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Pokémon Go as a Positive Virtual Reality Game: Promoting Cognitive, Affective, and Empathic Benefits

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by

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Abstract

Video game popularity and time playing in children, adolescents, and adults is steadily increasing due to heightened accessibility, advanced technological game design, and a rising sedentary lifestyle among Americans. The advent of exergames and virtual reality paradigms has led to a new wave of mobile video games that can be played anywhere, involve the combination of mobility and gaming, and may be used to improve cognition, affect, and perhaps empathy. The aim of the present study was to examine if the exergame Pokémon Go would improve visual and verbal working memory, attention, positive and negative affect, and empathy. Additionally, the current study is an extension of seminal research that discovered being in nature alone has positive effects on working memory and affect. Participants (N = 62) from a Florida University were assessed on the Alloway Working Memory Assessment (AWMA), the Positive and Negative Affect Schedule (PANAS), and the Interpersonal Reactivity Index (IRI) before and after playing Pokémon Go outdoors around the most natural parts of the campus (e.g., ponds, dense foliage). The participants then returned several days later, completed the assessments, and spent time outdoors not playing. The study was counterbalanced over the course of a year to control for seasonal differences. Main findings included increased verbal working memory scores and decreased negative affect after playing Pokémon Go with no changes in empathy. The results have important implications for those interested in using Pokémon Go to improve working memory and decrease stress and negative affect in adult populations.

Keywords: Working memory, affect, empathy, cognition, Pokémon Go, virtual reality paradigms

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Video Games

One-hundred and fifty million Americans play video games for more than one hour per day and some players exceed 12 hours per week (ESA; 2015). Since 2003 the amount of time Americans spend playing video games has risen 51% according to the American Time Use Survey (Bureau of Labor and Statistics; 2015). This nationally representative annual survey questioned Americans about their average daily game play compared to other daily activities (e.g., spending time with friends or family, participating in hobbies, etc.). This increase in game play is attributed to a rising sedentary lifestyle among Americans (Vandewater, Shim, & Caplovitz, 2004), and advancements in video game technology and design adding to their appeal (Newman, 2013). This rising popularity of video games among adolescents, children, and adults has spurred debate for parents, video game creators, researchers, and policymakers regarding the positive and negative consequences of this nationwide increase.

Positive Effects

In the line with the current study, video games provide several benefits including improved physical activity levels (Mhurchu, Maddison, Jiang, Jull, Prapavessis, & Rodgers, 2008), increased visual-spatial skills and working memory (Blacker, Curby, Klobusicky, & Chein, 2014), heightened skill and intellect (Adachi & Willoughby, 2013), and decreased aggression towards those that fall outside of their "in group" in prosocial video games (Greitemeyer & Osswald, 2009). Additionally, gaming has been reported to be a highly effective method of generating and improving affect and empathy, with some studies reporting a causal link between playing certain games and increased positive emotion (Granic, Lobel, & Engels, 2013).

One of the most pressing concerns are the health risks of playing sedentary video games for long periods of time (Salmon, Tremblay, Marshall, & Hume, 2011). There is little research to date regarding the positive benefits of video games regarding physical activity because until recently most video games were played sitting down. While normal console-games do not expend much energy, new generation "active-console (e.g., Nintendo Wii)" video games provide the opportunity to get children and adults moving. Maddison and colleagues (2007) compared active and non-active console-based video games in 21 children aged 10-14. Heart rate and oxygen consumption were measured to derive kcal expenditure which illustrated significant increases from baseline compared to those playing traditional console games. The authors concluded that playing active-console video games are similar to other physical activities such as walking or light jogging.

Regarding cognition, a brief video game session improved visual-spatial skills, perceptual speed, and 3D rotation abilities in 61 fifth-grade students who initially had lower cognitive capacities compared to their other classmates (Subrahmanyam & Greenfield, 1994). More recently, Colzato, Van den Wildenberg, Zmigrod, and Hommel (2012) investigated the effects of "First Person Shooter (FPS)" video games to explore improvements in working memory. First Person Shooter games require players to constantly monitor their gaming environment for fast moving visual or auditory stimuli. Experienced video game players and individuals with little video game experience performed an N-back task and a stop-signal paradigm that provided information regarding working memory and response inhibition (i.e., behavioral impulsivity) respectively. Results indicated that experienced gamers performed better on the N-back task, concluding that playing FPS games was associated with a quicker updated working memory and controlled impulsivity. A recent functional magnetic resonance imaging (fMRI) study discovered that FPS games induce controlled attention allocation in the fronto-parietal network in heavy gamers who completed a pattern-detection task compared to non-gamers. Bavelier, Actman, Mani, and Focker (2012) concluded that FPS video game players allocate their attentional resources more effectively and filter out irrelevant information which improves working memory within the prefrontal cortex (PFC).

Based on the Uses and Gratification Theory (UGT; Katz, Gurevitch, & Hass, 1973), one of the most cited reasons individuals seek out video games is to enhance their mood and emotional state (Granic, Lobel, & Engels, 2014). Russoniello and colleagues (2009) discovered that games involving puzzles (e.g., Angry Birds, Bejeweled), short-term commitments, and those that are easily accessible elevate player's mood and decrease anxiety and stress. Additionally, some researchers believe that playing video games enhance intense positive emotions. These include fiero, the Italian word for feeling immense pride after succeeding in a video game challenge and achieving a flow state in which the individual has a high sense of control, but a low sense of self-consciousness (Granic, Lobel, Rutger, & Engels, 2014). Experiencing these intense positive emotions can be elaborated by Fredrickson's (2001) Broaden-and-Build theory of positive emotions. This theory states that experiencing positive emotions may broaden the number of behaviors that are deemed positive and may lead to building more supportive social relationships.

In addition to affect there have been several findings that indicate playing prosocial video games induce empathic prosocial behaviors and attitudes (Gentile et al., 2009; Greitemeyer & Osswald, 2010; Greitemeyer, Osswald, & Brauer, 2010; Greitemeyer & Mugge, 2014). While previous literature has indicated that violent video games seem to increase aggressive behavior, playing prosocial video games that are specifically designed to induce empathic and helping behavior seem to do just that. Greitemeyer, Osswald, and Brauer (2010) illustrated that exposure to prosocial video games are positively related to prosocial affect, and are negatively related to antisocial affect. The researchers conducted a study on 56 German school-aged children in which one group played a prosocial video game, compared to participants who played a neutral video game. The prosocial game increased interpersonal empathy and decreased reported pleasure at another's distress. This hypothesis was based on the General Learning Model (Buckley & Anderson, 2006) in which media effects have pervasive tendencies on social behavior by individuals observing characters engage in helping behaviors.

Negative Effects

Recent findings surrounding the negative effects of video games include possible attentional and cognitive problems (Swing & Anderson, 2014), increased aggressive thoughts and behaviors when playing games with excessive violence (i.e., cortisol arousal; Gentile, Bender, & Anderson, 2017), decreased mood, empathy, and prosocial behaviors (Greitemeyer, 2013; Greitemeyer, & Mugge, 2014), and negative impacts on school performance (Gentile, Lynch, Linder, & Walsh, 2004; Schmitt, & Livingston, 2015).

A meta-analytic review of the negative effects of violent video games investigated the impacts of violence on aggressive thoughts and behaviors (Ferguson, 2007). A literature search was conducted on peer-reviewed articles that addressed the effects of violent video games and analyzed the effect size r (i.e., correlational coefficient) on all included studies. Ferguson adjusted for publication bias which included six measures such as the avoidance of reaching a "funnel plot (e.g., asymmetrical results)," the fail-safe N, which incorporated studies that found a zero effect, and rank correlation tests that examined the relationship between the effect sizes and the standard errors of the effects. After correction for publication bias, Ferguson discovered that violent video games do not necessarily lead to aggressive behaviors but may lead to aggressive thoughts. Those that reside in specific populations and observe aggressive behaviors in their daily life may compound the violence seen while playing video games and may have affected the studies that found negative behaviors after playing. Future research should be conducted on possible moderating factors that lead directly to aggressive behaviors and not just aggressive thoughts such as negative environmental influences.

While several studies have found positive effects on affect regarding video game play, Fleming and Rickwood (2001) found no significant increases in positive affect after playing both a virtualized video game and a paper-and-pencil version in 73 children aged eight to 12 years old. Positive affect was measured by three 7-point semantic differential items (e.g., happy-unhappy, cheerful-irritable, and friendly-angry). In both conditions and in both genders, positive affect decreased after playing the game which indicated that modality did not affect mood and significantly decreased after brief game play. Additionally, Anderson and colleagues (2010) conducted a meta-analysis that examined playing video games that explored cultural differences in Japan and Western countries. Multiple meta-analytic procedures were conducted to examine the effects of violent video games on aggressive behavior and cognition, affect, physiological arousal, empathy, and prosocial behavior. This meta-analytic review included varying experimental designs including longitudinal, experimental, and cross-sectional, controlled for publication bias, and used conservative statistical controls including multiple moderator analyses. The authors discovered that exposure to violent video games is a causal risk factor for heightened aggressive behavior, decreased cognition, affect, empathy, and prosocial behavior in both areas of the world.

Similarly, Anderson and Bushman (2001) discovered in a meta-analytic review that violent video games increased aggressive behavior and attitudes in children and young adults. An increase in physiological arousal and aggression-related thoughts and feelings may also be correlated with decreased empathic concern and prosocial behavior. While research is being conducted on the positive and negative effects of console-based video games a new wave of virtual reality (VR) has increased in popularity with a swath of potential benefits for its players that may mitigate some of the previously mentioned negative effects of traditional video games.

Virtual Reality Paradigms (VRP; VRGIS) and Exergames

There has been a rapid development in mixed reality technologies or virtual reality paradigms (VPR) that integrates virtual reality and real-world perception and cognition (Gunia & Indurkhya, 2017), which is considered to be a revolution of non-sedentary video game technology. Specifically, VRGIS technology is a combination of virtual reality (VR) and geographic information system (GIS) technologies which emerged 30 years ago. This integrates three-dimensional (3D), internet-based GIS, and adopts human-computer interaction devices via personal computers, smart glasses, and smart phones (Boulos, Guerrero, Jennett, & Steed, 2017). One of the most popular adaptations of VRGIS technology-Pokémon Go an exergame (i.e., VR developed to promote physical activity)-emerged in July 2016. Developed by the same creators as Google Earth, the game relies on GPS, Wi-Fi, and mobile networks to deliver a multi-player experience by having the player walk around in the search of different characters of varying value (Bogle, 2016) to accumulate points. The game extends human perception by providing more information about other beings and by engrossing the player into their environment.

Exergames like Pokémon Go have been found to significantly improve physical health, self-esteem and affect, attention, and visual-spatial skills (Staiano, & Calvert, 2011). Similarly, augmented reality (AR) has documented improvements in the learning and retention of mathematical skills (Sommerauer & Muller, 2014), spatial abilities (Martin-Gutierrez et al., 2010), engineering (Fonseca et al., 2014), and natural science (Liu et al., 2009). Specifically, Gao and Mandryk (2012) explored the possible cognitive benefits of brief exergame play such as temporary improvements on concentration and attention. The researchers conducted two studies that compared playing 10 minutes of an exergame compared to a sedentary version. The results indicated that the exergame play induced acute cognitive benefits on two cognitive tests that measured concentration and attentional abilities after playing the exergame. Significant improvements on affect were also deduced and participants concluded that exergame play is more fun compared to traditional treadmill exercise.

Exergames such as Pokémon Go should be of focus to researchers due to the combination of cognitive, affective, and physical factors. The incorporation of VRP technology may lead to a diversion away from sedentary game play to increased interactions with the natural environment and direct others potentially leading to physical, cognitive, and affective improvements.

Benefits of Pokémon Go

Physical Activity

One of the most significant benefits of Pokémon Go are the positive health impacts (i.e., increased caloric expenditure; LeBlanc, & Chaput, 2017), cognitive improvements, and increased positive affect. Of the most cited benefit, increased physical activity, Althoff, White, and Horvitz (2016) found within 50, 000 Microsoft Band users that Pokémon Go led to significant increases in physical activity (e.g., walking) over a period of 30 days, and concluded that Pokémon Go has added a total of 144 billion steps to the total activity level of Americans. Additionally, Kogan, Hellyer, Duncan, and Schoenfeld-Tacher (2017) discovered in a large adult sample (N=269) a significant increase in physical activity when comparing pre-to post game levels, more interactions with strangers, a willingness to journey to new places, and reduced anxiety and stress about novel areas within their urban environment.

Exergame play may directly improve cognitive function due to the physiological improvements demonstrated by exercise. Straiano and colleagues (2010) discovered through an exergame that separated participants into teams, an increase in executive control skills compared to a control group with no exergame play. It has been deduced that physical activity leads to physiological changes including increased cerebral circulation and blood flow, heightened neurotransmitter availability, and the release of endorphins (Etnier et al., 2006). During exergame play the spirts of physical activity may improve the cognitive control of attention (Hillman, Pontiflex, Raine, Hall, & Kramer, 2009) through these enhanced neurophysiological mechanisms. Researchers should consider if exergames directly improve cognition or if the physical exercise acts as a moderator. As research indicates that physical activity is related to improved cognition, exergames outdoors may also significantly improve affect.

Affective Benefits

Rauschnabel, Dieck and Rossmann (2017) proposed three hedonic benefits relevant to user reactions of augmented reality (AR games): Activity, enjoyment, and reaching a flow state. The researches defined enjoyment as the extent in which a player receives enjoyment from playing the game. The theory of enjoyment is grounded in neuroscience and is based off the benefits accrued from physical activity. Human evolution has linked physical activity to stress (e.g., hunting for resources), but the human mind copes with this stress by releasing a brain derived neurotrophic factor (BDNF) protein that acts to reset the body and heal and rebuild the muscular damage from strenuous exercise (Cotman & Berchtold, 2002). Additionally, and commonly known, exercise releases endorphins that reduces stress and boosts positive affect (Heijnen, Hommel, Kibele, & Colzato, 2016). By playing Pokémon Go, the researchers hypothesized that players would experience these benefits short-term. Flow theory, proposed by Csikszentmihalyi

(2014) defined it by “the holistic experience that people feel when they act with total involvement.” When engaging in Pokémon Go, players are completely immersed in the game and attention is not directed elsewhere. Achieving a flow state on a regular basis has been reported to boost positive affect, even after leaving this cognitive state. The researchers found significant findings for their hypotheses concluding that playing Pokémon Go does have affective benefits directed from enjoyment of the game, physical activity and the resultant neurophysiological responses, and from achieving a flow state.

Related to improved positive affect, Bonus, Peebles, Mares, and Sarmiento (2017) investigated if playing Pokémon Go benefits players’ psychological well-being through improved positive affect by integrating the Broaden-and-Build theory within the framework of the Differential Susceptibility to Media Effects Model (DSMM; Valkenburg & Peter, 2013). This model organizes, extends, and integrates researcher’s understanding of media effects. There are three types of susceptibility to media effects including, social (i.e., playing with friends), developmental (i.e., healthy development through group membership), and dispositional (i.e., varying reasons for playing from person to person) that state AR games may induce cognitive and emotional changes. The examination of 399 U.S. adults aged 18-75 indicated that playing Pokémon Go was significantly correlated with increased positive affect, nostalgic reverie by remembering the positive qualities of Pokémon characters, and friendship formation. Moreover, combining the above-mentioned benefits of playing Pokémon Go may be heightened when playing outdoors in a natural or rural environment.

It is widely known that exercise outdoors improves affect (Plante, Coscarelli, & Ford, 2001) but playing Pokémon Go outdoors may provide additional benefits. Within 168 college students who played an exergame, results indicated that they maintained a more positive affect

10 minutes after discontinuation of game play compared to a control group who did not participate in the exergame (Russell & Newton, 2008). Another study by Lieberman (2006) discovered that adolescents and children sustained exergame play more so than regular exercise due to enjoying the natural environment they played in.

Social Improvements

While physical activity levels and improvements to affect have largely been examined, there is a paucity in research regarding changes in empathy after playing Pokémon Go. While no studies to our knowledge have linked empathic improvements to Pokémon Go, McQuiggan, Robison, Phillips, and Lester (2008) developed a unified inductive framework that described how virtual agents within AR games induce parallel and reactive empathy. The researchers used a game in which a trainer guided a virtual agent (i.e., the participant) through a series of tasks who encountered characters that were designed to induce feelings of empathy. The data collected included the agent's actions, the locations they traveled to, their physiological responses, and their intentions. The researchers deduced two separate types of empathy that were evoked by its players. Parallel empathy is a replication of another's affective state, while reactive empathy leads to heightened cognitive awareness and arousal which may induce affective responses that are incongruent with those of the recipient (e.g., those intended to alter negative affect). Virtual reality paradigms may be useful in deducing which type of empathy is most beneficial for player's in a VR world as well as with direct interaction with others.

Researchers have deduced certain motivational factors that may influence the affective and empathic benefits that players achieve from Pokémon Go. Marguet, Alberico, Adlakha, and Hipp (2017) determined three motivational factors in 8,000 undergraduate students at North Carolina State University. These factors included players that are explicitly seeking physical activity, being a fan of Pokémon Go, and wanting to become more sociable. The sense of belonging to each unique group was associated with varying perceived outcomes. The most significant finding was that playing Pokémon Go improved positive affect in all three groups due to being physically active, being outdoors, or focusing on a single task and not ruminating on day to day monotonies. Socialization levels significantly improved from baseline leading the authors to believe that the exergame was able to improve affect by interacting with similar others and inducing empathy through direct contact with other players. It is currently hypothesized that since Pokémon Go provides a highly social gaming experience that increased empathy and pro-social attitudes may result.

Current Study

Based on past research there are several hypotheses to the present study. The study aims to examine the possible cognitive, affective, and empathic benefits of playing Pokémon Go coupled with being in a natural environment. Of the most important components is the evaluation of visual and verbal working memory and extending the most recent research that has illustrated the positive cognitive and affective benefits of simply being outdoors in a natural environment.

Working Memory (WM)

Working memory is the cognitive system responsible for temporarily holding information available for processing and recalling immediate information (Miyake & Shah, 1999). Working memory is activated in many video games, exergames, and specifically Pokémon Go. Continual game play has been linked to improved selective attention, concentration (Ruiz-Ariza, Casuso, Suarez-Manzano, & Martinez-Lopez, 2018), executive function (EF), motor deficits, and metacognition (Hilton, et al., 2014).

There are multiple models of WM some of which incorporate concepts of attention in memory (Engle, Kane, & Tuholski, 1999) and temporal duration in performing memory tasks (Barrouillet, Bernardin, & Camos, 2004), while others suggest that WM is an activated component of long-term memory. While many researchers believe that WM is synonymous with short-term memory, most cognitive researchers believe they are separate constructs. Working memory deals with immediately stored information while short-term memory evaluates and processes information that is only temporarily held (Diamond, 2014). Short-term memory specifically refers to the capacity of storing units of information and is typically assessed by serial recall tasks involving arbitrary verbal elements such as digits or words.

The key feature of WM is its capacity to both store and manipulate information. Working memory functions as a mental workspace that can be flexibly used to support everyday cognitive activities that require both processing and storage such as mental arithmetic. However, the capacity of WM is limited and the imposition of either excess storage or processing demands during an ongoing cognitive activity will lead to a loss of information from this temporary memory system (Gathercole & Alloway, 2005).

The model used in the present study is Baddeley's model (2000) which consists of four components: the central executive, the phonological loop, the visuo-spatial sketchpad, and the episodic buffer. The central executive is responsible for high-level control and coordination of the flow of information through WM including the temporary activation of long-term memory. It has also been linked with control processes such as switching, updating, and inhibition (Bull & Scerif, 2010). The central executive is supplemented by two slave systems specialized for storage of information within specific domains. The phonological loop provides temporary storage for linguistic material and the visuo-spatial sketchpad stores information that can be represented in terms of visual or spatial structure. The fourth component is the episodic buffer, responsible for integrating information from different components of WM and long-term memory into unitary episodic representations (Baddeley, 2000). This model of WM has been supported by evidence from studies of children in school settings (Alloway & Gathercole, 2006), adult participants (Bayliss, Jarrold, Gunn, & Baddeley, 2003), neuropsychological patients (Baddeley, Hitch, & Graham, 1994), and meta-analytic neuroimaging investigations (Owen, McMillan, Laird, & Bullmore, 2005). More recent models have been created to improve WM function and have been found to be effective for cognitive improvement (Jaeggi, Buschkuehl, Jonides, & Shah, 2011). Other researchers have used the current model of WM in the context of video game design in the classroom (St Clair-Thompson, Stevens, Hunt, & Bolder, 2010), for those diagnosed with ASD and ADHD (Geurts, Luman, & Meel, 2008), and in the development of exergames and video games to improve EF and WM (Gao & Mandryk, 2012).

Attention

Another component of cognition under examination is attention, the ability to selectively process information. Cho, Ku, Jang, Kim, and Lee (2004) illustrated the effective use of VR combined with cognitive training programs in improving the attention span of children and adolescents with impulsivity and attentional problems. Thirty participants were randomly assigned to a VR group (i.e., using a head-mounted display combined with cognitive training), a non-VR group (i.e., no head-mounted display but cognitive training), and a control group (i.e., no head-mounted display and no cognitive training) over the course of eight sessions over two weeks. The researches deduced significant findings in improved attention and lowered impulsivity in the VR group. Similarly, Pokémon Go may benefit those that have problems with attention and controlling impulsivity due to the sustained attention needed during game play and upregulating WM.

Cognitive Benefits of Interacting with Nature

There is a large body of research that suggests interacting with nature has restorative effects on health, affect, and cognition (Berman, Jonides, & Kaplan, 2008). The cognitive evidence stems from attention restoration theory (ART; Kaplan, 1995) that states attention is separated into two components: voluntary attention (e.g., directed by cognitive-control processes) and involuntary attention (e.g., attention is automatically captured by intriguing stimuli). Interacting with environments that are satiated with interesting stimuli (e.g., bodies of water or sunsets) invoke involuntary attention which permit voluntary or directed-attention a chance to relax and rejuvenate. Different than natural or rural environments, urban environments contain bottom-up stimulation (e.g., avoiding cars or large buildings) that instinctually capture attention and require directed-attention to overcome the immediate stimulation. While Pokémon Go can be played anywhere and its focus is to be played outdoors, many of its players play in strictly urban environments compared to natural or rural due to location restrictions such as their home or occupation (Colley et al., 2017).

Additionally, Berman, Jonides, and Kaplan (2008; see also Berman et al., 2012) demonstrated that college students who walked in a park had higher WM scores (measured by backward digit recall) compared to those who walked in a traffic-heavy downtown area. Wells (2000) also reported the cognitive benefits of a natural environment for children. Using a standardized scale to capture behaviors associated with ADHD, Wells found that children who moved to homes with more rural and natural settings had higher levels of attention after the move. This increased physical activity can also be linked to positive affective benefits due to the combination of being outdoors (Berman, 2006) and actively interacting with one's environment. Pertinent to this study is an extension of ART and the benefits of being outdoors, coupled with the exergame Pokémon Go to examine the added possible improvements in cognition, affect, and empathy.

Hypotheses

The hypotheses for the current study are as follows (See figures 1 and 2):

H_1: Playing Pokémon Go outdoors will improve visual and verbal WM and attention beyond just being in nature.

H_2: Pokémon Go will improve affect coupled with playing in a natural setting.

H_3: Playing Pokémon Go will induce empathetic and pro-social attitudes in its players due to its highly social design.

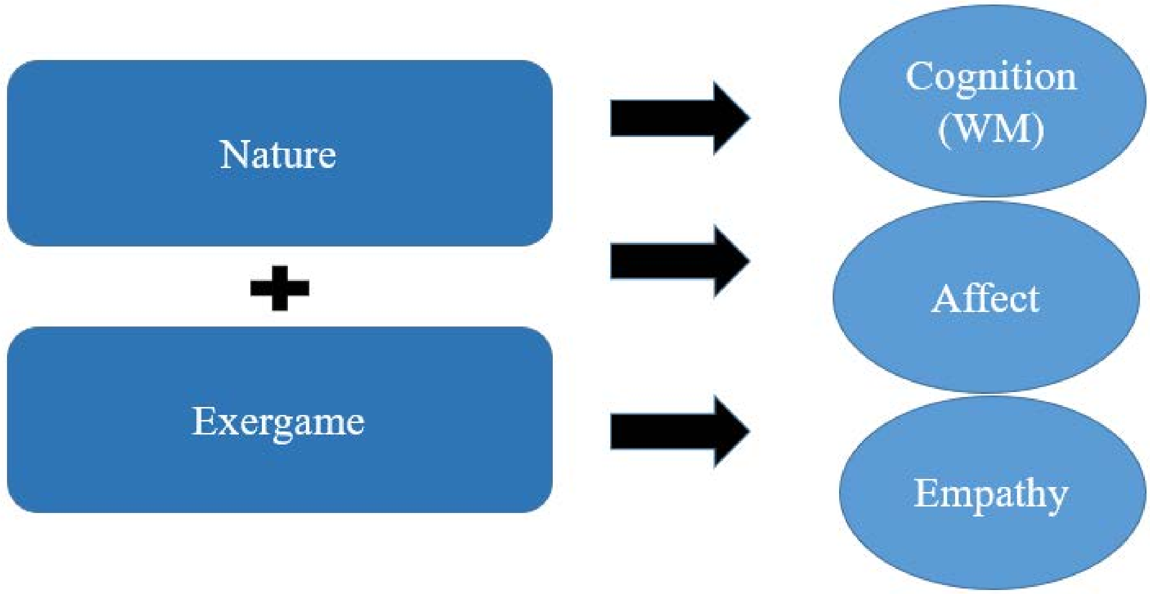

Figure 1 . Combining Pokémon Go with being outdoors to observe cognitive, affective, and social improvements (e.g., empathy).

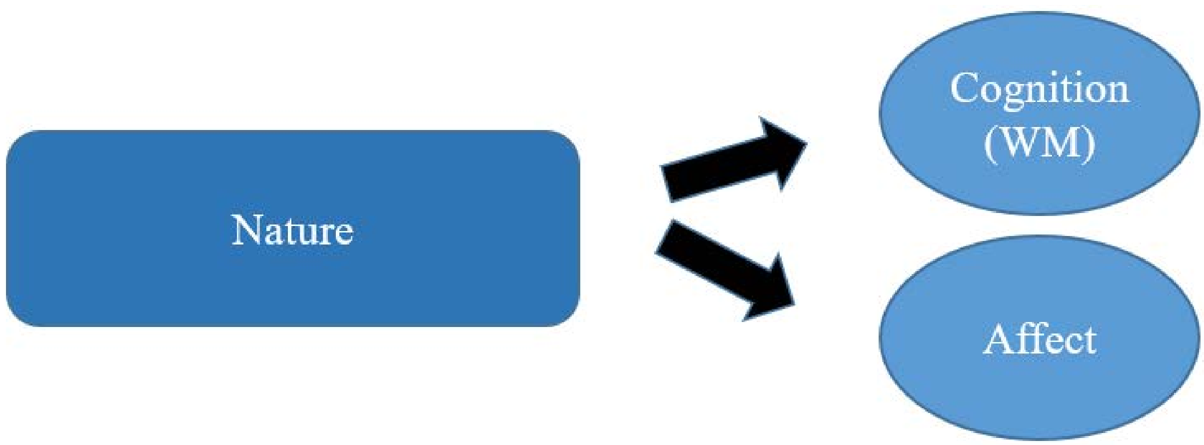

Figure 2 . The benefits of just being outdoors (without Pokémon Go) and the cognitive and affective benefits.

Method

Participants

Fifty-nine students from a public Florida university participated in this study in exchange for class or extra credit (78% females, 22% males). All participants were between the ages of 18 and 35 years (M_{age} = 23.33 years; SD: 3.70). Of those who responded, the majority were in their junior year (46%), and 20% were seniors. The participants were primarily Caucasian (42%), but also African American (5%), Latin/Hispanic (8.5%), and Asian (5%). All participants gave informed consent as overseen by the university's institutional review board.

Participants were also asked about the amount of time spent outside per day, and the majority responded that they spent 60 to 90 minutes outdoors (40%), 19% indicated they spent less than 30 minutes outdoors, 33% spent 30 to 60 minutes outdoors, and 8% spent more than 120 minutes outdoors. The majority of participants were in both urban and rural environments when outdoors (61.5%), 23% in primarily urban settings, and 15.5% in primarily rural areas. When asked about their familiarity with Pokémon Go, 34.6% had played since its release in 2016, while 54% had for less than one month. Most participants reported playing in both urban and rural environments (59.6%), with approximately 82% of the participants spending under 60 minutes a day playing.

Materials

Working memory was assessed using the computerized AWMA. The AWMA (Alloway, 2007a) consists of tests measuring verbal short-term memory, and visual working memory. The three verbal short-term memory measures were digit recall, word recall, and non-word recall. In each test, the participant hears a sequence of verbal items (digits, one-syllable words, and one-syllable non-words, respectively) and has to recall each sequence in the correct order. For individuals aged 22.5 years, test-retest reliability is .88, .89, and .69 for digit recall, word recall, and non-word recall, respectively.

The three visual working memory measures were listening recall, backward digit recall, and counting recall. In the listening recall task, the participant is presented with a series of spoken sentences, has to verify the sentence by stating “true” or “false,” and recalls the final word for each sentence in sequence. In the backward digit recall task, the participant is required to recall a sequence of spoken digits in the reverse order. In the counting recall task, the participant is presented with a visual array of red circles and blue triangles. He or she is required to count the number of circles in an array and then recall the tallies of circles in the arrays that were presented. For individuals aged 22.5 years, test-retest reliability is .88, .83, and .86 for listening recall, counting recall, and backward digit recall, respectively.

Sustained Attention. All participants completed a computerized assessment of visual sustained attention, which measures vigilance over time. The test used in the present study was in accordance with continuous performance test protocols. These protocols required the participant to be prepared to respond to an infrequent target (a cat-meow) and a dog (bark-noise) over an extended period which measures both sustained attention and inhibitory control. Scores were calculated based on the number of correct targets detected (HITS) and the number of false alarms (i.e., incorrect responses to nontarget stimuli; FAs). In the visual test, digits between 1 and 7 were presented on a screen, and the participants were instructed to press a button as quickly as possible every time a 1 or a 5 appeared. The auditory task was identical to the visual version except that the participants heard the digit spoken over a set of calibrated headphones. The auditory stimuli consisted of recordings of digits between 1 and 7 being read in a quiet recording studio by a female adult whose native language was Brazilian Portuguese (phonetic transcription of the stimuli: ['uw, 'do^{j}s, 'tejs, 'k^{w}at, 'sijk, 'se^{j}s, 'sɛtʃi]). The duration of the recorded digits was fixed at approximately 500 msec regardless of the number of syllables in the numeral. The stimuli were presented binaurally at a comfortable listening level that corresponded to a sound pressure level of 70 dB (A). The duration of each test was approximately six minutes, and each test consisted of 210 trials that were divided into three blocks of 70. The division of the tests into three blocks enabled an investigation into the vigilance decline effect, which measures the decline in performance over the course of the experiment. For each trial, the digit appeared during the first 500 msec of the trial and was followed by an inter-stimulus interval of 1000 msec. Three performance measures were compared across blocks: HITs, FAs and RTs (i.e., response times).

There were two different versions, which were switched over the course of four blocks of single digits in the following sequence: Version A, Version B, Version A, and Version B. In Version A, the participants responded to the computer screen by pressing the spacebar for every number presented except the number 5. In Version B, participants responded to the computer screen by pressing the spacebar only for the number 5. Participants responded to both versions A and B. Each of the four blocks consisted of 180 trials, with the target and distractor numbers randomly presented in the center of the screen for 500 milliseconds. After the number presentation, there were three response latencies of 1000, 1500, or 2000 milliseconds that were randomized across trials. Each block lasted for three minutes and the entire attention test, which included practice sessions, took approximately 15 minutes to complete. The following scores were recorded for each of the four blocks. First, the accuracy of responses was recorded as a percentage. A measure of false positives (errors of commission) and a measure of omission errors were also recorded as a percentage.

The Positive and Negative Affect Schedule (PANAS) is comprised of two affect scales that measure positive and negative affect. Ten descriptors are used for each positive affect and negative affect questions. Participants are required to respond to a 20-item inventory using a 5-point scale that ranges from very slightly (e.g., 1) to extremely (e.g., 5; Watson & Clark, 1988). Reliability and validity have been reported to be moderately good. For the positive affect scale, Cronbach's alpha coefficients ranged from 0.86 to 0.90, and the negative affect scale ranged from 0.84 to 0.87. The test-retest correlations are 0.47-0.68 for positive affect and 0.39-0.71-0.71 for negative affect.

The Interpersonal Reactivity Index (IRI) was designed to measure empathy as the "reaction of one individual to the observed experiences of another (Davis, 1983)." Twenty-eight items are answered on a 5-point Likert scale ranging from this "does not describe me well" to this "describes me very well." The IRI has four subscales, each made up of seven items that include Perspective Taking (i.e., the tendency to spontaneously adopt the psychological point of view of others), Fantasy (i.e., respondent's tendencies to transpose themselves imaginatively into the feelings and actions of fictitious characters in books, movies, and plays), Empathic Concern (i.e., assesses other oriented feelings of sympathy and concern for unfortunate others), and Personal Distress (i.e., measures self-oriented feelings of personal anxiety and unease in tense interpersonal settings). Reliability has been found to be high with Cronbach's alphas of 0.89, 0.90, 0.92, 0.94 respectively for each subscale (Konrath, 2013).

Procedure

Each participant completed two days of testing on an individual basis, approximately one week apart and were randomly assigned to conditions. In Phase 1 (Pokémon Go Condition), participants completed the demographic questionnaire, the AWMA, the IRI, the PANAS, and were then instructed to go outdoors for approximately one hour and play Pokémon Go. They returned from being outdoors and repeated the same assessments. In Phase 2 (Walk/Nature condition), the same participants returned and again completed the AWMA, the IRI, the PANAS and were then instructed to walk around on campus for approximately one hour without playing Pokémon Go and not looking at their phones. Participants returned and completed the same assessments in the respective order. All participants and in each phase/condition were informed to remain around trees, surrounding foliage, and water sources (e.g., wooded areas, and ponds) while playing or walking. The participants were provided with a map of the university grounds displaying the grassy and wooded areas of campus. The following semester the experiment was counterbalanced to control for the effects of either first playing Pokémon Go or walking. Participants first walked without playing Pokémon Go during Phase 1, and Phase 2 instructed participants to play Pokémon Go. Administration of the assessments remained constant. Participants were debriefed at the end of Phase 2 in each counterbalanced condition. All participants were tested within a five-month period to control for the effects of seasonal differences.

Results

H_1: Playing Pokémon Go outdoors will induce cognitive improvements including improved visual and verbal WM and attention compared to just being in nature.

<Table 1>

Descriptive statistics for WM are provided in Table 1. A 2 (Nature: Pokémon Go vs. Walk) x 2 (Time: Pre vs. Post) repeated measures analysis of variance (ANOVA) was conducted on verbal WM scores. There was not a significant difference in verbal WM scores as a function of nature, $F < 1$, but there was of time, $F(1, 38) = 14.35$, $p = .001$, $\eta^2_p = .27$; and the interaction was significant, $F(1, 38) = 11.46$, $p =.002$, $\eta^2_p = .23$. Post-hoc comparisons indicated that the verbal WM scores were higher in the post-Pokémon Go condition, compared to the pre-condition ($p <.001$); there was no significant change in scores in the Walk condition ($p =.67$). Additionally, there were no significant differences associated with the order of interacting with nature (i.e., playing Pokémon Go first or second). Thus, the cognitive benefits of nature improved verbal WM beyond any potential familiarity or practice effects of the task.

A 2 (Nature: Pokémon Go vs. Walk) x 2 (Time: Pre vs. Post) repeated measures analysis of variance (ANOVA) was conducted on visual WM scores. There was not a significant difference in visual WM scores as a function of nature, $F(1, 30) = 1.36$, $p =.253$; or time, $F < 1$; and the interaction was not significant, $F < 1$.

<Table 1>

Descriptive statistics for attention are provided in Table 1. A 2 (Nature: Pokémon Go vs. Walk) x 2 (Time: Pre vs. Post) repeated measures analysis of variance (ANOVA) was conducted on HITs for the attention task. There was not a significant difference in HITs as a function of nature, $F(1, 39) = 1.80$, $p =.187$; or time, $F(1, 39) = 1.12$, $p =.297$; and the interaction was not significant, $F < 1$.

A 2 (Nature: Pokémon Go vs. Walk) x 2 (Time: Pre vs. Post) repeated measures analysis of variance (ANOVA) was conducted on False Alarms for the attention task. There was not a significant difference in false alarms as a function of nature, $F < 1$; but there was for time, $F(1, 39) = 11.31$, $p =.002$, $\eta^2_p = .23$; and the interaction was significant, $F(1, 39) = 5.31$, $p =.027$, $\eta^2_p = .12$. Post-hoc comparisons indicated that false alarms were significantly less in the post-nature Pokémon Go condition, compared to the pre-condition ($p =.002$); there was no significant change in scores in the Walk condition.

H_2: Pokémon Go will improve affect coupled with playing in a natural setting.

<Table 2>

Descriptive statistics for affect are provided in Table 2. A 2 (Gaming: Pokémon Go vs. Control) x 2 (Time: Pre vs. Post) repeated measures analysis of variance (ANOVA) was conducted on the positive affect scores (PANAS). There was not a significant difference in positive affect scores as a function of gaming, $F < 1$; nor of time, $F < 1$; and the interaction was not significant, $F < 1$.

A 2 (Gaming: Pokémon Go vs. Control) x 2 (Time: Pre vs. Post) repeated measures analysis of variance (ANOVA) was conducted on the negative affect scores. There was not a significant difference in the negative scores as a function of gaming, $F < 1$; but there was for time, $F(1, 35) = 11.48$, $p = .002$, $\eta^2_p = .25$; and the interaction was not significant, $F(1, 35) = 1.12$, $p = .297$. Post-hoc comparisons indicated that negative affect decreased in the Walk condition ($p = .001$) but not in the Pokémon Go condition ($p = .127$).

H_3: Pokémon Go will induce empathetic and pro-social qualities in its players due to its highly social design.

<Table 2>

Descriptive statistics for empathy are provided in Table 2. A series of 2 (Gaming: Pokémon Go vs. Control) x 2 (Time: Pre vs. Post) repeated measures analysis of variance (ANOVA) were conducted individually on each of the IRI subscales. For Empathic Concern, there was not a significant difference in scores as a function of gaming, $F(1, 37) = 2.01$, $p = .165$; nor for time, $F(1, 37) = 3.07$, $p = .088$, and the interaction was not significant, $F < 1$. For Perspective Taking, there was not a significant difference in scores as a function of gaming, $F < 1$; nor of time, $F < 1$; and the interaction was not significant, $F < 1$. For the Fantasy Scale, there was not a significant difference in scores as a function of gaming, $F < 1$; nor of time, $F < 1$; and the interaction was not significant, $F < 1$. For Personal Distress, there was not a significant difference in scores as a function of gaming, $F < 1$; but there was for time, $F(1, 37) = 5.28$, $p = .027$, $\eta^2_p = .125$; the interaction was not significant, $F < 1$. Post-hoc comparisons indicated that Personal Distress scores decreased in the Walk condition ($p = .036$) but not post-Pokémon Go ($p = .181$).

Discussion

Working Memory and Attention

There were several main findings from this study. Regarding WM, verbal but not visual improved after participants played Pokémon Go in a natural environment. These WM improvements were not evidenced when the participants only walked in the same natural setting. Additionally, false alarms reduced after the Pokémon Go condition, but not in the Walk/Nature condition.

One explanation for why verbal WM scores were significantly higher after playing Pokémon Go may be the similarities in playing Pokémon Go and the actions necessary to complete a WM task. In a WM task the participant is instructed to examine a given piece of information and then execute a plan or make a decision based on the information given. This is similar to Pokémon Go in which a player scans the environment while observing the overlay of the game on their phone, actively decides which stimuli is most pertinent, and acts on either catching the character or looking for one of higher value. Playing Pokémon Go is strategic in how it engages the player to be constantly looking for characters to increase their points which provides the player with opportunities to engage in activation of their WM. Additionally, verbal WM may have increased after game play due to the social experience the game provides. Due to the university setting many of the students knew each other and played the game alongside their peers. While they were playing, they may have discussed their game play which may have led to enhanced processing and encoding verbal WM information.

Surprisingly, the data indicated that visual WM did not increase after playing Pokémon Go. One reason for this was that the majority of participants were in their later years of their undergraduate education. They may have been more familiar with the surroundings of the university and did not need to engage in high visual WM encoding due to extensive knowledge of the university's natural outdoor environment (Schmidt, Vogel, Woodman, & Luck, 2002). Additionally, Xie and Zhang (2017) discovered that long-term memory (LTM) can influence short-term memory (STM) in Pokémon Go players. They illustrated that in a Pokémon Go visual STM change detection task, participants remembered more first-generation Pokémon characters compared to the newer characters that have been recently implemented into the game design. Several alternative explanations were controlled for including prior video game experience, preference for certain characters, and visual STM encoding scores. Prior stimulus experience to the first-generation characters demonstrated a strong link between activation of LTM and STM. While controversial, many researchers believe that visual STM is similar or identical to visual WM in which the current participants may have been more familiar with certain familiar characters they encountered which may have led to no change in their visual WM performance.

The other key finding regarding cognition was that the number of false alarms was reduced after playing Pokémon Go. False responses in an attention task are thought to be an indication of impulsivity (Riccio et al., 1996), so the current pattern suggests that participants were better at discriminating specific stimuli and demonstrated better impulse control. There is evidence to suggest that WM is associated with behavioral inhibition in which upregulating WM improves inhibitory control (Barkley, 1997). This research may have implications for children with behavioral problems as an immersive augmented reality environment may reduce impulsiveness.

Moreover, the current WM and attention findings are similar to meta-analytic results illustrated by Stanmore, Stubbs, Vancampfort, de Bruin, and Firth (2017) in their examination of exergame interventions conducted outdoors. The benefits of exergames were explored in 926 clinical and non-clinical participants and presented the first meta-analytic review for the effects of exergames on cognition. The cognitive benefits of exergames were found in both populations, with significant findings in overall global cognition, improved inhibitory control, cognitive flexibility (i.e., task switching), EF, attentional processing, and visuospatial skills. In support of the current study no significant findings were found for verbal WM, although few studies have examined the individual components of WM and Pokémon Go. Additionally, the authors explored the benefits of exergames beyond regular exercise and discovered moderate cognitive benefits from exergame interventions. In line with the current study, the authors concluded that coupling exergames, physical exercise (e.g., walking), and being outdoors in a natural environment significantly improved cognition more so than just regular exercise without exergames. Additionally, the cognitive benefits of exergames may be explained by combining a cognitive demanding task with exercise and the resulting physiological effects of neurogenesis by preserving and stimulating neuronal growth within the hippocampus (Fabel, Wolf, Ehninger, Babu, Galicia, & Kempermann, 2009). Overall, the WM and attention findings indicate that playing Pokémon Go in a natural environment does improve verbal WM and leads to enhanced attention and inhibitory control. It is possible that these improvements are a combination of the nature of the game, such as employing certain strategies that upregulates WM, the restorative effects of nature, and physical exercise.

Affect

There was a decrease in negative affect after participants played Pokémon Go, but not in the Walk/Nature condition, and no increases in positive affect in both conditions. One reason for the decrease in negative affect may be due to Pokémon Go reducing negative emotions and stress. The Uses and Gratification Theory (UGT; Ruggiero, 2000) states that people choose certain forms of media and gaming experiences in a goal-directed fashion that ultimately provides desired idiosyncratic benefits. Participants may find reductions in stress and negative affect from Pokémon Go due their original choice to play the game combined with the player escaping from their daily worries (Zolkepli & Kamarulzaman, 2011). In a similar vein, several studies have demonstrated that college and university campuses have students with heightened levels of depression and anxiety (Furr, Westefeld, McConnell, & Jenkins, 2001; Watkins, Hunt, & Eisenberg, 2011). The reduction in negative affect after playing Pokémon Go may have resulted from participants who were experiencing depressive or anxious thoughts. Future studies on college campuses should control for such psychopathologies.

A reason for the lack of increase in positive affect may be the reliance college students have on their cell phones and the anxiety that can arise if usage is restricted. In the Walk/Nature condition, participants were not able to use their phones which may have induced anxiety and stress either decreasing positive affect or increasing negative affect. These current findings are supported by Lepp, Barkley, and Karpinski (2014) who investigated the Pew Center's Internet and American Life Project (2010) which indicated that college students are the most rapid adopters of cell phones with the highest frequency of use. In 490 college students the authors discerned two separate hierarchical linear path models which demonstrated that cell phone use was related to anxiety and decreased life satisfaction. Additionally, James and Drennan (2014) found that being without a cell phone can result in feelings and behaviors that resemble addiction withdrawal such as depressive feelings, compulsions, and heightened anxiety. Future studies should allow players to use their phone in the Walk/Nature condition to control for the possible negative side effects of restricted use.

Empathy

Playing Pokémon Go did not lead to an increase in empathy; however, some aspects of emotional empathy were different in the Walk/Nature condition. The *Personal Distress* ("self-oriented" feelings of personal anxiety and unease in tense interpersonal settings) scores decreased after being in nature but not post-Pokémon Go. It was originally hypothesized that due to the highly social nature of Pokémon Go, interactions with others would increase empathic concern due to more frequent connectedness with strangers (Jungselius, Weilenmann, & Rost, 2015). Several reasons for the current findings may be due to its original design for single-player game play, unrealistic game characters, and the restorative effects of nature on positive emotions.

While the player is collecting as many characters as possible, they are only accumulating points for themselves. Although Pokémon Go can lead to more interactions with strangers, the social connections demonstrated here were most likely not strong enough to facilitate increases in empathy. The design of Pokémon Go does not induce emotional responses from its players and characters within the game are never seen in distress. If the game were redesigned away from autonomous game play and included a cooperative group that aided characters in distress, then our original hypothesis may have been supported.

Interestingly, several months after the game's release it became possible for players of a certain ability to join a team to accumulate points not for each individual, but for the group as a whole. After reaching level five the player has the option to join team *Valor, Mystic*, or *Instinct*- each of which have varying philosophies of game play. The benefit of reaching level five is the possibility of combined efforts in catching a Legendary Pokémon (e.g., a character with the highest value). By being on a team you commonly must fight one or two of the other teams on behalf of your own to protect your team's collected characters which undoubtedly adds a competitive component (Tapsell, 2017). While it seems that Pokémon Go is becoming more competitive, added elements such as group cooperation and the promotion of helping characters that require aid may induce empathic concern. This idea is supported by Morschleuser, Maedche, and Walter (2017) in which they explored how cooperative AR games can promote positive attitudes towards cooperating with others and cultivating the desire to work in a group to achieve a goal. Two-hundred and six users of the AR game *Ingress* played in teams over the course of eight weeks. The results indicated that cooperative games induced "we intentions" through positively increasing group norms, social identity, attitudes toward cooperation, and anticipated positive emotion. The authors concluded that researchers, teachers, parents, or practitioners that are interested in looking to cultivate cooperation should utilize games inspired by cooperative game design rather than autonomous achievement. It is worth noting that while the present findings did not indicate increases in empathy levels, other researchers have demonstrated that playing Pokémon Go cultivates a sense of belonging to a community and promotes social interactions (Zach & Tussyadiah, 2017).

Another reason for the lack of significant changes in empathy may have been due to the unrealistic nature of the Pokémon Go characters. Empathy is typically induced by human and/or animal interactions and the characters in Pokémon Go are highly animated, magical, and fantastical, and only minimally represent actual animals. To demonstrate the importance of realism in AR to induce empathy, Gillath, McCall, Shaver, and Blascovich (2008) utilized Virtual Environment Technology (VET) a type of AR with high ecological validity (i.e., representative of the natural world). The researchers conducted two studies in which participants navigated through a virtual world in which they would meet people, some who needed help. The results indicated the more realistic the depicted character was in the VET, the more likely the participant was to aid the character in need and experienced higher levels of personal distress. On the other hand, Peysakhovich and Rand (2017) discovered that playing Pokémon Go increased in-group bias from those that played within a similar gaming group, and increased out-group bias in those that did not not based on trivial groupings. The researchers used over 900 Pokémon Go players randomly matched with other players to participate in a Prisoner's Dilemma Task. It was illustrated that players were more inclined to participate and be cooperative when they were matched with players of their same group, which was deemed as an important moderator of the in-group bias effect.

The decrease in *Personal Distress* scores in the Walk/Nature condition may be similar to past findings that have illustrated being in nature leads to more empathic thoughts and behaviors due to its restorative components. Zhang, Piff, Iyer, Koleva, and Keltner (2014) discovered in four studies that beautiful nature compared to less beautiful nature increased prosocial behavior. The researchers found that natural beauty moderates positive emotions and prosociality and participants exhibited heightened prosocial tendencies, increased levels of agreeableness, enhanced perspective taking in both conditions, and decreased levels in personal distress when seeing another person in need.

Limitations

One of the most significant limitations to the current study was the significant lack of power (N = 59) which may have resulted in the null findings. A power analysis was conducted in G*Power on a repeated measures ANOVA with four measurements, a power of 0.80, an alpha level of 0.05, and small effect size (F = 0.10), that determined a required sample size of 102 participants. Future studies should obtain a higher number of participants before running statistical analyses (Faul et al., 2013). The current study employed a cross-sectional design, but a longitudinal design may be better to examine the long-term effects of Pokémon Go on WM, attention, affect, and empathy. Research has demonstrated that improvements in WM are not typically observed in short sessions (Jaeggi, Busschkuehl, Jonides, & Perrig, 2008). A more optimal design would have participants play for longer than one-hour periods, become extremely familiar with the game design, and play over the course of 8 weeks or more.

To better examine verbal WM, future studies should control for interactions with others while playing. If some participants are placed into teams and instructed to discuss their game play, verbal WM may be better examined and controlled. Regarding visual WM, research should inquire into the participants familiarity with the university's surroundings to control for participants that may view more novel stimuli compared to others. Future questions should also be posed about how much time participants spend on campus. Observing more interesting stimuli such as the ponds and bamboo garden may have increased WM processing in some participants due to a first-time experience, compared to others who may have viewed the natural stimuli on a regular basis.

Due to the highly social nature of Pokémon Go, empathy and pro-social attitudes may be better assessed by controlling the social nature of the participants. In the current study, some participants may have played the game autonomously and others may have played in groups which may have influenced the IRI scores after direct interaction with others. Moreover, a different scale than the IRI may have better examined the intended constructs of empathy. The original goal of the experiment was to examine improvements or changes in empathy over a short period of time after a brief intervention. The IRI measures stable empathic traits in participants which are unlikely to change after a brief one-hour period. Empathy may be better examined through a scale that examines specific *states* of empathy. Several other scales such as the Helping Attitudes Scale (HAS; Nickell, 1998) or the Dissociation of Cognitive and Emotional Empathy: Multifaceted Empathy Test (MET; Dziobek et al., 2008) are designed to understand and share another person's immediate emotional or cognitive state compared to the evaluation of long-standing empathic traits of the individual.

While research has demonstrated that being in nature can improve affect (Berman, 2006), the present study did not indicate that being in nature alone affected positive or negative affect. Future studies should have participants play in both natural (e.g., rural) and urban environments, and for extended periods of time. The current study had participants outside for approximately one hour which may have been too limited to examine changes in affect. Participants that spend much time in urban (e.g., downtown Jacksonville, FL) environments may have experienced a change in affect simply due to the restorative effects of the university's surrounding foliage and ponds (natural environment). Those that typically spend time outdoors at the university or in rural areas may not have shown any affective changes due it being their typical experience. Additionally, no research to our knowledge has examined the effects of playing Pokémon Go indoors compared to outdoors. By employing this design, we may have seen significant differences in WM, attention, and affect due to participants in the indoor condition not experiencing the restorative benefits of being outdoors.

While there is evidence that Pokémon Go may be a potentially efficacious therapeutic tool there are several safety and privacy limitations of Pokémon Go. Lovelace, Sharma, and Vassiliou (2016) reported that since the game's introduction road traffic incidents due to distraction by the game, muggings, and predation have increased in players. Additionally, smart phone holders should be aware that their location is being tracked by the GPS's positioning technology. Policymakers, researchers, teachers, and parents should be wary when adopting mobile AR games for beneficial purposes.

Future Directions

To examine if Pokémon Go can be used as a tool to cultivate empathy and promote pro-social attitudes and behaviors, research is currently being conducted on the University of North Florida and Refugee populations. It was demonstrated in a previous German study that after the large influx of Syrian Refugees, a VRP exergame forced German natives to come face-to-face (i.e., familiarity effect/Contact Hypothesis; Islam & Hewstone, 1993) with their out-group (Refugees) and were more likely to practice pro-social behaviors compared to those that did not play in an area where Refugees were present (Neuenhaus & Aly, 2017). The researchers grounded the study on two critical problems demonstrated by German natives and Refugees: (a) the Refugees did not have much contact with the locals and (b) the Refugees felt that the Germans did not wish to interact with them. The University of North Florida has a large Refugee population not just from Syria, and there is the possibility that Pokémon Go may cultivate more connectedness and pro-social attitudes on campus between the two populations.

Beyond empathy, positive video games without the incorporation of violence have been used therapeutically to aid several types of mental health disorders including schizophrenia, ADHD, PTSD, Autism (ASD) and anxiety (Fenandez-Aranda et al., 2012; Wilkinson, Ang, & Goh, 2008). In addition to the common video game, the current findings on the exergame Pokémon Go may also have important implications for individuals who struggle with cognitive deficits, other mental health impairments, and may be presented and implemented as a valid therapeutic tool.

A study conducted by Tateno, Skokauskas, Kato, Teo, and Guerrero (2016) found that Pokémon Go helped youth in Japan with severe social withdrawal (e.g., hikikomori). A survey in Japan indicated that the total number of youth with severe social withdrawal was 230,000, identifying a serious mental health concern for Japanese adolescents and emerging adults. While unlike other video games where young people play within their homes, Pokémon Go forces them to adventure outside. The authors noted that similar to a token economy system for those with ADHD used by Japanese psychiatrists, collecting Pokémon Go characters provides a sense of accomplishment, boosts self-esteem, and alleviates the fears of leaving the home associated with hikikomori. In a similar vein, Van Ameringen, Simpson, Turna, Patterson, and Pullia (2017) demonstrated significant improvements in social behavior function and a sense of well-being after playing. One-hundred and fifty-two participants played Pokémon Go for 11 weeks and spent a mean seven hours a week playing. Results indicated that 85% spoke to more unfamiliar people, 76% spent more time with friends, 41% made new friends while playing, and 29% reported an improved sense of well-being. Those that had a history of mental health impairments (e.g., depression, generalized anxiety disorder, ADHD, and agoraphobia) spent more time playing compared to those that did not have mental health problems.

Additionally, Parsons and Mitchell (2002) illustrated potential benefits using VR in social skills training for people with ASD. For those with ASD, approaches to aid in teaching social behavior cues and demands typically use a theory of mind (ToM) or behavioral approach. These approaches have demonstrated limitations, but the authors noted that the integration of both approaches coupled with VR may be beneficial. Their review found that behavioral and ToM approaches achieve some success, but there is continual failure with those with ASD to generalize learned behaviors to novel environments. Virtual reality may be an ideal tool for those with ASD to practice newly learned behavior in comfortable and safe role-play situations that permit the repetition of tasks.

More generally, the majority of those that play Pokémon Go are teens and young adults who are sometimes difficult to engage in cognitive behavioral treatments (CBT) for depression and anxiety disorders (Kingery, Roblek, Suveg, Grover, Sherrill, & Bergman, 2006). Exergames like Pokémon Go may be advantageously holistic by avoiding prescribing young people medications and is a free and readily accessible application for practitioners that may alleviate symptoms of mental health impairments.

Overall, the current results suggest that while Pokémon Go was not designed to directly improve cognition, game play does seem to improve some aspects of WM and attention. Those that wish to improve their cognitive capacities may find the game efficacious. Other games that have been designed to improve WM, attention, and EF (e.g., Lumosity) are relatively costly, time consuming, and have not demonstrated significant evidence for cognitive improvement (Redick et al., 2013). While previous studies have demonstrated that Pokémon Go, other exergames, and VR do improve affect the current study specifically found an improvement in negative affect. Pokémon Go may better assist those that are feeling down and be more effective in aiding those with more extreme forms of negative affect such as depression lending its use as a possible therapeutic tool.

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Table 1

Descriptive Statistics of Working Memory and Attention Performance

	Pokémon Go		Walk	
Measure	Before Interaction	After interaction	Before Interaction	After Interaction
WM: Verbal	3.36 (3.83)	6.64 (4.55)	4.85 (3.78)	5.23 (3.74)
WM: Visual	8.48 (3.13)	8.39 (3.78)	7.74 (3.83)	7.68 (3.85)
Attention:	8.45 (5.37)	8.67 (6.53)	9.0 (5.88)	10.02 (5.91)

Note: WM = working memory

Table 2

Descriptive Statistics of Positive and Negative Affect, and Empathy Scores

	Pokémon Go		Walk	
Measure	Before Interaction	After Interaction	Before Interaction	After Interaction
Affect: Positive	27.75 (10.38)	28.28 (10.62)	28.64 (9.38)	27.78 (10.65)
Affect: Negative	19.47 (7.77)	17.00 (7.48)	18.50 (9.04)	17.58 (8.35)
Empathy: Fantasy Scale	2.25 (.66)	2.30 (.65)	2.24 (.66)	2.30 (.66)
Empathy: Empathic Concern	2.55 (.42)	2.49 (.48)	2.38 (3.58)	2.36 (4.32)
Empathy: Perspective Taking	2.36 (.50)	2.41 (.50)	2.32 (.52)	2.31 (.57)
Empathy: Personal Distress	1.60 (.58)	1.51 (.47)	1.55 (.51)	1.45 (.48)

Note: Positive and Negative affect derived from PANAS scoring, and empathy scores derived from the IRI.

Curriculum Vitae

Rachel Carpenter received her undergraduate degree from the University of Colorado, Colorado Springs in 2015 before moving to Florida and attending the University of North Florida for her Master's Degree in Psychological Science. While attending UNF, she was the manager for Dr. Katherine Hooper's functional-near infrared spectroscopy (fNIRS) lab where she delegated roles to undergraduate research assistants, developed and maintained oversight of multiple projects, and worked on grant writing. The lab is currently working on a publication investigating the use of fNIRS to examine laterization in the brain based on positive and negatively valenced images and the resultant change in hemoglobin levels. Additionally, fNIRS is being used cross-collaboratively with UNF's engineering department and a study with the Mayo Clinic.

In addition to the lab, Rachel worked closely with Dr. Tracy Alloway and first-authored a publication in the *Journal of Psychoeducational Assessment* investigating the methodological differences between paper and computer-based testing of the Alloway Working Memory Assessment (AWMA). She additionally has several other publications under revise and resubmit examining the affective and cognitive benefits of Pokémon Go, false memories and cognition, and Zimbardo's theory of depression and working memory.

Rachel has worked in many different clinical realms from substance abuse rehabilitation centers, in-state psychiatric hospitals, and bio-feedback centers. She plans to attend Florida State University in the fall of 2018 to pursue a doctoral degree in Counseling Psychology.