feel guilt (Baron, Cohen, 1995). In fact, researchers have delineated three key stages of ToM development: First-order ToM (Wellman et al., 1990), second order ToM (Perner and Wimmer, 1985), and the comprehension and recognition of faux pas (Stone et al., 1998). Many of these social-emotional and perspective-taking abilities are crucial for developing healthy relationships with others. Thus, it is interesting to consider that at the stage of development immediately preceding adolescence, children begin forging more intimate and selective friendships, and become more self-conscious of how others perceive them (Interbitzen-Nolan, 2000). While there is a dearth of ToM literature pertaining to the general developmental trajectory in normative populations after adolescence, the presence of a few advanced ToM tasks for adults, such as Baron Cohen's Reading the Mind in the Eyes Test (2001) suggests that ToM abilities may continue to improve after adolescence.

Measuring ToM

The Reading the Mind in the Eyes Test Revised Version (2001) is an improved version of Simon Baron Cohen's original ToM measure, the *Reading the Mind in the Eyes (1997)* test. The eyes test assesses its users on the specific, advanced ToM task of emotion recognition, or attributing relevant mental states to others. While this test does not include the second stage of ToM of inferring the content of a mental state, recognition and attribution of mental states is a significant and important component of ToM to measure in adults. The test was primarily created to detect deficits in ToM abilities of individuals with high-functioning autism (HFA) or Asperger's Syndrome (AS), but the test has also demonstrated success in distinguishing performance levels of males and females in the typical population.

Five Key Disabilities in Regular Education Classrooms

Autism

One in every 68 children (1 in 42 boys and 1 in 189 girls) is currently diagnosed with an Autism Spectrum Disorder in the United States (Autism Speaks, 2018). ASD is neuro-developmental disorder that can be characterized by severe, social and language impairments (Silton & Fogel, 2012). These social and language deficits manifest in many ways and may impair the interpersonal relationships between individuals with and without ASD from childhood to adulthood. While social communication is a hallmark deficit of autism, there are a variety of strengths individuals on the spectrum may possess. Studies have noted that at least 10% of individuals with autism appear to have savant syndrome, a rare condition in which a person with a specific disability or otherwise low cognitive functioning demonstrates a striking ability or skill in a certain area (Pring, 2005). Individuals with savant syndrome may possess exceptional skills in the areas of music, art, mathematics, memory and spatial orientation. They may also exhibit superior performance in both visual and auditory modalities in everyday life and when completing various cognitive tasks (Mottron, Dawson, Soulieres, Hubert & Burack, 2006). Finally a growing literature suggests that individuals on the autism spectrum may exhibit special abilities in connecting with the animal world. Grandin (2005) offers a possible reason for this connection, by suggesting that individuals with autism may be capable of empathizing with animals' hyper-vigilance and hyper-sensitivity to high-pitched sounds and sudden movements. Additionally, like animals, individuals with autism may be extra sensitive to individual's voices, gait, and specific types of clothing, but may experience difficulty decoding their facial expressions (Grandin, 2005).

Attention-Deficit/Hyperactivity Disorder

Attention-deficit/hyperactivity disorder (ADHD) is currently the most frequently diagnosed mental health condition in children in the United States (Butcher, 2013). ADHD is characterized by three main symptoms: inattention, hyperactivity, and impulsivity, which leads to difficulties both at home and in school (DuPaul, Weyandt, & Janusis, 2011). In fact, about 50 percent fail annual school exams by adolescence (Shaw and Lewis, 2005). As a result, children with ADHD are more likely to face social rejection than their peers (Hindshaw, 2002 as cited in DuPaul, Weyandt, & Janusis, 2011). However, clinical studies suggest that there may be a link between ADHD and enhanced creativity, arguing that children with this disability have elaborate imaginations, greater problem-solving skills and perform better on tasks requiring divergent thinking skills (White & Shah, 2006).

Visual Impairment

According to the American Community Survey (2013), 694,300 children ages 4 through 20 reported a visual disability (NFB, 2016). Visual impairment ranges from low vision, which includes dimness of vision, abnormal sensitivity to light, or visual field defects, to complete blindness (Vanderheiden & Vanderheiden, 1991). Depending on the severity of impairment, individuals may use aids such as magnifying tools or braille letters to perform everyday tasks like reading. However, those with a lack of visual ability may benefit from heightened skills in their other senses such as pitch discrimination and sound localization (Wan, Wood, Reutens, & Wilson, 2010). According to Ockelford (2009), individuals who are blind are 4,000 times more likely to have perfect pitch than their fully sighted peers.

Hearing Impairment

Hearing impairment is the most common sensory disability in the world (Vanderheiden & Vanderheiden, 1991) and can be described as "a broad term that refers to hearing loss of varying degrees, ranging from hard-of-hearing to total deafness (Shemesh, 2010). The degree to which communication is affected depends on the severity of hearing loss. Children who are hard of hearing may experience challenges with learning vocabulary and grammar while children who are deaf tend to trail their peers in writing, reading, and speaking (Moeller, Osberger, & Eccarius, 1986). In some instances, hearing aids or cochlear implants may be used to communicate effectively. In addition to assistive technology, sign language is a common form of communication among individuals with hearing impairment. Research has suggested that learning sign language can enhance creativity, spatial cognition and mental flexibility (Courtin, 2000). Studies have also shown that individuals who are deaf may have enhanced visual abilities since the auditory cortex of the brain adapts to enhance vision (Than, 2010).

Physical Impairment

In 2014, an estimated 7.1% of individuals reported that they suffered with an ambulatory disability (Erickson, Lee, von Schrader, 2016). Paraplegia, a type of ambulatory disability, refers to the loss of movement and/or feeling in the lower half of the body due to an injury to the nervous system (Kohnle, 2011). The causes of this disorder are often a result of a stroke, spinal cord injury, genetic disorder, infection or a tumor within the spinal cord (Melzak, 1969; Kohlne, 2011). In the United States, the majority of cases of paraplegia result from motor vehicle accidents (46%) followed by falls (22%), violence (16%) and sports injuries (12%) (CDC, 2010). Symptoms of paraplegia include loss of movement and muscle control in the legs, feet, toes and trunk, tingling in the legs and loss of bowel and bladder control (Howlett, 2012). Wheelchairs are essential for mobility and individuals with this disorder have to learn to make independent transfers. Individuals with paraplegia are required to strengthen the non-paralyzed muscles of their bodies to make these transfers and to prevent muscle atrophy (Howlett, 2012). The strength they develop from these independent transfers often helps them glean stronger upper-body muscles and helps them be more cognizant of the world around them.

Affect/Effort Theory

The affect/effort theory posits that expectations influence an individual's affect and the amount of effort her/she puts forth (Rosenthal, 1989). When a child is presented with a negative expectation of a social interaction partner, he/she is less involved, makes less of an effort to interact, and is less friendly towards the social interaction partner, even if the social partner does not possess significant emotional or behavioral issues (Disalvo & Oswald, 2002; Harris, Milich, Corbitt, Hoover, & Brady, 1992). However, it is possible for typical children to overcome these expectancies if they are aware of them and are highly motivated to alter them (Darley & Oleson, 1993; Disalvo & Oswald, 2002). Moreover, if typical children are presented with positive strengths information about children with disabilities they may be more interested in socially interacting with them. Based on the Affect/Effort Theory, defying these expectancies is a crucial intervention goal since fostering typical children's interest, positive behavioral intentions, cognitive attitudes, and understanding of children with disabilities would help motivate social interaction with children with disabilities and could, in turn, encourage them to be motivated to socially interact with typical children.

The current research study aims to improve the treatment of children with disabilities in and outside of the classroom by utilizing the active approach of disability simulation through Virtual Reality Technology (VRT) to enhance typical children's knowledge, attitudes and intentions towards their peers with disabilities. In consideration of Affect/Effort Theory, the proposed disability simulations will not only inform VRT participants about the limitations associated with the disorder, but will also reveal potential strengths associated with each disorder, as well. The literature below reflects the strengths and limitations of disability simulations and VRT and best practices for conducting effective VRT disability simulations.

Disability Simulation

Simulations can be used as learning strategies within educational, organizational, or business settings through hands-on activities or via personal computers. Disability simulations place participants without disabilities into situations designed to briefly mirror the lives of those with disabilities (McGowan, 1999 as cited by Flowers et al., 2007). Some popular simulations include, using a wheelchair, a "blind walk," a leg brace, earplugs or being fed by another person. Activities are created to be as close to reality as possible so participants have an accurate sense of life with a specific disability. The goal is to foster positive attitudes and empathy towards those with disabilities. Compared to other educational methods, simulation exercises are meant to bridge the gap between passive learning and direct personal experience (Herbert, 2000).

Virtual Reality Technology

Virtual Reality Technology (VRT) is a three-dimensional computer-based world where users can interact in an immersive environment. This technology has been employed in medical education programs to simulate surgery and in pilot training programs to practice the maneuvers involved in flying a plane before stepping inside a real one (Burgstahler & Doe, 2004). It has also been used as an educational tool for "enhancing, motivating and stimulating students' understanding of certain events" (Shim & Park, 2003). Moreover, VRT requires students to be hands-on in their learning experience in order to help them grasp complex topics through reality simulations (Shim & Park, 2003). This technology may be beneficial for modifying behaviors and attitudes of typical children towards children with disabilities. Computer-based worlds can simulate and foster positive attitudes and behaviors towards children with disabilities by affording participants without a disability the opportunity to delve into the world of an individual with a disability.

Strengths of Disability Simulations

Various researchers have discussed the strengths and limitations of utilizing simulations to enhance attitudes, intentions and behaviors. With respect to strengths, some activists agree that simulations enhance disability sensitivity, alter attitudes, establish more positive behaviors and bring attention to the prejudice experienced by individuals with disabilities (Kiger, 1992).

Experiencing what is it like to be blind for 30 minutes and navigating through a familiar or unfamiliar area does not necessarily offer a realistic representation, but it can provide some insight into the reality of the disability. Actively engaging participants also makes lessons more lively and appealing, and therefore more likely to be recalled (Burgstahler & Doe, 2004).

Prior research has shown that simulation exercises are most effective when combined with other learning methods such as direct social interaction with individuals with disabilities or audio/visual learning material (Herbert, 2000). Virtual Reality Technology (VRT) and disability simulation combined with peer strategies have been utilized as teaching tools for improving child and adolescent attitudes and behaviors towards disabilities.

Potential Limitations of Disability Simulations

However, the current study is necessary, since previous disability simulations have been criticized in the disability advocacy community due to the limited number of reported positive changes in the behavioral intentions and attitudes of typical participants following the simulations (Smart, 2001 as cited by Flowers et al., 2007). In Kiger's (1992) study, the author notes that simulation exercises cause no harm, but the positive effects may be negligible. In a study conducted by Flower, Burns, & Bottsford-Miller (2007), any positive attitudes or behavioral changes linked to disability simulations were reportedly brief.

One explanation for the lack of change in attitudes can be attributed to the fact that briefly experiencing a disability cannot fully represent the experience of living with a life-long disability. Participants are not given the time to develop the coping skills necessary to successfully absorb the simulation experience, which can often lead to negative feelings towards the simulated disability (Kiger, 1992). As a result, participants may leave the simulation experience feeling frustrated, insecure, and humiliated; which can further reinforce negative stereotypes and bias (Herbert, 2000). Many simulations focus primarily on presenting limitations, which can often negate the possible accommodations or even strengths of a particular disability.

Another concern with disability simulation is that it often ignores how disabilities are socially constructed (Burgstahler & Doe, 2004). Personal experience and the understanding of disabilities may affect participants' perceptions of how disabilities affect an individual's quality of life (Herbert, 2000). Someone without a disability might say that a person who is deaf cannot listen to music because his/her definition of enjoying music relates to hearing sound; however, this is not the case for everyone. Ignoring the socially imposed limitations of disabilities can further reinforce negative feelings towards those with disabilities.

Simulations via Virtual Reality Technology (VRT) come along with their own considerations. "Cybersickness" which includes nausea, dizziness and headaches has been reported by some participants (Cobb et al., 1999 as cited by Parson & Mitchell, 2002) and usually occurs when the activity involves head-mounted displays (Parson & Mitchell, 2002). Instructors should watch out for signs of "cybersickness" and anxious feelings from the participants to ensure they are establishing and maintaining a safe environment.

Literature-Informed Practices for Optimizing the Disability Simulation VRT Experience

Due to the potential aforementioned limitations of using VRT equipment to simulate disability, it is instructive to consult the literature to determine how best to optimize the VRT experience and the learning objectives of the disability simulation. It is useful to look at how age, gender, study duration, introductory and debriefing remarks before and after the simulation, respectively can be important considerations prior to developing an improved VRT disability simulation experience.

Age

Age is likely to influence a child's attitude towards individuals with disabilities (Karnilowicz, et al., 1994). A meta-analysis of disability research conducted by Flower et al. (2007) found that when comparing children and adults, studies using children showed a larger effect size in attitudinal change than studies employing adult participants. Thus the effects of simulation appeared stronger and more powerful among child participants compared to their adult counterparts. Although there have only been a few research studies which involve child participants in VRT, children seem to learn proper social interactions almost effortlessly. Children may be more likely to change their attitudes or behaviors if they are provided with activities that simulate accurate and influential knowledge about a disability (Parson & Mitchell, 2002).

Gender

With respect to gender, many studies report that girls possess more positive attitudes towards individuals with disabilities than their male counterparts. When compared to males, females between the ages of 6 and 12 years of age, "tolerated, rather than accepted or rejected" children with disabilities (Karnilowicz et al., 1994). The gender, age, adult or parental perspective and previous experience with individuals with disabilities can all affect the attitudes expressed by an individual (Georgiadi et al, 2012).

Duration of Study

With regard to the duration of simulations, Flower et al. (2007) found that the length of simulations ranged from fewer than 30 minutes to 60 minutes. The sessions that had a shorter duration of fewer than 30 minutes were found to be more successful and effective than longer simulation sessions.

Introductory and Debriefing Remarks

For a disability simulation to be effective and to leave the participants with a positive and insightful experience, the simulation administrators must provide a safe and stress-free simulation experience. A simulation that increases a participant's anxiety may be doing more harm than good in enhancing the participant's attitudes towards a disability (Wright, 1975 as cited by Kiger, 1992). Since many simulations do result in strong emotional responses, introductory and debriefing sessions are essential and should be held before the start of the simulation activity to effectively limit the amount of stress or anxiety expressed by participants. Full understanding of the purpose and layout of a simulation may also decrease participants' feelings of pity towards individuals with disabilities (Kiger, 1992). In fact, these sessions can be used to emphasize how a person with a disability is "an active participant in valued activities …having abilities that have intrinsic value" (Wright, 1978 as cited by Kiger, 1992).

Best Practices in VRT Authorship

In contrast to passive, non-interactive depictions of disability that invoke viewer sympathy, VRT's potential for promoting viewer empathy lies in the interactive features of the simulation platform. The spatial attributes of visual and aural media change in sync with the VRT user's movements. Additionally, VRT users possess agency: they are able to manipulate the simulated environment and to affect change in the depictions presented. Designers can carefully craft the experience within VRT disability simulations to manifest the social contexts and conditions that elicit positive behavior towards individuals with disabilities. In this manner, authors of VRT experiences enable conscious place taking and role play, the precursors to cognitive empathy within the viewer. The following design considerations allow media producers to craft more compelling VRT disability simulations.

Experience Design and Embodied Cognition

The prominent feature of VRT that capacitates the user to assume the view of another is the seamless integration of the different types of sensory feedback. When a number of senses are recruited in tandem to support a fabricated narrative, VRT users are still able to suspend disbelief and allow themselves, to become immersed in even crude reproductions of simulated environments. The key to the design of VRT experiences lies in the judicious pairing and synchronization of salient stimuli. For instance, the perceptual phenomenon of the McGurk effect, in which the parsing of speech is influenced by lip reading, points to the interconnected relationship between our sense of sight and sound (McGurk & McDonald, 1976). In a disability simulation depicting hearing loss, the media producer can recreate the difficulties that arise when the activity instructions are obfuscated by unintelligible speech. By attenuating the higher frequencies, the sibilants and plosives in the aural prompts are masked, and the player is unable to understand the instructions because of the lost consonants in spoken word. The designer of a VRT simulation can craft different social contexts, such as a lunch conversation with a peer in a noisy restaurant, or a service announcement at a bus terminal, that determine the availability and the nature of the stimuli coupling. The simulated conditions allow the VRT user to experience firsthand a more nuanced range of perceptual phenomena, from light perceptual masking to severe obfuscation of speech. Such a simulation offers a high quality tool for educational interventions, since it highlights the various challenges of hearing loss that come with different environmental conditions.

In authoring VRT simulations, a designer can elect to emphasize materiality – the defining characteristics of physical attributes that can span multiple senses – so that the activities can engage viewers through their preferred learning style. For instance, the virtual reality installation, "Over the River," employs the tactile sensation of gravel to promote the perception of environmental authenticity. The installation simulated Hunter's Point South, an abandoned postindustrial site in New York City that grew into verdant forest. Soon after the site was razed for high-rise development, the VRT designers created a simulation of the site to promote empathy for place (Fontanilla & Wright, 2016). In crafting the viewer's experience, the designers elected salience over relevance. Instead of incorporating many forms of site detritus, such as decaying soil and drying leaves, to provide a range of olfactory and tactile cues, the VRT producers instead focused solely on the material attributes of gravel to convey authenticity. They emphasized the timbral qualities of the footstep sounds to complement the sensation of gravel beneath the VRT viewer's feet. The selective emphasis of material attributes in the simulation was effective in conveying an authentic experience. Visitors reported that the installation "felt so real," as if they were transported to the forest before it was demolished; a hallmark outcome of compelling immersion.

Similarly, in simulating autism spectrum disorder, a VRT designer's material considerations may include exaggerating vocal inflection, gait in walk cycles, and the prominence of colors and patterns in clothing, while subduing the facial expressions of simulated-world characters. Creative measures as these allow the VRT user to more directly experience hypersensitivity to tangential stimuli, and by the same token witness the difficulty of decoding emotions of others, firsthand. In this way, the VRT disability simulation allows engagement with immersive activities through the eyes of a person with a disability, distorting the viewer's capacity to read the emotions of other players – two dimensions that relate to cognitive empathy.

The unique confluence of technological features – the coupling of bodily orientation, haptic feedback, and audio-visual stimuli – can leverage cross-sensory metaphors to achieve simulation objectives. Consider that cognitive researchers have correlated the way we form and recall memories to actions that we perform using our bodies (Casasanto & Dijkstra 2010). Repetitive tasks involving upward gestures (e.g, the transfer of marbles from a lower shelf to a higher shelf) affected the rate and frequency of recalled positive memories. Conversely, repeated downward motions (moving a set of marbles from the top shelf to the bottom shelf) incurred a greater likelihood of negative memory retrieval. In another investigation, researchers suggest that the mental metaphor influenced by hand preference – that sided notions of "good" and "bad" correspond to one's dominant and non-dominant hand – is flexible (De la Fuente et. al., 2016). If people's implicit associations of space and attitude can be influenced by motor fluency, perhaps the consideration of the VRT simulation interface should include particular attention to user-handedness. These recent findings in embodied cognition provide VRT producers with compelling opportunities to carefully craft in-simulation activities and user experiences that may boost positive attitudes toward people with disabilities.

VRT's constellation of technological attributes as delineated above has thus far examined its relevance to two dimensions that support cognitive empathy: immersion in the world of another person's perspective, and awareness of other players' emotions (whether those in-game players are simulated or human). Disability simulations can be designed as 'serious' games, differentiated from prototypical entertainment-oriented video games in that they can be used as a teaching tool (Mouaheb et. al. 2012, Djaouti et al). The experiential features of game mechanics – the rules and conditions that constrain or encourage particular behaviors of human players – enable a third dimension that supports cognitive empathy: computer-generated simulations in the form of educational games have the potential to condition the user to avoid judging others. Leveraging the platform inherent in serious games, simulation designers can manufacture contrasting social ecologies. Different rule-based systems can deter inappropriate behavior, facilitate quid pro quo, promote team building, reward collaboration towards shared goals, encourage mutual concern, and awaken shared responsibility. Together, judiciously crafted game mechanics and integrated stimuli-feedback systems can simultaneously enable perspective-taking, elevate emotional awareness, and attenuate judgment of others. Facilitators can utilize disability simulations as a social sandbox for young people to try out different methods for communicating and responding to emotions. Such computer-generated disability simulations can serve as effective interventional tools as part of a comprehensive educational program.

Mitigating Risks

Crafting an immersive experience by synchronizing multiple types of stimuli does not come without risks. Consider that if the non-interactive medium of filmic storytelling can evoke a multi-modal perceptual experience, VRT experiences may be overly rich with stimuli. Implicating more senses than just sight and sound, Luis Rocha Antunes (2015) postulates that audiovisual media can involve the vestibular, proprioception, and thermoception through several feedback mechanisms. Authors of training materials overtly summon these senses, in videos like "178 Seconds to Live" (Air Safety Institute, 2014). In this educational video, the disorientation pilots experience in a classic graveyard spiral – known colloquially in the figurative expression, death spiral – are recreated. The narrator details the vestibular senses at odds with the information shown on the instrument panel. Without the aid of the horizon line as spatial reference, the pilot can feel the plane's loss in altitude, but not the turn. Whereas passive viewing of such videos is less likely to result in subsequent viewer disorientation, participatory VRT simulations can bring risks because the confluence of rich stimuli can overwhelm the viewer.

VRT simulations can augment, or conversely fracture, perceptual experiences. Depending on the refresh rates of the VRT platform and other technological features, immersive simulations present visual stimuli that can betray perception of motion and belie the user's sense of their own body, resulting in nausea or loss of balance. For instance, in mimicking visual hypersensitivity, a simulation designer may employ 'bloom,' a computer-generated shader effect that can be configured to yield extreme and rapid changes in contrast and hue. These rapid visual changes may cause some discomfort, but can be exacerbated by additional factors. Computationally intensive simulations can suffer from latency, a perceptible delay between angle of view and head orientation. When snug-fitting VRT masks encompass the user's entire field of vision, the combination of rapidly-changing stimuli and pronounced latency overwhelms the viewer with false sensory cues. The occasional fracturing of perceived realism imperils the simulation's veridicality and worse yet can lead to disorientation and injury.

In cases where atypical or extreme presentations of stimuli are integral to simulate disability, certain practices in the design of the user experience can mitigate the hazards intrinsic to VRT-based simulations. Including interstitial sections help to mitigate these risks. Introductory segments that precede a simulated activity can methodically initiate the user to the new stimuli, so that they can adjust to the new perceptual experience. A simulation designer may also map stimuli intensity (e.g., rate of change in contrast of visuals; amplitude, Q-factor in frequency of sound) to a method of control that is manipulated in real-time. In this way, the user or the facilitator can appropriately modulate the rate of change and scale the range of extremes. Scaling the intensity of the stimuli mitigates both extremes of simulation: the diminished efficacy of the simulation stemming from habituation, or the overpowering perceptual experience interfering with the desired impact of the simulated task.

Disorientation can be mitigated by allowing a viewer a peek of their physical environment. The inclusion of holes and gaps in the viewing apparatus that permit a peripheral view of the space can mitigate disorientation. VRT masks that allow the user to maintain an external visual reference permits real world spatial cues to reinforce the vestibular and proprioceptive signals that are integral for maintaining equilibrium. (Berthoz, 1991; Ivanenko et al., 1999).

Another method of preventing injury- albeit labor intensive- relies on simulation facilitators to serve as spotters to ensure that VRT users do not inadvertently hurt themselves or damage equipment. When movement is called upon in a simulation, a spotter that works alongside, or in place of, the room-scale indicators (visual markers within the virtual environment that indicate the limits of the physical space) ensure the safety of the user. Rope lines and flooring treatments that delineate space also aid the user in room-scale virtual reality simulations. Rope lines are a necessary component in public installations, while transitions in floor treatment may offer enough tactile cues for a home user of VRT.

In addition to creating a safe physical space through barriers, a designer can also create one using the dimension of time. Constraining the duration of the VRT simulation, particularly when the game mechanics that incorporate taxing exposure to extreme stimuli, onerous tasks, or demanding contexts. By limiting the duration, designers can better control the quality of the disability simulation, and attenuate the risk that a negative experience would compound an antipathetic attitude towards individuals with disabilities. Short sessions that employ scaffolding, progressively building on experiences towards constructive outcomes, enable successful social-emotional learning.

Incremental Development

In preparing for the creation of the disability simulations, designers should remember that a young viewer might conflate negative simulation experiences with a negative attitude towards disabilities. A development cycle that incrementally adds and tests the features that comprise immersive viewing can guard against VRT's pitfalls. Consider the development framework articulated by Daniel Jacobson in the Create Once, Publish Everywhere (COPE) philosophy (Jacobson 2009), where media producers explicitly separate content from the display mechanism, such that the simulation material remains modular and portable. Prominent game engines were surveyed for their capability to support the integral features of disability simulation and for their potential for broad dissemination across multiple platforms (for viewing in VRT form, as a mobile app, and as a desktop computer program). The Unity3D game development environment meets the criteria as a viable platform for developing serious games, and has been widely adopted in the education sector as a teaching tool. Particularly valuable to the present discussion is Unity3D's capability to build simulations for a number of mainstream VRT platforms (such as Google Cardboard & Daydream, Oculus Rift, and SteamVR). In the COPE model, a workflow is created within the Unity3D environment that serves as the content management system. The content – the activities that are crafted to expose the salient differences experienced in different disability perspectives – can be crafted separately from the display systems, and can be built as different interventional tools. Consequently, the planned creation sequence for disability simulations would involve a graduated integration of immersive technologies. Activities that elicit a cognitive load appropriate for young viewers are crafted first. The next step of disability simulation development would evaluate the activity content with conventional 2D screen-based viewing (e.g., a laptop computer) and two-channel audio (e.g., headphones) to determine its efficacy in promoting cognitive empathy without the benefits of immersive viewing. In the next phase of development, the aspects that comprise an immersive experience are incrementally added: stereoscopic vision, spatialized sound, and input mechanisms with haptic feedback.

In a pilot study begun in August 2017, the authors designed and tested a number of disability simulations that incorporated the considerations outlined above. The computer-generated disability simulations were created as interventional tools that dovetailed with a research-based curriculum, entitled *Realabilities* (Silton 2010). Consisting of animation for television, comic books, and an Off-Broadway Puppet Musical (titled *Addy & Uno*), *Realabilities* features five characters with disabilities including autism, ADHD, physical disability, visual disability, and hearing disability. In the various stories portrayed, the *Realabilities* characters harness their individual strengths and problem-solve together to achieve shared goals in age-appropriate contexts (e.g., winning a school district math competition, addressing bullying in the school, etc.) In the pilot study, young participants explored computer simulations of Autism, Attention Deficit Hyperactivity Disorder (ADHD), moderate and severe hearing loss, low vision, and visual hypersensitivity. Assuming the perspective of *Realabilities* characters, the young players engaged in a word-finding activity within a classroom setting, and virtually experienced first-hand some of the challenges in participating in the designated activity as a result of the simulated disability.

Participants

Eight participants between third and sixth grade, who attended a Jewish overnight camp in Liberty, NY participated in the pilot simulation. The participants were divided evenly by gender, with four female and four male participants. All participants self-identified as White and all participants had previous exposure to individuals with disabilities.

Procedure

Participants received pre-tests prior to and post-tests following reading through sample *Realabilities* Comic Books, viewing a video taping of the *Addy & Uno Puppet Musical* (based on the *Realabilities Educational Comic Book* series) and after participating in the aforementioned Disability Simulation. The simulations were administered using a laptop computer as the viewing device to evaluate the efficacy of the in-world experience design. In addition, participants responded to qualitative questions after each part of the intervention (after the comics, the Musical and after the disability simulations). The preliminary results below highlight the principal qualitative findings from the Pilot Disability Simulations.

Preliminary Results

Preliminary findings indicated that the simulated activity served as a significantly effective interactive tool to complement the other media forms of the *Realabilities* curriculum (the comics and Musical). The findings also suggest that the pilot simulations would encourage positive attitudes and behavioral intentions towards individuals with disabilities. The majority of participants (6; 75%) identified the low-vision simulation as the most compelling simulation, while others suggested that the low-hearing simulations (2; 25%) were also highly effective. When asked how the simulations could be more effective, one participant remarked that the hearing simulation could have even been quieter. Another suggested that it might be helpful to go through the entire day with the disability and the others suggested that the simulations were highly effective. With respect to if and how their impressions of disabilities have transformed since viewing the disability simulations, one participant reported that it taught her "to be nicer." Another commented that she was grateful since she could now better understand how individuals with disabilities feel. The majority of others suggested that their impressions did not significantly change since they had previous exposure and knowledge of disabilities. Finally, when asked what they would create if they could innovate a video game of their own to teach kids about the strengths and limitations of disabilities, one participant suggested that the video game content relate to how the *Realabilities* team stands up to individuals who are teasing them. Another suggested that the game involve individuals in wheelchairs getting on a bus. Another participant recommended a video game related to low vision. Still another envisioned a video game wherein the Realabilities characters would compete against other characters. The other participants recommended a fun, non-educational video game where you could assume the perspectives of the characters and complete activities as them. The pilot study was promising, and confirms the latitude that the selected game development platform offers to the authors of the *Realabilities c*omputer-generated disability simulations.

Conclusion

As part of a multi-faceted educational curriculum, we anticipate that the next phase of the study – the creation and testing of the *Realabilities Disability Simulations* in virtual reality form – will yield even stronger outcomes. With immersive viewing, the experiential conditions can more compellingly manifest the precursors of cognitive empathy. VRT-enabled disability simulations, when developed with these considerations and best practices, carry great potential as interventional tools that promoting place-taking, understanding, acceptance, and the social integration of disabilities.

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