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The Relationship Between Augmented Reality Games and Well-Being Outcomes: A Self-Determination Theory Approach

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The Relationship Between Augmented Reality Games and Well-Being Outcomes: A Self-Determination Theory Approach

by

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Abstract

Video games have become a prevalent source of media entertainment globally. Their popularity has made them a topic of interest to researchers, medical professionals, educators, politicians, and many more who are concerned about the role and impact video games have in society. Research has often focused on the effects of violence and addiction; however, the use of video games as an educational tool has been explored as well. Additionally, the literature suggests that video games may also be a useful medium for increasing positive health behaviors such as exercise. A popular type of video game known as an augmented reality game, or ARG, serves to overlay the gaming interface onto the real world and players are often encouraged to move about the game's environment, and hence the real world, to further engage with the gaming activity. The current study examines the physical and psychological well-being of ARG players, as compared to people who report engaging in light exercise on a regular basis. For this research, the framework of Self-determination theory (SDT) is applied to evaluate the role motivational constructs may have with regards to ARG engagement, in particular whether positive and negative effects can be predicted based on how the games facilitate or undermine the basic needs of those who engage with them. A total of 407 participants completed questionnaires about their physical and psychological health, motivation, and activity engagement. Results supported the hypotheses that SDT's basic psychological needs constructs significantly relate to physical and psychological well-being outcomes for ARG players, and the same patterns replicated in light exercisers. Participant approach orientation (task and ego involvement) demonstrated mixed results within each group. Findings suggest the importance of SDT-related constructs like autonomy, competence and relatedness when evaluating the influences of ARGs and videogames that could be designed to improve physical and psychological well-being outcomes.

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The popularity and utilization of video games has grown considerably over time, and a large portion of the population plays electronic games in some capacity: nearly 50% of the population (NPD, 2009). This trend is more pronounced in the 18-29 year old age group, with 80% of men and almost 60% of women playing video games of some kind (Pew Research Center, 2015). Researching video games from a psychological perspective continues to draw interest from both academics and the general public who share concerns for the potential effects of behavioral changes and motivations associated with gaming. Furthermore, the components of physical activity with augmented reality games (ARGs) raise the possibility that gaming may have associations with improvements to health and health behaviors, demonstrated in both child and adult populations (Kim, Prestopnik, & Biocca, 2014; Das, Zhu, McLaughlin, Bilgrami, & Milanaik, 2017). A recent review of the ARG literature highlights a number of areas where augmented reality (AR) has been applied to promote physical health, often illustrating common themes among the AR research particularly in the focus of physical activity (Baranowski & Lyons, 2020).

Understanding the underlying motivational nature and behavior changes related to video game engagement has been a particular point of interest to researchers, and has even been explored through the framework of self-determination theory (SDT; Deci & Ryan, 2000). To ensure that the lens of SDT could be satisfactorily applied when analyzing the domain of video games, validity testing was performed to observe the nature of video games and video game engagement (see Ryan, Rigby, & Przybylski, 2006; Przybylski, Rigby, & Ryan, 2010). As a result, SDT has been utilized to help understand a variety of different areas in relation to video

games such as: engagement styles for video game play (Przybylski, Weinstein, Ryan, & Rigby, 2009), video game addiction and violence (Przybylski, 2014; Przybylski, Deci, Rigby, & Ryan, 2014; Wittek et al., 2015), the appeal of video games (Przybylski, Weinstein, Murayama, Lynch, & Ryan, 2012), and aggression (Przybylski et al., 2014). However, the nature of these prior studies has only focused on what is perceived as the "typical" style of video game; one that uses a console and controller, or a computer. The nature of video games and the method in which they are available to people extends beyond the console and the computer to being available on a cellphone or tablet, and sometimes even incorporates the physical environment as part of the game itself. Moreover, in recent years when looking at the whole of the SDT literature that has explored video games, recommendations have been given to expand this research further, especially into alternative game types which explore virtual environments such as ARGs (Ryan & Deci, 2017). ARGs are a type of game that utilizes the physical environment, and these are often applications which operate on a user's cellphone without any additional equipment. One ARG in particular, Pokémon Go, had a notably successful launch when the game was released and has risen to be a quite popular ARG over time (Business of Apps, 2016; 2021). The current study proposes to extend the SDT's literature on video games by using its theoretical framework in an ARG setting, specifically through Pokémon Go. By using this framework, the current study aims to gain an understanding of the relationship between SDT constructs and ARGs, how these factors relate to psychological and physical well-being outcomes, and how this relationship compares to non-ARG players.

Self-Determination Theory

Self-determination theory is a theory of human motivation that is comprised of three primary constructs: autonomy, competence, and relatedness, which exist within the sub-theory

known as Basic Needs Theory (BNT; Deci & Ryan, 2000). BNT operationalizes the three key constructs which are: *autonomy*, which is having a sense of volition with respect to one's behaviors (e.g., "I'm going to medical school because I want to help people in medicine, and this field is meaningfully important to me"); *competence*, which is concerned with the perceived mastery people feel over the tasks that they engage with (e.g., "I consistently have good grades in my geometry class, and it still gives me a good challenge"); and *relatedness*, which describes the meaningful connections established with important others (e.g., "Sally is a great tutor for my calculus class, and really wants me to succeed. I enjoy having Sally as a tutor;" Deci & Ryan, 2000). BNT proposes that the satisfaction of basic psychological needs tends to promote behaviors that are strongly correlated with intrinsic motivation and more internally-regulated forms of extrinsic motivation (e.g., "I don't really like to exercise, but I value the health benefits that come with it, and those benefits are meaningfully important to me"). Promoting behaviors that are more aligned with one's sense of self and pursuant to one's own interests leads to greater levels of enjoyment with the tasks of interest, and healthier styles of engagement with those tasks. Additionally, promoting intrinsic behaviors in people can result in more effective behavioral change, perhaps because it helps people find a meaningful difference in such changes to improve lifestyle choices (e.g., smoking cessation, see Williams & Deci, 2001; Williams, Gagné, Ryan, & Deci, 2002). It is important to note that while relatedness is a key tenet, it is not always required for fulfillment of the basic psychological needs. For example, it is not always required for someone to find others to connect with to enjoy an activity. Rather, one can find full engagement and joy simply through engaging in a task of their own volition while by themselves.

As a whole, the three constructs altogether – autonomy, competence, and relatedness – form SDT's basic psychological needs. The satisfaction or thwarting of people's basic psychological needs can be used to predict a number of different outcomes such as health behavior change and engagement with different activities (Deci & Ryan, 2000; Niemiec, Ryan, & Deci, 2009; Przybylski et al., 2010; Ryan, 1982). Additionally, basic psychological needs satisfaction has also been shown to be a strong predictor for sustained levels of well-being (Niemiec et al., 2009), sustained engagement for activities that are autonomy- and competence-supportive (Vansteenkiste & Deci, 2003), and to support harmonious models of play (Przybylski et al., 2009).[1]

These findings are of interest to the current research exploring ARGs since the results demonstrate benefits (e.g., improved overall health, less anxiety, less fatigue, lower rates of activity burnout) when the basic psychological needs are satisfied. If an ARG is capable of offering an autonomy- and competence-supporting environment, then we would expect to see similar outcomes in improvements to physical and psychological health.

SDT Model in Video Games

The value of SDT as an explanatory and predictive theory of motivation is highlighted in research analyzing the engagement of video games (e.g., Ryan et al., 2006). These studies focused on the engagement styles of players when playing games, and the motivational effects of violence in games. Examining the styles of engagement afforded new information that contributes to the already extensive research concerning the effects of violent content within video games. However, unlike its predecessors, behavioral engagement models differ from the

[1] Models of harmonious play emulate the SDT construct of autonomy such that a person is engaging with an activity because of their interest or desire to do so, and that this engagement is done so volitionally. Harmonious and obsessive play is analyzed such that two composite scores are created – one for harmonious play and one for obsessive play (Przybylski et al., 2009).

typical “violent video game” model by studying the motivational styles of the individuals rather than the specific content of the video game itself (Przybylski, Ryan, & Rigby, 2009). In particular, SDT research has shown that the satisfaction or thwarting of basic psychological needs relates to engagement styles. We can think of a person’s engagement in terms of their basic psychological needs satisfaction, but also in terms of how they experience that particular game (state-level psychological needs satisfaction), and also how people generally approach the game they play which we describe as ‘approach orientation’.

The idea of approach orientation has been explored in prior work, notably in the domain of sports (Duda, 1989; Reinboth & Duda, 2004; 2006; Smith, Ntoumanis, & Duda, 2007). In this work the constructs of task- and ego-orientation are introduced. People who are engaging with activities in a task-oriented manner are doing so out of interest for the activity itself, whereas people who are more ego-oriented are more focus on the outcome of the activity (e.g., winning or losing) or are focused on importance in such a way that this focus centralizes around an outcome-dependent contingency (e.g., “I have to win or I’ll be a failure”). In essence, the constructs of task- and ego-orientation conceptually relate to the notion of an autonomy-supported (or not supported, respectively) environment. When adopting an approach orientation which is task-oriented – one that is agentic, promotes choice, and we are engaging in the activity for the sake of the activity itself --we would expect this to relate to an autonomy-supportive environment. Conversely, when our approach orientation is more ego-oriented – where our performance or activity outcome are determinants of (if any) positive outcomes we may receive from the activity -- we would expect this not to be an autonomy-supportive environment as our actions appear largely compelled or controlled, and our sense of agency removed from the relationship.

SDT began to explore engagement styles within video games, specifically examining those who approached playing video games more 'harmoniously' and those who approached them more 'obsessively' (Przybylski et al., 2009). Harmonious play is described as being fully agentic, meaningfully important, and is in alignment with other facets significant in one's life. Conversely, obsessive play is described to be forced or having little to no decision in the matter, and does not align or is in opposition to important factors to oneself. In the SDT literature, these descriptions of harmonious and obsessive play characterize the satisfaction or thwarting of the construct of autonomy, one of the three components which make up the basic psychological needs. Furthermore, results in prior SDT research show that trait-level need satisfaction (e.g., satisfaction of the basic psychological needs) is positively correlated to harmonious play and negatively correlated to obsessive play, and this relationship remains significant when basic psychological needs satisfaction is regressed onto harmonious and obsessive play (Przybylski et al., 2009). Conceptually, harmonious play can also be thought of as a task-oriented approach orientation since both constructs appear to align themselves with an autonomy-supportive environment by definition – that is, an environment which promotes agency, personal choice, and engagement for the sake of the activity itself. With regards to obsessive play, this conceptually relates to the idea of ego-oriented approach orientation – engaging with an activity out of a sense of obligation or requirement to perform, and in turn this would not be an autonomy-supportive environment.

In terms of the SDT model, satisfying the need for autonomy is to promote the sense of control over one's environment. By supporting autonomy, and by extension personal choice, the SDT approach argues that people feel in tune with their decisions and display a healthier attitude towards their own behaviors (Deci & Ryan, 2000). Regarding the participants who approached

the games more autonomously, these people also tended to have higher energy after a play session, reported a better state of mental health, and were more stable with their life satisfaction. Conversely, people who engaged with games less autonomously (e.g., more obsessively) expressed lower levels of life satisfaction, physical, and mental health; and player feelings of tension after a gaming session were higher than the participants who reported engaging in games more autonomously (Przybylski et al., 2009). This highlighted the importance of how the satisfaction, or undermining, of one's basic psychological needs can affect other domains, including health outcomes, and further influence how an individual engages with a particular activity (Przybylski et al., 2009).

The engagement phenomenon is not unique to videogame play. Studies of sports have compared autonomy-supportive vs. non-supportive coaches in burnout-related situations (Gagne, Ryan, & Bargmann, 2003). Results showed that before and after practice, higher levels of autonomy support correlated with higher levels of well-being outcomes (positive affect, self-esteem, and subjective vitality), and lower levels of autonomy support correlated with lower levels of well-being outcomes (higher negative affect, lower self-esteem and subjective vitality). While this research did not directly address engagement, the evaluations of pre- and post-practice autonomy support suggests an engagement or 'approach orientation' construct may exist in the pre-practice assessment to the extent that it may influence the post-practice measurements. It is possible then, for example, for participants who are more ego-oriented (i.e., participants who hold their value or self-worth contingent upon the outcome of their engagement to an activity) to display behaviors that are more ego-involved in a pre-task environment (e.g., "I must do well on this task or I won't be seen as capable"). Such behavior may result in an ego-oriented pre-task approach that would likely persist throughout the task. Upon completing the task, well-being

outcome results would be divergent dependent upon the participants' perception of their own task performance (e.g., "I met the required goals so I'm seen as capable," or "I did not meet the required goals, so I failed and I am not capable"). This emphasizes the need to consider approach orientation as a construct which may exist between the relationship of basic psychological needs satisfaction and well-being outcomes. The common thread linking these features together is an environment, person, or device that can promote the satisfaction of the basic psychological needs, subsequently leading to a more fulfilling approach orientation. In the case of Augmented Reality (AR) and ARGs, the current question is whether we can infer a relationship between physical and psychological well-being outcomes and the factors of basic psychological needs, approach orientation towards an activity, and state-level needs satisfaction with the activity.

When taken as a whole, these studies of game use and SDT, with the sub-theory of BNT, suggest that the positive and negative effects of video games, and some other activities, can be predicted based on how they facilitate or undermine the basic needs of those who engage with them. Additionally, those who have their needs satisfied outside of a video gaming context should be more likely to approach video games in a more task-oriented manner. Conversely, those individuals who do not have their needs met are more likely to approach video games in a more ego-oriented manner.

The SDT model has also been employed to address global issues about video games, in particular the effects of violent video game content (Przybylski et al., 2009; Przybylski et al., 2014). This prior SDT work on video game violence examined the trait-level aggression of the participants and hypothesized that it was not the violent content of the game itself which was the motivator for the game to be played, but that the motivational construct was indicative of the participant's trait-level personality and disposition towards aggression. While the individuals

who possessed higher levels of trait aggression were more likely to choose a violent game compared to a non-violent game, these participants did not derive more state-level psychological needs satisfaction from the violent component of the game itself. Additionally, violent content did not correlate with game enjoyment or interest to play a sequel of the game in the experiment. These findings are quite interesting from a motivational standpoint in suggesting that the violence in video games did not affect motivation for the participants wanting to play the game, and that playing non-violent content did not necessarily detract from the game play experience among participants with higher levels of trait aggression.

The influence of trait-level disposition towards aggression is particularly interesting as earlier research examining links between video game violence and aggression do not necessarily examine this factor or whether it plays a motivational role in seeking violent video game content. For example, work by Bushman and Anderson (2002) examined a link between violent video game context and aggressive thoughts. In this study participants played one of four violent or non-violent video games for a period of 20 minutes. After the play session, participants were asked to read three different stories and complete what would happen next in each of the stories. Results from this study showed that participants who were primed with a violent video game described the next steps of the story with higher levels of aggression when compared to the participants who were presented with the non-violent video game session. However, this study did not consider trait-level aggression as a distinguishing factor for the participants. Though both of these studies about violent video game content offer insight into these games and their relationship with human behavior, the constructs of SDT helped to explain this relationship further by demonstrating that basic psychological needs satisfaction and state-level needs

satisfaction with video game play are better indicators for video game enjoyment and continued interest in the game (Przybylski et al., 2009; 2010; Ryan et al., 2006).

These results by Przybylski and colleagues (2009; 2010) are key for understanding the potential effects of ARGs as they suggest that the game itself need not contain violent content to elicit interest from the participant. Rather, interest in the activity itself, be it through the satisfaction of one's basic psychological needs, the motivational approach used when engaging in the activity, or a dynamic interaction between both of these factors, prevails above and beyond the game's subject content.

This research serves to highlight that the interplay of how an activity is approached and the manner in which it is done (e.g., task vs. ego) predicts health-related outcomes associated from the activity. Specifically, individuals who engage in an activity or behavior in an ego-oriented way, thereupon having one's ego contingent upon the outcome of the activity itself (e.g., win vs. lose, success vs. failure) tend to derive fewer well-being outcomes relative to those who approach behaviors and activities in a task-oriented manner.

Self-Determination Theory, Approach Orientations, and Video Games

A key component from these findings on the SDT view of video games is the implication that the way in which one engages in the activity is a critical determinant of task outcome. The literature offers some insight into the basic psychological needs facilitating styles of play within the activity itself. Activity engagement has also been explored with the SDT model using the constructs of task vs. ego orientation to predict well-being outcomes defined by positive and negative affect (Poquadeck & Ryan, 2014). This study assessed participant's basic need satisfaction while also exploring their motivational orientation (task vs. ego) towards sports and video games regarding their most recent experience of competitive play, and whether the

participants perceived that they "won" or "lost" at that activity. This research found that people who reported engaging in a competitive play activity, specifically video games or sports, with a task-oriented approach showed high levels of positive affect regardless whether they reported winning or losing, and there were no significant differences in positive affect outcome between activity types. However, those who approached activities with an ego orientation tended to have lower levels of positive affect when reporting a loss compared to those participants who had an ego-oriented approach but who had won their most recent experience of competitive play.

With respect to the current study measuring motivation to play ARGs and health outcomes, we expect to find that task-oriented players in ARGs would display better physiological and psychological health outcomes. Players whose needs are not satisfied would be more likely to approach ARG engagement in an ego-oriented manner, thus having their experience of the activity be contingent upon their satisfaction with the activity. These findings lead to the predictions for the present study, adapting similar questions to health behavior change in the ARG context. Specifically, I predicted that when basic psychological needs are satisfied, I expected players to report a motivational orientation focused on the task (i.e., task-oriented). Being more task-oriented, along with having one's needs met, should predict an engagement with ARGs that successfully relates to healthier physical and mental outcomes. In contrast, participants who are more ego-oriented in their approach to the task will report having less need satisfaction, and fewer positive outcomes. However, unlike competitive games or sports, there is no particular "win" or "lose" condition in an ARG that is purely a single-player experience, as in the present research. In this research with single player ARGs, we might see the contingent outcomes by measuring a person's needs satisfaction with the activity.

Higher levels of needs satisfaction of the activity may predict higher levels of well-being outcomes, whereas lower levels of needs satisfaction with the activity may predict lower levels of well-being outcomes. In particular, the needs satisfaction with the activity represents the participants' perceived performance and in some activities, this performance may be a dichotomous win vs. lose condition. In other cases; however, this performance may be a goal that the participants seek to obtain or meet (e.g., 10,000 steps per day of exercise). Due to the variability in this construct, and the clear absence of a win vs. lose condition, the present study defines the needs satisfaction with the activity as a measure of activity "performance" regarding contingent outcomes. The contingency effect found by Poquadeck and Ryan (2014) would occur in the ego-oriented sample such that their perceived outcome is dependent upon their performance, and that if these players perceive themselves to be "winning" (by meeting health goals) this would predict similar positive health outcomes as those who are task-oriented; whereas those who perceive themselves to be "losing" would suffer more negative consequences as a result of their perceived failure despite any contributed effort. For analysis purposes, higher levels of needs satisfaction with the activity represent success, "winning," or meeting one's expected goals. Lower levels of needs satisfaction with the activity would then represent failure, "losing," or not meeting expected goals.

Augmented Reality vs. Virtual Reality

The present study involves augmented reality games, specifically Pokémon Go. This study chose Pokémon Go given its wide popularity around the world upon its launch, and that the game still maintains popularity several years after its inception (Business of Apps, 2016; 2021; Baranowski & Lyons, 2020). The large volume of users, global appeal, and sustained game longevity suggest that ARGs, or at least Pokémon Go, have a noticeable role with human

behavior. Precedence for the involvement of ARGs is discussed further within, and prior research has shown that ARGs exhibit demonstrably noticeable effects on human behavior (Baranowski & Lyons, 2020; Das et al., 2017; Kim et al., 2014). Some of these effects have taken novel approaches to classroom task assignments which has shown positive effects on student learning. Others applications are in the realm of physical therapy by incorporating new technological models to improve rehabilitation efforts. However, the existing literature encompasses ARGs used or developed for the purposes of research, education, or applications in clinical environments, and though these are not without their merits they cannot reasonably generalize to a larger audience since these applications of AR and ARGs have not been applied to a larger population. However, the popularity of Pokémon Go is less limited since it is not localized to single or handful of nations, but has drawn appeal from cultures across the globe (Business of Apps, 2021). As such, Pokémon Go offers a way to do a more practical assessment of the general population. Thus, the objectives of the current research aim to explore some of these possible ARG-related correlations with human behavior with a focus on psychological and physical well-being outcomes.

One note about related research, the current study is only focused on ARGs and not virtual reality-based games, as these are functionally and fundamentally different. Augmented reality and virtual reality are addressed differently within the scholarly literature and due to these differences, it is important to distinguish between their meanings. These definitional differences are summarized by (Akçayır, Akçayır, Pektas, & Ocak, 2016). Augmented reality (AR) is a virtual environment that overlays itself with the physical world that people operate and interact with. This overlay can be accessed through electronic devices (e.g., cellular phones, tablets) where the AR application or game has features, landmarks, or other important monuments that

correspond and “overlap” with physical world features. For example, within the ARG an objective for the game will be tied to a specific real-world location. To access the objective, the user must physically be within close proximity to the location, at which point the GPS signaling through the application will subsequently issue the commands for the user to follow to reach the objective. For example, in Pokémon Go there are Pokémon gyms where players may participate in special content of the game that is only available at these locations. These locations can often be set at points of interest around one’s neighborhood, and could be appreciated as a means of encouragement to get out and acquire a better understanding of one’s residential area. Other times these points can link to historical sites of interest and offer cultural information that may otherwise have gone unnoticed (e.g., as with the game Ingress).

Virtual reality (VR) differs in that the user requires equipment to be worn (e.g., a VR headset), and the user experience typically occurs within their own home. Additionally, the VR experience is a world constructed through the application and relayed to the user through the VR equipment; as such the world the user is experiencing may not necessarily be indicative of the physical world nor is interaction with the physical world required as a function of the VR application itself (Akçayır et al., 2016). For example, the VR interface is often accessed by the user wearing a visor through which all of the digital media is then projected to them via ocular sensation. Navigating through the virtual field is done by means of controllers in one or both hands of the user. While in virtual space, the user may physically look upwards which in turn reveals to the user what is above them in the digital space. Moving forward and left-to-right are often done by means of the controllers in the user’s hands, so not much actual walking occurs to move the digital field forward. This is not to say that VR games are not physically demanding, as is the case with Beat Saber, a game made in the rhythm-genre (such as Rock Band or Guitar

Hero, for example) where the player is tasked to hit musical objectives at the appropriate times using their arms, but also involves full-body motion requiring the player to duck and move side-to-side – all of which takes place within the solitary environment where the gaming equipment is established.

Both AR and VR have been part of the research literature given their effects on human behavior. Due to the significant differences between interaction styles (e.g., the differences between AR and VR), the current study focused solely on AR and ARGs – specifically Pokémon Go.

Applications of Augmented Reality

Several areas within the psychological literature have explored the use of augmented reality across a range of domains. The following sections review the applications of AR in education, clinical application, and health-behavior change. Each of these areas discusses how AR can be used to affect or relate to physical or psychological well-being outcomes, or methods in which AR can associate with motivational constructs. While the present study focuses on the role of SDT and AR, reviews of the literature offer insight into AR applications, and motivational phenomena that demonstrate similar characteristics as seen in the core constructs of SDT. Furthermore, SDT is a macro theory of human motivation and behavior, and as previously discussed, has been shown to have applications into a number of research areas. As such, it is reasonable to demonstrate the holistic value in the predicted relationship between SDT and AR rather than individual components, specifically, observing both the physical and psychological well-being outcomes.

ARGs in Education

Augmented reality has become popular in educational settings as a means to facilitate immersive learning (Chang, Chung, & Huang, 2014; Tscholl & Lindgren, 2016), enhance early childhood education (Yilmaz, 2016), and improve upon science laboratory learning in higher education (Akçayır et al., 2016). As such, the literature on ARGs within an educational setting spans multiple age groups which highlight the generalizability and adaptability of ARGs. This adaptability is particularly important as it suggests that AR (and consequently ARGs) can be utilized in different areas of human engagement (e.g., clinical settings and education as discussed here), and that AR can be utilized to enhance outcomes with specific objectives, such as learning, so it is possible that AR may be able to have a role in psychological and physical well-being outcomes.

ARG-mediums have been used to enhance learning within science laboratories to replicate environmental phenomena that may otherwise not be available, and so provide a practical learning tool (Akçayır et al., 2016). Participants reported that the AR models used in the virtual laboratory enabled them to engaged with the laboratory tasks more effectively. Additionally, the virtual materials appeared effective to the extent that it was reported that less assistance was needed from instructors, thus the students appeared to be more focused on the tasks and had fewer questions about the assignments (Akçayır et al., 2016).[2] The key value in ARGs shown here is the supplemental nature that appears to be intrinsic with ARGs to facilitate the learning process. As the researchers discovered, the participants appeared to be less dependent on the instructor to assist with assignment challenges. This suggests that the AR models not only convey information adequately to the users, but that user interaction with the

[2] For design purposes, the study limited the times in which the AR environment was available such that both users of in-laboratory assignments and those using the AR models would have the same "class time" (Akçayır et al., 2016).

model could be responsible for providing a better understanding of the material thus promoting learning capabilities among participants.

This research shows that ARGs can be used effectively in schools not because they provide fundamentally different information, but because they increase students' freedom of access to the information by making it available virtually (Akçayır et al., 2016). The benefit of this freedom could be explained by the SDT model of human motivation in the sense that ARGs afforded the opportunity to the students to approach the science laboratory assignments in a manner that supported their freedom of choice in how to engage with the task, and provided educational models to facilitate deeper learning of concepts. In relation to SDT, this freedom of choice may correlate with SDT's construct of autonomy. Supporting one's autonomy, specifically the basic psychological need to feel in control over one's behaviors and actions, is one of the components that relates to more intrinsically motivated behavior. Additionally, the efficacy demonstrated by the participants in the AR environment (e.g., better understanding of the assignment material, improved execution of experiments, and laboratory assignments enhanced with the AR model) suggest a relationship to the SDT construct of (Akçayır et al., 2016; Deci & Ryan, 2000). Taken as a whole, the AR model used in these laboratory tasks give the impression that AR models can successfully enhance the basic psychological needs proposed by SDT which would relate to improved outcomes.

ARGs have also been effective in promoting learning behaviors in an early childhood context (Yilmaz, 2016). In this study, kindergarten-aged children were given AR-style toys which were used to help them learn about different animals, objects, shapes, and colors by adapting methods such as visual puzzles and flash cards that would present the learning material in a virtual setting. Both teacher ratings and child reports were used to assess the effectiveness

of the AR-style toys. Teacher reports indicated that the use of AR-style toys was easy and that the teachers found these tools useful in their practice, overall providing very positive ratings of an AR-style tool as an education implement. From the perspective of the children, they reported these toys were engaging and that they had fun using them. Although learning outcomes were not directly assessed, findings from this study catalogued behaviors that the children interacted with the AR objects. Notably, the children would point at and move the objects around, suggesting that the objects appeared more "real" with the interactive AR model (Yilmaz, 2016).

AR applications and their effectiveness appear to depend partially on the opportunities that they provide to the users (Yilmaz, 2016). In this study, the dualistic opportunities led to positive ratings of the AR-style toys both from the teachers and the students. These positive ratings suggest that these outcomes may also align themselves with competence-supportive behavior as part of the SDT model. For the teachers, the AR tools may have supported the sense of mastery these professionals experience within their environment, and act as a supplement to further improve the learning opportunities of the students they teach. In turn the children find the AR tools fun to use, and can feel effective in their use of the tool by finding it enjoyable. These findings suggest that the use of AR in early childhood education might, when viewed from an SDT model, promote competence-supportive behavior along with an intrinsic motivational style, making them effective learning tools. As was demonstrated in the literature regarding the use of AR for science laboratories in a higher education setting, AR has applications as a supplement to both young adults and young children in their educational pursuits. The outcomes of these studies suggest that similar findings may be observed when SDT is applied directly to the study of AR.

Supportive learning environments utilizing AR as a tool are also not limited to teacher-child interactions, but have been demonstrated in parent-child discussions as well (Tscholl & Lindgren, 2016). These AR learning environments are developed with the intent to stimulate conversation between the parent and child so that the parent can help guide the child to a better understanding of scientific phenomena. In this particular study by Tscholl and Lindgren (2016), astronomical behavior (e.g., orbiting bodies, gravity) was the focus of the AR app, and the parent could interact in collaborative discourse with the children asking them where they think certain planets and moons should be based on gravity. The parent also provided some instructions to the children such as where the children should begin their task, or giving a hint on what to do. The children then use their understanding of the phenomena to interact with the AR environment, and in turn receive feedback from the parent. The parental role is to supplement the child's exploration of the AR environment by guiding the child toward a better method to understand the phenomena being presented in the AR environment, offering suggestions for children to explore during their AR interactions, and provide positive reinforcement and praise as the child progresses through the activity.

This style of supportive learning and parent-child feedback (Tscholl & Lindgren, 2016) may relate to the SDT constructs of autonomy and competence. Utilizing the core constructs from SDT we can make the following interpretations as to how SDT would explain these observations. First, children's autonomy and competence are supported such that they have control over the environment that they are exploring, and their mastery over the topic material is provided an optimal challenge by encouraging the children to offer their understanding of the AR environmental phenomena in the activity. The importance of this is that it encourages children to observe how astronomical phenomena occur rather than having to imagine a series of

hypotheticals. In the case of this study, the child is able to explore the different orbiting bodies and observe how they are being replicated in the AR environment, and move between those that interest them. As children explore this AR environment, they make their own predictions as to where the orbiting body will move based on their understanding of scientific laws (e.g., gravity), and as such are creating their own informed decisions. Second, the parent's autonomy and competence receive support by encouraging the child explore the environment at hand but still remaining a point of contact to offer guidance. By promoting feedback and positive reinforcement to the child, the parent's sense of mastery to bridge the child's gap of knowledge supports the parent's own sense of competence by successfully guiding their child to more knowledge. This view suggests that AR interactions can positively enhance the user's approaching to learning in a need-supportive environment: an environment where the user can explore the AR world aligned with their own interests, and the user also receives meaningful, engaging, and positive feedback from those around them.

Immersive AR learning environments have also been shown to promote interest in learning among young children, particularly with reported increase in children's motivation to learn (Chang et al., 2014). In particular, students using an AR environment to learn about plant biology expressed higher levels of motivation to learn about this specific domain, and retained knowledge about plant biology more accurately when compared to students who learned this topic using only videos to complement the material. While the motivational observations themselves were not specifically aligned with SDT in terms of variable construct and theoretical design, the AR environment nonetheless promoted the interest in the students to pursue further knowledge in plant biology to the extent they felt more engaged with the classroom topic. This higher level of engagement may be representative of intrinsic motivation given the students

volitional pursuit and interest (e.g., autonomy) in plant biology, and the immersive nature of the AR environment acts to facilitate the student's engagement in learning more and doing so in a manner that the student feels effective and masterful (e.g., competence). Therefore, the complementing nature of AR in the classroom affords many opportunities to promote the basic psychological needs as described by SDT, encouraging greater intrinsic motivation. To this extent, we see that AR environments offer supportive learning potential when the environment provided to the user is one that engages them in a personally meaningful way through positive, tangible, and relevant feedback, and when the user is able to explore the environment in a manner that interests the user. This is not to say that the environment is absent of all structure, but that the user is able to operate in an autonomous fashion within the structural design of the AR environment rather than following a strict, regimented path laid before the user. Thus, the design of an AR environment may enhance other areas of personal growth and maintenance, for example in terms of health behaviors.

AR in Clinical Settings

Augmented reality has also been used in settings beyond the scope of education and have shown value when applied to areas which coincide with clinical populations. The use of AR has been demonstrated to be very effective in children and adolescents with autism spectrum disorder (ASD) to promote facial and emotional recognition, and social skills training (Chen, Lee, & Lin, 2016). Using AR in a medical setting has also been effective as a rehabilitation tool for patients recovering from a stroke (Hoermann, Hale, Winser, & Regenbrecht, 2014). SDT theory provides a suggestion for the parallel between the effectiveness of AR in education and clinical settings by relating their effect to how they satisfy a set of basic psychological needs. In

each case, from the perspective of SDT, the AR component of the intervention provided increased autonomy for the user.

Children with autism spectrum disorder have a number of clinical characteristics, among them are challenges regarding emotion and facial recognition and social adaptation. Through the use of video modelling, an AR interventional model was shown to significantly improve children's social functioning skills and greater differentiation in facial expressions associated with emotions (Chen et al., 2016). This AR model would display facial expressions and was designed for children to mimic the appropriate facial expression when a given emotion was told throughout a storybook context. Additionally, these effects persisted across time suggesting that the AR model was highly effective post-intervention and this improvement in face recognition with different emotions remains stable. This AR model and post-intervention stability serves to highlight how AR can contribute to improving the quality of life of the individuals who use such interfaces, and further characterizes the application of AR in domains beyond supplementing academic experiences. For the present study the durative components that have been shown in AR show promise that, given the contexts for a need-supporting environment, applications such as ARGs could promote behavioral change to better one's health.

The augmented reality models designed to assist with social skills training and facial and emotional recognition in ASD populations have demonstrated outcomes which appear to be related to the SDT constructs of autonomy and competence. From an SDT perspective, such models allow the user active exploration of the environment while affording the user control over the delivery of information (Chen et al., 2016). Specifically, the children were able to proceed at their own pace and introduce information to themselves at a pace they appeared comfortable with following. Furthermore, this design helps to address challenges related to attention span in

children by being less demanding on the child's participation. Within the context of SDT, active exploration could encourage a feeling of choice within the environment in terms of exploring and interacting with that environment, thus relating to SDT's construct of autonomy. Similarly, control over the information that is delivered to the user contributes to a sense of mastery over available information, permitting the users to filter out what they find important and possess a degree of efficacy in their actions, relating to competence. As this particular AR model was designed to promote social skills, it is important to control the information to allow users to filter how much information is being received so they feel capable and not overwhelmed (Chen et al., 2016).

Sharing this benefit of self-controlled information at the user level, another use of AR models is in patient populations to encourage rehabilitation efforts (Hoermann et al., 2014). In cases of stroke, rehabilitation of motor functioning may be required for the affected individuals. The degree of rehabilitation will depend upon the severity of the stroke and individual differences and needs of the patients themselves, but many times rehabilitation can be a grueling process for those who seek to regain their motor function capabilities. To promote rehabilitation efforts, simple AR models have been used to complement this process by using a virtual medium to aid in the grasping of objects in an effort to reconstitute prior physical ability (Hoermann et al., 2014). This medium functions by presenting objects on a monitor while the patient moves their hand in a designated box-like area. The box area creates a hand display on the monitor tracks and follows the movement of the patient's hand, allowing the patient to "grasp" the AR objects. The AR model is dynamic in that it can be tailored specifically to each patient (e.g., whether the impairment is left- or right-sided; task adjustment suited to degree of impairment, and so forth). Additionally, the patient uses the AR tool with a therapist present who monitors

the patient's progress, providing clinical intervention as necessary. Patients undergoing rehabilitation with an AR model to represent their specific rehabilitation task (e.g., an image to help with grasping or moving objects) have reported higher levels of engagement with the rehabilitation tasks, view the models as easy to use and understand, and those who had a lesser degree of impairment even reported wanting more challenges for them to participate in. Furthermore, some patients derived clinical benefit, noting improvements in hand and upper arm movement capability (Hoermann et al., 2014). The key component here is that the patients found the AR models enjoyable, engaging, and easy to apply in their rehabilitation environment in addition to clinical benefit. These feelings would be identified in the SDT model as a sense of autonomy and competence, and providing opportunities for the patients to interact with their rehabilitation tasks in a manner that they can find interesting, stimulating, and novel, while feeling effective in their therapy, and would predict more successful outcomes.

AR and Health-Behavior Change

While a majority of the literature on AR focuses on the effectiveness of education, and medical and clinical interventions, there has also been some exploration into the use of AR to promote health-behavior change, specifically through exercise. This is central to the present research which asks whether engagement with an AR game might be associated with better health behaviors depending on the user's style of motivation and interaction (i.e., approach orientations). A key feature to addressing health-behavior change in physical activity using AR models is the necessity of such models being accessible via a mobile device (e.g., cellular phone), enabling the user to move about their physical environment. Several studies incorporated physical activity in conjunction with the AR tool, and the tool itself was easily operated by the user (Das et al., 2017; Kim et al., 2014; Laine & Suk, 2015; Mackintosh,

Standage, Staiano, Lester, & McNarry, 2016). Additionally, these studies measured effectiveness of the AR tool with respect to the physical task. In some cases the participant's feelings towards the incorporation of the AR tool were also assessed (Laine & Suk, 2015).

The work from Mackintosh et al. (2016) explored how exercise-based games ("exergames") contribute to game engagement and energy expenditure. Energy and engagement were assessed using psychological measures immediately after an exercise session. The exercise sessions also recorded participants' heart rate and acceleration.[3] Notably, as energy expenditure increased so did game engagement. Greater levels of vitality were also found in females compared to males, whereas males demonstrated higher levels of negative affect and tension. These findings suggest that an exercise component coupled with a game outlet may contribute to improved exercise habits.

The effects of exergames were also researched by Das et al. (2017) to evaluate how physical activity and changes in health behavior were affected by different types of AR environments participants would interact with. This study randomized participants into one of three groups, and each group was assigned a specific type of feedback interface that would relay information to the participants within the group. The low level interface group was only provided video feedback. In addition to video feedback, the medium level interface group was also provided with motion detection coupled with a sound indicator via a "beep" noise to inform that the participants had performed the task correctly within the AR environment. The high level interface group offered motion detection in conjunction with human speech sounds and an avatar which would "communicate" with the participants. Results from this research showed that

[3] The experimental model incorporated a single- and dual-player mode that all participants engaged with, was competitive in nature and participants were randomly selected in the dual-player mode. The design also counterbalanced single- and dual-player first conditions for the participants to test for order effects. Statistically significant order effects were not observed within the groups; however, the dual-player first condition group did expend significantly more energy than the single-player first condition group.

participants had greater levels of enjoyment with the game and presence (feeling as though you are part of the game) in the high level interface group when compared to the medium and low level interface groups. Participants in the high level interface group also expended significantly more energy than the other groups despite that the exercise instructions provided to participants in all three groups were identical. The results from these tests suggest that the models afforded to participants significantly impacts not only their enjoyment and feeling as though they are part of the game, but also overall energy expenditure which suggests that participants in the high level interface group may be working harder than the other two groups. This research also assessed future intent for both exergaming and exercise, and the results for these outcomes were mixed. Participants in the high level interface group expressed a higher intent for exergaming, but did not express a higher intent for exercise itself. These findings suggest that the participants may pursue further physical activity by means of exergaming, but not necessarily by means of exercising outside of an AR or exergame framework. Interestingly, the implication from these results suggests that participants who would be less likely to explore traditional exercise outlets may become interested to engage in physical activity when presented through an exergame focus.

In recent years, a review of the ARG literature which specifically focused on ARG use in children and adolescents covered a number of positive and negative outcomes associated with the physical and social aspects related to ARG engagement (Das et al., 2017). For physical benefits, exergaming has also been explored in this population and the review notes how ARGs can be utilized to help improve physical activity levels and function as an intervention against obesity. Additionally, ARGs have been shown to increase levels of socialization in both similarly-aged groups of children and adolescents, and for people who are older than their age

bracket. A notable drawback to ARG engagement is that it can become a distraction, limiting the ability to be mindful for one's physical safety, and in some reports this has resulted in physical injury from accidents (e.g., sprains, fractures) and motor vehicle accidents (e.g., not observing traffic safety rules). There is also concern for mental safety, particularly related to video game addiction, though the authors caution against loose interpretations of ARG research into this area and that video game addiction has to be carefully and methodically evaluated within context.

In a study by Laine and Suk (2015), an ARG was designed to promote more vigorous exercise by requiring the participants to run between designated locations. This design followed the idea of the "ticking time bomb" where strict time limitations were imposed, so that in order for the participants to succeed at the activity higher levels of exercise were needed (e.g., running instead of walking to each location). Results showed that the participants enjoyed the activity and shared their experiences often among their group members, and that children were more likely to complete the activity rather than the young adults. To note, this study focused on the design of an ARG that could be used to promote exercise behaviors. Feedback about the use of the ARG was solicited from participants; however, specific outcomes regarding exercise itself (e.g., monitoring heart rates, calculating calorie usage) were not assessed. One of the more noteworthy pieces to this research is that it draws on the concept of "flow," theorized by Csikszentmihalyi (1998), to discuss appropriate ARG designs. The idea is that these designs could bring users into a heightened state of awareness and provide improved interest in the activity that they are engaging with. The concept of "flow" has been regarded within the SDT literature as being similar to that of intrinsic motivation to the extent that a person is engaging in an activity or behavior out of pure interest and enjoyment of the activity itself. While Laine and Suk (2015) did not directly observe the motivational components (and more specifically, did not

measure SDT constructs), they used concepts from motivational literature to influence their hypotheses concerning the design of AR and ARGs. These concepts were integrated into the ARG design and implementation of the study's tasks in an effort to observe participant engagement with an ARG coupled with tasks involving high levels of physical activity.

SDT addresses the concept of "flow" and intrinsic motivation such that the underlying mechanics are a person's satisfaction of the basic psychological needs (Deci & Ryan, 2000). These needs, when satisfied, have been shown that participants engage in activities more for the task itself rather than a goal, and do so for the sake of the experience rather than an achievement. This element of flow, and task- and ego-involvement is critical to the current study as it 1) addresses constructs in ARGs previously unobserved and 2) maintains continuity with established literature concerning the concepts of flow and the theoretical architecture of SDT. Though evaluated differently, the prior work on harmonious and obsessive play conceptually relates to task- and ego-involved play, respectively (Przybylski et al., 2009). Harmonious play likens itself to task-involvement such that it is more intrinsically motivated as the individual is engaging with an activity for its own sake. Obsessive play appears to be more ego-involved in that activity engagement suggests that it places more significance on performance outcomes beholden to one's ego. Given these parallels we would expect that task-involved play has better physical and psychological well-being outcomes rather than ego-involved play overall. Additionally, well-being outcomes for ego-involved play may be more performance driven such that meeting one's performance expectations (i.e., satisfying one's ego) should demonstrate higher levels of physical and well-being outcomes when compared to ego-involved play where performance expectations are not met, thus failing to satisfy the ego.

Present research: SDT Model and Augmented Reality Games

Video game research within the field of psychology and studies utilizing an SDT perspective continue to grow, further highlighting how games and their method of engagement can have a variety of effects. The current academic research on ARGs has largely focused on applications in education, clinical, and medical contexts, with several studies analyzing the every-day applications of ARGs within the domain of health-behavior change. Presently, no known research has been conducted on ARGs using an SDT perspective. A recent comprehensive review of the emergent SDT literature over the past decade also notes the importance of furthering research in virtual environments and ARGs (Ryan & Deci, 2017). The research from the SDT approach to understanding video game effects in general suggests that SDT might provide a valuable perspective for measuring how ARGs affect people's behavior. The question for the present research is whether the light exercise involved in playing a popular ARG may show similar links to health outcomes, based on how the activity satisfies basic psychological needs. In the present research, ARG-players and non-players who are light exercisers will be assessed in terms of their basic psychological needs, motivational orientation, levels of activity needs satisfaction, and overall psychological and physical health. Non-ARG players who are light exercisers are chosen as a comparison group as their activity level should be comparable to people who engage in ARGs such as Pokémon Go. ARGs like Pokémon Go enable the user to engage with the activity while passively exercising as the user travels to different locations in the real world to obtain different Pokémon that appear in the digital region which is overlaid onto a camera image of the real world. This level of exercise may reasonably compare to people who engage in light exercise.

Hypotheses

H1: For both ARG users and light exercisers, basic psychological needs satisfaction will (BPNS) relate to well-being outcomes (physical and psychological health ratings) such that higher levels of BPNS will correlate with higher levels of physical (e.g., physical functioning, physical role functioning, pain, and general health) and psychological well-being outcomes (e.g., emotional role functioning, emotional well-being, energy, and social functioning). BPNS will also be positively correlated with task-orientation ratings, and negatively correlated with ego-orientation ratings. Additionally, state-level needs satisfaction with the activity (PENS) will be positively correlated to physical and psychological well-being outcomes.

H2: Higher levels of ego orientation will predict higher levels of physical and psychological well-being when PENS ratings (state-specific needs satisfaction with the activity) are also high. In contrast, higher levels of ego orientation and lower PENS ratings will relate to lower levels of physical and psychological well-being outcomes.

As the overall relationship between SDT constructs and ARGs is not well understood, along with the co-authors of SDT acknowledging that further research into the area of AR and ARG is warranted for the SDT model (Ryan & Deci, 2017), exploratory analyses will be performed to evaluate the overall relationship between BPNS, task and ego orientation, PENS ratings, and physical and psychological well-being.

Method

Participants

A total of 407 participants were recruited (see Table 1; LE or light exercise group N = 198, ARG group N = 209). Respondent gender was as follows: For the exercise group, 123

male, 71 female, and 4 preferred not to answer. For the ARG group, 131 male, and 78 female.[4] In the exercise group, participant age had an average of 36.15 years (*SD* = 11.328), and in the ARG group, participant age had an average of 32.27 years (*SD* = 8.427). Ethnic demographics were not collected as these were not relevant to the phenomena of interest. Participant sampling was restricted to the United States.

Study participants were recruited online via Mechanical Turk (mTurk) and were asked to respond to a series of questionnaires. Participants could enroll into one of two survey sets based on whether they did light exercise (LE group) or played Pokémon Go (ARG group). Participants were awarded $1.50 USD for completing the survey. Participant recruitment was also restricted to the United States only, and the recruited participants were required to have a Human Intelligence Task (HIT) approval ratio of 90% or greater to enroll into the study. These restrictions were discussed by Hauser, Paolacci, and Chandler (2019) as methods to help prevent against problematic data quality that can occur with mTurk. After the survey information was collected and complete, an Internet search was performed to assess for crosstalk among the study's possible participants. No overt crosstalk was observed outside of mentioning information which was presently on the participant consent form (e.g., "This is a study about Pokémon Go"). A power analysis suggested that 385 participants would be sufficient to detect a large effect size with a power = 0.95, $\alpha = 0.05$, df = 1, and provide a sufficient base of participants should some surveys be incomplete to sufficiently analyze.

Materials and Procedure

The participants were informed they would be presented with a series of questionnaires and be asked questions about their engagement with light exercise or ARGs, respectively. For

[4] The option of "transgender" was presented to the participants; however, no one selected this option.

the purposes of this study, light exercise was defined as no more than four (4) hours each week (approximately 34 minutes per day or less). Additionally, an example of walking one's dog to represent light exercise was presented to the participants to provide a frame of reference. Furthermore, participants who reported more exercise: e.g., working out in a gym, going jogging or running, or participating in sports (such as football, hockey, soccer) were excluded from the analyses. No participants were excluded as a result of these eligibility criteria. However, one participant completed both sets of questionnaires for the light exercise and ARG groups which was not permitted. As a result, this participant was excluded from the analysis entirely.

As the present study utilizes two groups, light exercisers and ARG players, subtle phrasing changes were performed on the measures listed below for language continuity. Both phrases are included in the item descriptions; however, participants were only presented with the relevant phrasing dependent upon their survey of choice.

Basic Psychological Needs Satisfaction (BPNS). This is a 24-item Likert scale survey that assessed overall (trait-level; autonomy, competence, and relatedness as a composite) psychological needs satisfaction. Participants were asked to respond to items in terms of how they pertained to the participant in general, with example items such as, "I feel that my decisions reflect what they really want," "I feel disappointed with my performance," and "I feel a sense of choice and freedom in the things I undertake." Item ratings ranged from 1 = "Strongly Disagree" to 7 = "Strongly Agree." Applicable items were reverse-coded such that lower scores represent lower levels of overall needs satisfaction. This scale demonstrated an internal consistency of α = .950 for the exercise group, and α = .934 for the ARG group (Chen et al., 2015).

Task and Ego Orientation in Sport Questionnaire (TEOSQ). This 13-item Likert scale survey evaluated both task and ego orientation towards a particular activity, resulting in a

composite score for each variable. The items were presented with the leading phrase "I feel most successful in ARGs / exercising when…" to provide a frame of reference. Items were rated from 1 = "Strongly Disagree" to 5 = "Strongly Agree" with items such as "I am the only one who can do the task or skill," "A skill I learn really feels right," and "I can do better than my friends." Lower overall scores for items represent lower levels of ego orientation and task orientation. The task orientation items collectively demonstrated an internal consistency of α = .897 and .836 for the exercise and ARG groups, respectively. The ego orientation items collectively demonstrated an internal consistency of α = .899 for the LE group and .818 for the ARG group (Duda, 1989; Duda & White, 1992).

Player Experience of Need Satisfaction (PENS). This is a 9-item task rated on a Likert scale that focuses on targeted activity need satisfaction (state-level; autonomy, competence, and relatedness as a composite) of individuals. The items were presented with a leading phrase of "In my most-recent ARG / exercise experience…" to provide a frame of reference for the participants. Example items included "I felt very capable and effective when exercising / playing," "I experienced a lot of freedom in the activity," and "I didn't feel close to other participants." Items were rated from 1 = "Not at all" to 5 = "Very much." Applicable items were reverse-coded such that low scores represent lower levels of need satisfaction with their most recent experience of ARG use / light exercise. Higher scores indicate a higher level of state-level needs satisfaction. This scale demonstrated an internal consistency of α = .845 and .824 for the exercise and ARG groups, respectively (Ryan et al., 2006).

RAND 36-Item Health Survey. This survey is the short-form version of the Medical Outcomes Study (MOS) and assesses four sub-categories which create a composite score for overall physical health: physical functioning, role functioning (physical), pain, and general

health; and four sub-categories which create a composite score for overall psychological health: role functioning (emotional), emotional well-being, energy / fatigue, and social functioning. The survey is rated in a Likert format ranging from 0 to 100, where higher scores indicate higher levels of physical and/or psychological well-being. For the physical subscale, this measure demonstrated an internal consistency of $\alpha = .938$ (light exercise group), .926 (ARG group), and .950 overall. For the psychological subscale, this measure demonstrated an internal consistency of $\alpha = .900$ (light exercise group), .875 (ARG group). The overall internal consistency for each group was $\alpha = .949$ and $\alpha = .938$ for light exercise and ARG players, respectively (Hays, Sherbourne, & Mazel, 1993).

Analyses

Descriptive statistics were calculated to include the overall scores of each variable when both ARG and LE groups were combined. A second set of descriptive statistics were performed to analyze these variables for each of the groups alone (ARG or LE). T-tests analyzed the response to each measure by ARG and LE groups in order to evaluate for any significant differences between the groups.

H1 was tested by first assessing correlations between: BPNS and well-being outcomes, BPNS and approach orientation (task and ego), approach orientation and well-being outcomes, and PENS and well-being outcomes. First, it was expected there would be significant positive correlations between BPNS and physical and psychological well-being outcomes. BPNS was predicted to positively correlate to task orientation and negatively correlate to ego orientation. Task orientation and PENS were expected to positively correlate to physical and psychological well-being outcomes, while Ego orientation was expected to show a negative correlation with both well-being outcomes. PENS was predicted to positively correlate with both well-being

outcomes. To test for differences between these variables in both groups, one-way ANOVAs were used. H2 was tested by using a median split of ego orientation to form a group of "high ego orientation" participants, and then performing a one-way ANOVA to assess whether the group with high vs. low PENS ratings (based on a median split) differed in their physical and psychological well-being.

The exploratory analyses were tested by two sets multiple regressions with the dependent variable as physical and psychological well-being for each set. Group ID (ARG or LE group) was entered in the first step of the regression for all sets. BPNS was entered into the second step of the regression for all sets, followed by task and then ego orientation as the third and fourth steps for each set. The fifth step was PENS ratings. Then a second set of regressions was performed, reversing the order of steps three and four to analyze for order effects among task and ego orientation. It was expected each step of the regression would demonstrate statistically significant relationships between the factors and both psychological and physical wellness.

To account for error inflation given the number of hypothesis tests a Bonferonni correction was applied, setting the threshold of significance to $p = .01$. A principal component analysis was also performed to analyze factor structure to ensure psychological measures are loading appropriately in the study sample.

Results

A summary of variable descriptive statistics is shown in Table 2. Overall ratings of health (both physical and psychological) were high, and slightly but not significantly different by group. Ratings of physical health were slightly higher for the LE group ($M = 74.1$, $SD = 22.2$) than the ARG group ($M = 70.7$, $SD = 21.2$; $t(377) = 1.52$, $p = .130$). Overall ratings of psychological health were also higher but not significantly so for the LE group ($M = 67.2$, $SD =$

22.6) than the ARG group (M = 63.6, SD = 20.7; $t(383) = 1.64$, $p = .101$). For the individual tests, the groups rated themselves the same on trait-level basic psychological needs satisfaction (BPNS; M_{LE} = 4.92, SD_{LE} = 1.14; M_{ARG} = 4.79, SD_{ARG} = 1.00; $t(381) = 1.17$, $p = .051$). However, there were slight but significant differences between groups in the other ratings. In task orientation the ARG group rated themselves slightly higher (M_{ARG} = 3.87, SD_{ARG} = .64) than LE (M_{LE} = 3.68, SD_{LE} = .82; $t(396) = -2.76$, $p = .004$). By contrast, for ego orientation, the LE group (M_{LE} = 3.16, SD_{LE} = .99) rated themselves higher than the ARG group (M_{ARG} = 2.63, SD_{ARG} = .80; $t(397) = 5.92$, $p = .003$). The two groups also differed slightly but significantly in state-level needs satisfaction (PENS) ratings (M_{LE} = 3.24, SD_{LE} = .79; M_{ARG} = 3.57, SD_{ARG} = .66; $t(396) = -4.46$, $p = .045$). Next, the set of hypotheses were analyzed with each group treated independently (ARG and LE) and then repeated with the groups combined.

Hypothesis 1

It was hypothesized that overall basic psychological need satisfaction (BPNS) would relate to psychological and physical well-being such that higher levels of basic needs satisfaction would correlate with higher levels of psychological and physical well-being. A Pearson product-moment correlation was computed to examine the relationship between BPNS ratings and both psychological and physical well-being (RAND) scores. Across a combined group of light exercise and ARG players, and within each group individually, basic needs satisfaction did relate to health. For the combined groups, there was a positive correlation between BPNS and psychological health, $r_{combined}$ = .698, n = 364, $p < .001$. Likewise, there was a positive correlation between BPNS and physical health, $r_{combined}$ = .554, n = 361, $p < .001$. The same significant correlations held for the individual groups for both physical well-being (r_{LE} = .547, n = 176, $p < .01$; r_{ARG} = .558, n = 186, $p < .01$) and psychological well-being (r_{LE} = .717, $p < .01$;

r_{ARG} = .675, n = 187, p < .01). A scatterplot summarizes these results in Figures 1 and 2, respectively, and shows the individual groups and fit lines. This result demonstrates that there was a strong, positive correlation between reporting basic psychological needs satisfaction and ratings of both physical and psychological well-being by both groups. The correlations between these groups combined and separately are detailed in Tables 3, 4, and 5, respectively.

As part of H1, it was also predicted that higher levels of BPNS would relate to higher levels of task-orientation, and lower levels of ego-orientation. This hypothesis was only partly supported, and there were slight but significant differences between groups, as depicted in Figures 3 and 4. BPNS scores overall showed the predicted positive correlation with task-orientation, and this held with the groups combined ($r_{combined}$ = .386, n = 379, p < .001) and separate (r_{ARG} = .410, n = 197, p < .001; r_{LE} = .388, n = 182, p < .001). To test the question with an ANOVA, BPNS scores were coded into high vs. low BPNS based on a median split. A one-way ANOVA showed that there was a significant difference in task orientation between high BPNS ($M_{combined}$ = 4.04, SD = .666) and low BPNS groups ($M_{combined}$ = 3.54, SD = .717; $F_{combined}$ (1, 397) = 53.081, p < .001). When looking at the groups individually, we see a similar pattern of significant differences between the task orientation ratings of high BPNS (M_{LE} = 3.93, SD = .760; M_{ARG} = 4.17, SD = .973) vs. low BPNS groups (M_{LE} = 3.40, SD = .798; M_{ARG} = 3.65, SD = .630; F_{LE}(1,192) = 21.880, p < .001, F_{ARG}(1,204) = 40.693, p < .001). This finding was expected as part of the original hypotheses.

A second part of the approach orientation prediction was not supported: overall BPNS ratings did not demonstrate the predicted negative correlation with ego-orientation. This nonsignificant relationship held when the groups were combined ($r_{combined}$ = .062, n = 378, p= .233), and separate (r_{ARG} = .003, n = 195, p =.972; r_{LE} = .080, n = 183, p =.280). As with the

measure of task orientation, this prediction was also tested by comparing ego orientation levels between groups of people who were split into high vs. low BPNS ratings and showed a conflicting result. A one-way ANOVA on the combined groups showed that there was a significant difference in ego orientation between high BPNS ($M_{combined}$ = 2.99, SD = 1.01) and low BPNS groups ($M_{combined}$ =2.80, SD = 0.86; $F_{combined}$ (1, 398) =4.26, p =.040). When looking at the groups individually, it becomes clear that the overall difference in ego orientation is driven by the LE group only. In the LE group the high BPNS participants rated themselves significantly higher on ego orientation (M=3.31, SD=0.98) than the low BPNS group (M=3.01, SD=0.99; F_{LE}(1,194)=4.62, p=.035). By contrast, in the ARG group, there was no difference in ego orientation based on high vs. low BPNS (F_{ARG}(1,203)=.000, p=.996), reflecting the nearly identical ego orientation ratings for the high BPNS group (M=2.63, SD=0.93) and the low BPNS group (M=2.63, SD=0.70).

These results do not conform to the predictions of a negative correlation between BPNS and ego orientation ratings. In fact, the ANOVA reveals that for the LE group only, there was the opposite relationship to the prediction: people with higher BPNS reported slightly and significantly higher ego orientation, rather than the predicted lower ego orientation. Finally, a correlation revealed the expected negative relationship between task- and ego-orientation, and this held when the groups were combined ($r_{combined}$ = -.376, n = 393, p < .001) and separate (r_{ARG} = -.280, n = 202, p <.001; r_{LE} = -.405, n = 184, p<.001). The relationship between task- and ego-orientation was not directly part of this study's hypotheses; however, this finding is expected as this was originally demonstrated in the measure's validity testing (Duda, 1989).

When examining the relationship between task orientation and well-being outcomes while the groups are combined, we see there are small, significant positive correlations between

task orientation, and both physical ($r_{combined}$ = .106, n = 379, p < .001) and psychological well-being ($r_{combined}$ = .166, n = 385, p < .001). While looking at each group individually we see a similar pattern between task orientation, and physical and psychological well-being for the ARG group (r_{ARG} = .161, n = 186, p < .001; r_{ARG} = .188, n = 187, p < .001, respectively). In the LE group the relationship between task orientation and psychological well-being was significant (r_{LE} = .170, n = 177, p < .001); however, task orientation was not significantly correlated to physical well-being (r_{LE} = .087, n = 175, p = .247). These findings are further illustrated in Figures 5 and 6, respectively. Overall, the results examining the relationship between task orientation, and physical and psychological well-being were mostly supportive of H1.

The correlational relationship was also examined between ego orientation and well-being outcomes, and a negative correlation was predicted. While the groups were combined, ego orientation and physical well-being demonstrated a small, significant positive correlation ($r_{combined}$ = .159, n = 379, p < .001); however, ego orientation was not significantly related to psychological well-being ($r_{combined}$ = .059, n = 385, p = .256). Examining each group individually we see that in the ARG group, ego orientation was not related to either physical or psychological well-being (r_{ARG} = .134, n = 186, p = .066; r_{ARG} = .080, n = 187, p = .272, respectively). In the LE group, ego orientation was significantly positively correlated to physical well-being (r_{LE} = .150, n = 175, p < .001) but ego orientation was not significantly related to psychological well-being (r_{LE} = .009, n = 177, p = .904. These relationships are illustrated in Figures 7 and 8, respectively. Overall, the results between the relationship of ego orientation, and physical and psychological well-being outcomes were mixed, but largely do not support H1.

Lastly, the analysis of PENS ratings revealed that when the groups were combined, the predicted significant positive correlation was observed in the relationship between PENS and

both physical well-being ($r_{combined}$ = .166, n = 371, p < .001) and psychological well-being ($r_{combined}$ = .275, n = 376, p < .001). We see a similar pattern of significance in the correlations when the groups are separated, for both physical well-being (r_{ARG} = .166, n = 186, p < .001; r_{LE} = .222, n = 175, p < .001) and psychological well-being (r_{ARG} = .220, n = 187, p < .001; r_{LE} = .362, n = 177, p < .001) These results are illustrated in Figures 9 and 10, respectively.

Overall, the analyses revealed support for parts of H1, particularly the strong positive correlation between BPNS and overall psychological and physical well-being. The expected correlations among BPNS and the two kinds of approach orientation showed mixed results: BPNS was positively correlated with Task orientation, as expected, but BPNS was not correlated with Ego orientation. Similarly, Task orientation was positively correlated with well-being outcomes, while Ego orientation did not show the predicted relationship. Finally, PENS ratings were significantly positively correlated with both physical and psychological well-being, as predicted.

Hypothesis 2

It was predicted that higher levels of ego orientation would relate to physical and psychological well-being outcomes when PENS ratings were also high. Participants (combined across groups) were sorted into groups of high vs. low ego-orientation, then only the high ego-orientation group was tested (n=177). This group was then divided based on a median split of PENS ratings, and groups were examined for differences in well-being outcomes with a one-way ANOVA. The ANOVA revealed that there was a slight but nonsignificant difference in physical well-being, after taking the Bonferonni correction into account, (F(1, 169) = 5.267, p = .023, $M_{LowPENS}$ = 71.55, SD = 20.87, $M_{HighPENS}$ = 78.89, SD = 20.65). However, there was a significant difference between high and low PENS groups in the predicted direction for psychological well-

being ($F(1,167) = 14.905$, $p < .001$, $M_{LowPENS} = 59.81$, $SD = 22.67$, $M_{HighPENS} = 72.89$, $SD = 20.77$). This shows that for the subgroup of participants who rated themselves high on ego orientation, participants who reported higher state-level needs satisfaction (PENS ratings), reported better psychological well-being than participants who reported lower state-level needs satisfaction. But the same predicted difference did not emerge for physical well-being.

The same questions were asked for the individual groups, and we see that for the LE group, results from the high ego-orientation subset (n=98) replicates the group results, with the high PENS group reporting slightly but nonsignificantly higher physical well-being ($F(1,90) = 5.059$, $p = .027$,$M_{LowPENS} = 72.28$, $SD = 23.45$, $M_{HighPENS} = 82.86$, $SD = 17.92$), and significantly higher psychological well-being ($F(1,90) = 11.587$, $p = .001$, $M_{LowPENS} = 59.55$, $SD = 25.42$, $M_{HighPENS} = 76.47$, $SD = 18.10$). However, the ARG subgroup with high ego-orientation (n=79) did not show significantly different ratings when comparing high and low PENS groups for either psychological well-being ($F(1,75) = 4.280$, $p = .042$), or physical well-being ($F(1,77) = 1.521$, $p = .221$). The mean ratings for the high ego subset of the ARG group showed a slight but nonsignificant difference for both physical well-being ($M_{LowPENS} = 70.36$, $SD = 16.00$, $M_{HighPENS} = 75.84$, $SD = 22.26$) and psychological well-being ($M_{LowPENS} = 60.21$, $SD = 17.86$, $M_{HighPENS} = 69.85$, $SD = 22.57$). Thus although the differences were in the predicted direction, they were small and nonsignificant for the ARG high ego-orientation subgroup. Overall, these results only partially supported H2; results are depicted in Figures 11 (physical well-being) and 12 (psychological well-being).

Exploratory Analyses

Lastly, multiple regressions were performed to evaluate the relationship between the variables of BPNS, task and ego orientation, and PENS ratings with respect to the outcome

health variables. Two sets of regressions were performed, with the first regression treating overall physical well-being from the RAND scores as the dependent variable, and the second with a dependent variable of overall psychological well-being. The participants' respective group (light exercise vs. ARG players) was entered into the first step, followed by the overall BPNS scores as the second step. The third step included overall task orientation, and the fourth step included overall ego orientation. Lastly, the overall PENS scores, measuring engagement with the activity, made up the final step. To evaluate for order effects in approach orientation, the regression was performed again for each set; ego orientation was entered as the third step, and task orientation was entered in the fourth step. This variation in testing order did not change the significance or direction of any of the results, so only the first order (task scores followed by ego scores) is reported.

The results from these regressions (Tables 6 and 7) show the following about physical health. In step one, group classification (ARG vs. light exercise) was non-significant ($p = .063$) which suggests both groups can be treated as a single entity as there was no significant difference between our sample of how people engaging in light exercise rate their physical health compared with people engaging in ARGs. In step two, BPNS scores were significant ($p < .001$) which supports the prediction that basic psychological need satisfaction has a meaningful relationship with physical well-being outcomes. In step three when task orientation was entered into this layer, task orientation appeared non-significant ($p = .051$) though strongly trended towards statistical significance with its relationship to physical well-being outcomes; this result does not support the original hypothesis. In step four when ego orientation was entered into this layer, ego orientation was significant ($p = .040$) which supports the hypothesis that ego orientation also relates to physical well-being outcomes in addition to BPNS. Finally, the last step, overall PENS

scores – that is, state-level needs satisfaction with the activity itself -- had no significant effects ($p = .702$). Several general patterns emerged from these regressions: both trait-level needs satisfaction (BPNS) and ego orientation predicted higher levels of physical well-being, but they were not moderated by state-level needs satisfaction. These results for physical well-being show that ego orientation explains the most variance when accounting for the relationship between BPNS, approach orientation, and physical well-being; while ratings of task orientation and state-level needs satisfaction are not significant factors.

The second set of regressions, where psychological well-being is treated as the dependent variable, calculated each step using the same method as for physical well-being. Steps three and four were first analyzed as task then ego orientation, and then re-analyzed as ego then task orientation. Again, there was no difference in results based on the order of steps three and four, so the results are reported as above, with the order of task then ego. The results from these regressions are detailed in Tables 8 and 9. The results from the second regression revealed some similar results between psychological and physical health: Step one, group membership (ARG vs. light exercise) was again non-significant ($p = .093$) suggesting that each group did not significantly differ in psychological well-being outcomes. In step two, BPNS scores were significantly related to psychological well-being outcomes ($p < .001$). This indicates that higher levels of basic psychological needs satisfaction positively correlated to higher levels of psychological well-being outcomes. Step three showed task orientation was significant ($p = .022$) suggesting that task orientation, in addition to BPNS, positively relates to psychological well-being outcomes; this is supportive of the original hypothesis. In step four when ego orientation is entered in this layer, ego orientation is not significant ($p = .650$), which does not support the initial hypothesis. These two steps revealed a difference from the tests on physical

health, which showed an influence of ego orientation but not of task orientation. Lastly, in step five, PENS scores did not significantly relate to psychological well-being outcomes (p = .990), similar to the results for physical health and failing to support the original prediction. Overall, these results suggest psychological well-being outcomes are better accounted for by BPNS and task orientation, while ego-orientation and state-level needs satisfaction (PENS scores) were non-significant.

Principal Component Analysis

PCAs were performed for each measure with both the LE and ARG groups separately. In the LE group, PCA factor loadings for BPNS demonstrate having one factor with an eigenvalue of 11.345, further supported by the scree test. In the ARG group, PCA factor loadings for BPNS demonstrate having two factors with eigenvalues 9.632 and 3.896, also supported by the scree test. For the TEOSQ, PCA factor loadings demonstrate two factors for the LE group, eigenvalues 5.880 and 2.630, and in the ARG group two factors were also observed with eigenvalues 4.379 and 2.478. The PENS demonstrated PCA factor loadings consistent with two factors for the LE group with eigenvalues of 4.252 and 1.604, and the ARG group showed one factor with an eigenvalue of 3.872. Both of these eigenvalues were supported by the scree test. Lastly, PCA factor loadings for the RAND in the LE group demonstrated two factors with eigenvalues of 13.924 and 4.069. In the ARG group, factor loadings demonstrated three factors, eigenvalues of 12.343, 3.952, and 1.989. These eigenvalues were also supported by the scree test.

Discussion

The goal of this study was to test whether the predictions of self-determination theory can be used to interpret how people's engagement with ARGs, specifically Pokémon Go, relates to

more or less positive health and well-being. The results showed some support for the SDT model predictions but raised some questions as well.

The first main prediction was that both basic psychological needs satisfaction and approach orientation (task and ego) would play a significant role when predicting physical and psychological well-being outcomes. The results showed a clear positive correlation between both physical and psychological health and ratings of basic psychological needs satisfaction (BPNS). While there were slight differences between groups on the levels of their self-ratings, the pattern of results was the same for both light exercisers and ARG players. For both groups, higher BPNS levels related to higher well-being outcome levels, and lower BPNS levels related to lower well-being outcomes. Similarly, the state measure of psychological needs satisfaction, the PENS, also showed significant positive correlations with both well-being outcomes. These results suggest that people overall report feeling higher levels of physical and mental health when their basic psychological needs – autonomy, competence, and relatedness -- are satisfied. Aligned with the predictions of SDT, this means that as we are more agentic over our behaviors and choices, feel effective in the tasks we engage with, and develop meaningful connections with important others, we feel that we have an overall sense of better physical and psychological wellness. These findings underscore the importance the role basic psychological needs satisfaction has on an overall basis – when people report that they believe that their basic psychological needs being satisfied, we also see that people report feeling physically and mentally better overall.

The relationship between trait-level needs satisfaction (BPNS) and approach orientation was mixed. While the relationship between BPNS and task orientation was significant as predicted, the relationship between BPNS and ego orientation did not demonstrate significance.

Since task orientation conceptually aligns itself with the notion of an autonomy-supportive environment, and that BPNS and task orientation were positively correlated, it stands to reason that people who have their trait-level needs satisfied would likely have higher levels of autonomy-support, and that this would share a relationship with task orientation. However, since ego orientation was unrelated to BPNS, this suggests that ego orientation may not conceptually align itself with the thwarting of trait-level needs satisfaction (e.g., overall lower levels of autonomy, competence, and relatedness), so it is possible that ego orientation functions as a different construct altogether.

Approach orientations also offered mixed results in their relationship to physical and psychological well-being outcomes. Small, positive correlations were discovered in the relationship between task orientation and both physical and psychological well-being in the ARG group; however, these correlations were rather weak. Since BPNS was much more strongly correlated to both physical and psychological well-being in this group, it is difficult to interpret if task orientation was providing any meaningful information among the overarching hypotheses. One explanation for this would be that BPNS as a whole is a better indicator for evaluating a relationship between physical and psychological well-being. The exploratory regressions appear to support this idea as BPNS accounts for the vast majority of the variance across all variables of interest. In the LE group, the correlation was significant between task orientation and psychological well-being, as predicted, but not significant between task orientation and physical well-being, which was unexpected. This difference between groups could reflect differences in how being task-oriented approach interacts with different kinds of activity. Overall, the H1 predictions about task orientation were largely, though somewhat weakly, supported.

However, unlike task orientation, the data largely did not support the predicted negative relationship between ego orientation and physical and psychological well-being. For the ARG group, ego orientation was not correlated with health outcomes at all; participants with high ego orientation did not report different health from participants with low ego orientation. For the LE group, there was no relationship between ego orientation and psychological well-being. But there was a small, significant correlation in the LE group between ego orientation and physical well-being, and this correlation was in the positive direction. This result was very unexpected, suggesting that (at least within one group of light exercisers), people who reported higher ego-orientation were also reporting better physical health than people with lower ego-orientation. Since ego-orientation is associated, in previous research, with poor outcomes, this unpredicted result needs more research.

The exploratory regressions showed similar patterns, and any significance demonstrated by ego orientation to physical and psychological well-being outcomes is difficult to interpret given that BPNS and ego orientation did not share a relationship whatsoever. One possible explanation could be how ego orientation manifests in the LE group. Since ego orientation incorporates an element of contingency based on outcome or performance, such a contingency could be clearer within the LE group. For example, when engaging with light exercise, distinct goals can be set (e.g., lifting a specified number of weights, taking so many steps per day). With the ARG group these goals or performance may more ambiguous and less objective in perceived outcome or performance. As a whole, it appears that approach orientations offer little to be gained in understanding the relationship between trait-level needs satisfaction, and physical and psychological well-being outcomes. Additionally, the LE group demonstrated an unexpected finding by showing a positive correlation between ego orientation and physical well-being which

was contrary to the predicted direction. Rather, trait-level needs satisfaction, followed by state-level needs satisfaction, appears to be better indicators when looking at such a relationship.

A significant relationship was also found between state-level needs satisfaction, and physical and psychological well-being. Consistent with prior SDT literature, we see that needs satisfaction with the activity also plays an important role when understanding their relationship to physical and mental health (Przybylski et al., 2009). In the current study, BPNS and PENS were found to strongly, positively correlate with each other; however, the correlation was not a complete overlap. This suggests that trait- and state-level needs satisfaction are slightly different but might both be important when understanding how the SDT model relates to physical and psychological well-being.

Support for the specific predictions about ego orientation in H2 was somewhat mixed. It was predicted that among participants with higher levels of ego orientation, that higher levels of PENS ratings would relate to higher levels of physical and psychological well-being, compared to those with lower PENS ratings. With both groups combined, the results supported this prediction for physical well-being; however, looking at the individual groups we see that only the LE group showed the predicted significant relationship. By contrast, for psychological well-being, there was a significant difference in outcomes based on PENS ratings when both groups were combined, and also when the groups were observed individually. Thus for psychological well-being, participants who were high in ego orientation and also high on PENS ratings reported better health than those with high ego orientation and low PENS ratings. Overall, the original H2 hypothesis was mostly supported with the exception of physical well-being within the ARG group. This may be due in part to the nature of the LE group in this sample, who also reported significantly higher ratings on physical well-being than the ARG group. It is also

possible that higher ratings may obscure the difference between high and lows PENS ratings in this relationship. From an SDT perspective, the relationship demonstrated between the PENS ratings and health outcomes is also consistent with prior literature, which supports the idea that state-level satisfaction with the activity itself may play a role in well-being outcomes (Przybylski et al., 2009).

Regarding the exploratory analyses for this study, which were conducted to examine possible relationships among all of the variables, mixed results added questions for understanding how the components of SDT fit together. First, trait level needs satisfaction (BPNS) was significantly related to both well-being outcomes for both groups. This confirms the correlation results and the main prediction that psychological needs satisfaction is related to well-being. For approach orientation, it was found that both task and ego orientation relate to physical and psychological well-being outcomes; however, results show that ego orientation only correlated with physical health ratings whereas task orientation only correlated with psychological health ratings. Thus for approach orientation, the predictions were not clearly supported, and it is only possible to hypothesize why. With respect to ego orientation, one explanation may be due to the nature of one's perceived performance with physical activities. Prior research has shown that pre-task assessments of anticipated performance can affect how participants engage with the activity, and how these pre-task assessments affect results after activity completion (Gagne et al., 2003). For the present study, perceived performance may be a factor influencing ego orientation in both the LE and ARG groups. For the LE group, this perceived performance may manifest in meeting certain goals set on a daily basis (e.g., achieving 10,000 steps per day). For the ARG group, perceived performance may be shown in the amount

of area the user covers while interacting with the Pokémon Go application to obtain objectives within the game itself that may be contingent upon number of steps taken, for example.

With respect to the results on task orientation, one explanation for the inconsistent effects may be the significant relationship task orientation shares with BPNS, an SDT construct. SDT posits that higher levels of autonomy, competence, and relatedness – all of which encompass BPNS – correlates with intrinsic motivation, and that intrinsic motivation and task orientation are conceptually similar. In task orientation and intrinsic motivation, we are engaging in activities and behaviors authentically and for the experience itself rather than contingent on outcomes (such as performance), so it stands to reason that higher mental health ratings may occur when we are engaging with an activity because we take interest or joy in doing so (Deci & Ryan, 2000). Task orientation is more difficult to interpret within the context of the exploratory regressions as this appears to only relate to psychological well-being and so presents a two-fold challenge. First, though task orientation does demonstrate significance within the regression it is difficult to state if this is meaningful to the entire model since the correlations between task orientation, and physical and psychological well-being were rather weak. Rather, it appears that BPNS is a better, and stronger, indicator of this relationship from both a correlational and regression standpoint. Second, task orientation only appears to be significant within the regression relative to psychological well-being. One possible explanation, as mentioned earlier, is that BPNS is the prevailing construct when measuring physical and psychological well-being, as such, BPNS may be accounting for most of the variance when exploring a relationship between task orientation and physical well-being such that little to no variance is remaining for task orientation to account for on its own.

Further exploratory analyses, with the groups separate and combined, showed that BPNS did positively relate to task-orientation; however, BPNS did not relate to ego-orientation. These results suggest that when basic psychological needs are satisfied people are more likely to approach activities such that they are engaging in the activity for the sake of itself, or simply because they are interested in doing so (task-oriented). However, BPNS did not relate to ego-orientation, suggesting there was no relationship between trait-level needs satisfaction and approaching the activity in a manner where one's performance or self-worth are tied to the activity's engagement (ego-oriented). This finding is unexpected. It is made more interesting by the expected negative correlation between individual's ratings of their own task vs. ego orientation; showing the constructs were functioning generally as expected, and people who rated themselves higher on task orientation also rated themselves lower on ego orientation. SDT predicts that lower levels of BPNS are generally related to higher levels of extrinsic motivation to the extent that individuals may engage in activities or behaviors out of a sense of fear, guilt, shame, or obligation to oneself or another (conceptually similar to ego orientation) rather than engaging an activity or behavior because it interests them personally, or provides the person a sense happiness (conceptually similar to task orientation; Deci & Ryan, 2000). Based on the literature of SDT we would then expect ego orientation to negatively correlate to BPNS; however, that was not the case in the current study and was an unexpected finding as a result. This may be due to ego orientation requiring a more detailed analysis relative to the SDT framework, or that the effect was not demonstrated due to an unknown phenomenon unique to this current study's sample. Overall, the relationship between approach orientation and the variables of interest was unclear in the present results.

The final set of exploratory analyses was designed to examine a more nuanced relationship among all of the variables with respect to physical and psychological well-being. Contrary to predictions, in the regression the results differed by health type. While all regressions confirmed the importance of BPNS, or trait level needs satisfaction, for both well-being outcomes, the results for the remaining variables were not as expected. For physical health, ego orientation was a significant factor, but task orientation was not. For mental health, task orientation was significant in the regression whereas ego orientation was not significant. This means that when we analyze the variables in a stepwise manner, BPNS initially takes its share of the variance with its relationship to physical and mental health ratings; however, when the dependent variable is physical health ratings then ego orientation is accounting for the remaining variance above and beyond both task orientation and PENS scores. One possible explanation lies with the relationship between BPNS and task orientation. Since these two variables shared a significant, positive correlation, it is possible that when these variables are entered into a regression that BPNS is accounting for any variance that task orientation may have on its own. Unexpectedly, this only occurs in the regression evaluating physical health ratings and not when mental health ratings are the outcome in the regression. Additionally, the correlation between task orientation and psychological well-being outcomes, while significant, is not particularly large, and this is true when the groups are analyzed together or separately. This suggests that task orientation has a very important dynamic with respect to psychological well-being outcomes to the extent that task orientation, with only a small, positive correlation to psychological well-being outcomes, accounts for the remaining variance above and beyond both ego orientation and PENS scores after BPNS has already taken its share.

The regression also revealed that higher levels of needs satisfaction with the activity (PENS) do not relate to higher levels of well-being outcomes, and appears to add no further explanatory power above and beyond the BPNS scores and task or ego orientation depending on whether the outcome variable was physical or mental health ratings. Overall, we see that PENS scores are non-significant in their relationship to both physical and psychological well-being outcomes within the context of the regression. This means that needs satisfaction with the activity does not necessarily influence health outcome ratings. Rather, these health ratings appear better accounted for by BPNS and, in uneven ways, by approach orientation. The lack of contribution of PENS ratings, above and beyond BPNS, is something that should be explored in future research.

One possible reason for the differences between ARG and LE groups that emerged in the regression is that different kinds of activities may show the influence of different factors. While this is not specifically predicted by the general SDT model, it may not have been widely enough tested to show differences based on comparison activities, as in this research. Some of the unexpected finding from this study may be a result of a phenomenon similar to "predetermination," observed in earlier research where participants' pre-task assessments appeared to be an indicator of their task performance and post-task assessment outcomes (Gagne et al., 2003). With the current study, this trend appeared to occur within the light exercise group as demonstrated by their BPNS, ego orientation and well-being outcomes. However, in the ARG group the ego orientation measure was non-significant factor in the regression. This may imply that different activities may fundamentally differ in how well-being is affected by BPNS and moderating factors. For example, with the light exercise group, the manner in which participants engage in light exercise directly affect light exercise performance and expected outcomes such

that these may be predetermined at the approach orientation level. It may be of interest to explore the possibility of priming one's approach orientation via pre-activity assessments to evaluate for significant differences in outcomes when compared to non-primed participants. Additionally, it would be of interest to explore whether the priming condition demonstrates any meaningful effect on participants as a function of participant approach orientation. It is possible that priming one's approach orientation pre-activity may not have a meaningful effect on participants who are more task-oriented. Given that participants who are more task-oriented are likely engaging with an activity for the sake of the activity itself (in parallel with SDT's description of intrinsic motivation), any priming effects may be less influential to the participant. However, in the case of participants who are more ego-oriented, and by extension having some degree of their self-worth or value placed on their activity performance, the priming effect may have a more noticeable effect on activity performance and demonstrate more profound outcomes in post-activity assessments, for better or worse.

Differences in how the SDT factors affect different activities may suggest that, with respect to the ARG engagement using Pokémon Go, the structure of approach orientation is better tied to overall basic needs satisfaction and specifically task orientation, but not ego orientation. As mentioned earlier, observing a significant, positive relationship between BPNS scores and psychological well-being outcomes is consistent with prior literature. Ego orientation was found not to relate to BPNS which suggests that 1) BPNS may not be a good indicator for ego orientation, 2) we may require a more detailed approach to evaluate ego orientation effectively within the SDT framework, or 3) ego orientation manifests in such way within this particular sample that a relationship could not be detected between it and BPNS. Finally, the PENS scores shared a similar non-significant relationship as observed in the exploratory

regressions, which was not expected, and in contrast to the strong positive correlation, in the initial correlations, between PENS and well-being outcomes. In the regression, the non-significant relationship may be accounted for by the predetermination of experience at the approach orientation level for non-gaming contexts, or may be better described by overall basic needs satisfaction with task orientation when a gaming context is introduced.

While some of the hypotheses were not supported, overall this research found the expected relationships between psychological needs satisfaction and well-being outcomes when playing an ARG, but the study was limited in important ways. One limiting factor to this study was the survey-only design used, meaning all the factors (including the "outcomes" of well-being) were measured simultaneously, and causality cannot be inferred. While this design helped to be able to test the general relationship among all the constructs, it could be advanced by using an experimental design which allows for a light exercise and ARG group to have physical (e.g., heart rate, calorie expenditure) and psychological measures (e.g., needs satisfaction, vitality) assessed pre- and post-activity. A study design using experimental procedures rather than survey-only may allow for a better representation of approach orientation as it is possible this variable could not be adequately assessed using survey-only methods. Such a design would also allow for better exploration of participant engagement time with the activity. Different increments of time (e.g., 30 minutes, 45 minutes, 60 minutes) may have different effects on overall outcomes. In addition, the SDT theory has many sub-theories, and other components of SDT might fit these groups better. For example, the prior literature on SDT and video games incorporates measures of harmonious and obsessive play where the present study did not. By itself this is a limitation to the current findings as earlier research found significant relationships with the measures of harmonious and obsessive play and needs satisfaction.

Furthermore, SDT constructs often link to, or can be further explained by, intrinsic and extrinsic motivation which was not evaluated in this study. Some of the inconsistent results in this research, between the predictions for task and ego orientation, may be better captured by measuring intrinsic and extrinsic motivation. Within the framework of SDT there are five sub-theories, one of which is Organism Integration Theory (OIT) which goes into much more detail for intrinsic and extrinsic motivation (Deci & Ryan, 2000). Future studies in this area should strongly consider incorporating BNT, as used in this study, and OIT as well, to clarify how psychological needs and these kinds of motivation are related.

Another limiting factor is that the overall sample in this study may have been healthier than expected. Overall psychological health in this sample was comparable to the central tendency published for the RAND; however, overall physical health was higher than the RAND's central tendency. It is unclear whether this effect may have been the result of the sample demographics, study design (survey-only), or a combination of these two. This study also did not evaluate participant ethnicity, which is a limitation of the area of AR and videogame research in general. A recent review by Baranowski and Lyons (2020) argued that much of the AR literature has participants who are predominantly White men, and that other ethnicities are not well represented. One possible reason is that non-White players of ARGs have reported feeling unwelcomed or unsafe in the community, as they follow instructions in the game to move from place to place. Additionally, societal views may adversely affect ARG participation such that cultures which are predisposed to a hostile attribution towards video games – regardless of documented positive outcomes – may adversely affect involvement (Baranowski & Lyons, 2020). Going forward, these are important factors to consider, and were not incorporated within

the current study as the data was collected prior to the publication of the review by Baranowski and Lyons (2020).

A final limitation is that the survey was conducted over mTurk, an online system, where the participants were offered a small monetary incentive for completing the survey. It is possible that participants may have felt the incentive offered was insufficient compared to other possible mTurk surveys, particularly if the expectation is for payment to be equivalent to at least minimum wage within the United States (Silberman et al., 2018). Data quality is also a valid concern when using mTurk although some methods were employed to improve data quality such as restricting the sampling pool and requiring a minimum threshold for participant HIT approval ratio; however, additional measures can be implemented on future studies, such as attention checks (Hauser et al., 2019).

Among the unexpected findings in this study was the discovery of a significant difference in age between the ARG and LE groups. Though the SDT and AR literature do not make predictions relative to age, this sample exhibited a significant difference with a small meaningful effect size ($p < .001$, $d = .389$). When looking at the relationship of age relative to the variables measured within the current study, age is only significantly, and weakly, correlated with BPNS and this correlation is only present within the LE group ($r = .200$, $p < .01$). Given the limited manifestation of this finding, and that this study was centered on ARG players, it is unlikely this contributed in any important way to changing the results on the main hypotheses. However, as a result of the unexpected finding it would be recommended to incorporate age as a variable of interest in future studies examining non-AR exercise groups.

Conclusion

The main prediction of this study, that psychological needs satisfaction is related to well-being outcomes for people who play ARGs, was supported. However, the overarching hypothesis that all SDT factors would be relevant to health outcomes was not fully supported. Findings indicate that there is a relationship between BPNS, task and ego orientation in limited contexts, and well-being outcomes among users of Pokémon Go, and these general relationships were confirmed in a group of light exercisers. The effects of approach orientation depended both on the analyses and the groups. While task orientation showed the expected positive correlation with both needs satisfaction and well-being, ego orientation showed either no correlation (ARG group) or the reverse of the expected (a positive correlation between ego orientation and physical well-being in the LE group). In the exploratory regression, ego orientation appears to only have an effect within the context of light exercisers, whereas task orientation appears to only manifest significantly in ARG players. These findings warrant further investigation as to whether effects of approach orientation are context-specific, and not the same across ARGs and light exercise. The current study interpretation is limited by its correlational design. An experimental design evaluating these constructs may produce similar results and could explore a model examining ARG and health outcomes in greater detail, by measuring factors pre- and post-play, and controlling for amount of involvement. It is recommended future designs incorporate evaluations of physical health post-activity use (e.g., heart rate, calorie consumption) to gain a better understanding of the role that ARG engagement has in relation to physical health outcomes. A structured use of activity engagement for both light exercise and ARG use would also contribute to improved analysis as there may be, on average, an amount of time which offers the maximal benefit while minimizing any detrimental effects, such as post-activity fatigue and energy depletion. Future studies should also consider prospective short- and long-term effects

of ARG engagement when evaluating ARGs to promote increased physical activity. A review of the AR literature strongly suggests, in limited cases, only short-term effects resulting from an AR manipulation, and no long-term effects have been observed (Baranowski & Lyons, 2020). However, there is reason to consider that long term effects may occur only within the SDT framework given the prior SDT research which has demonstrated durative components resulting from autonomy-supportive environments (Niemiec et al., 2009). These predictions contrast one another, therefore it would be of interest to explore them, and examine whether the SDT framework applied to an AR intervention could result in a sustained increased of physical activity secondary to an autonomy-supportive context.

Overall, this study found support for using SDT to understand the positive relationships between ARG use and physical and psychological well-being. In particular, measures of the main components of SDT (autonomy, competence, and relatedness) show clear correlations with health outcomes, both when measured at the trait and state level, for players of an ARG.

References

Akçayır, M., Akçayır, G., Pektaş, H. M., & Ocak, M. A. (2016). Augmented reality in science laboratories: The effects of augmented reality on university students' laboratory skills and attitudes towards science laboratories. *Computers in Human Behavior*, *57*, 334-342. doi: 10.1016/j.chb.2015.12.054

Baranowski, T., & Lyons, E. J. (2020). Scoping review of pokémon go: Comprehensive assessment of augmented reality for physical activity change. *Games for Health Journal*, *9*, 71-84. doi: 10.1089/g4h.2019.0034

Bushman, B. J., & Anderson, C. A. (2002). Violent video games and hostile expectations: A test of the general aggression model. *Personality and social psychology bulletin*, *28*(12), 1679-1686.

Business of Apps. (2016). *Pokémon Go Usage and Revenue Statistics*. Retrieved from: http://www.businessofapps.com/pokemon-go-usage-revenue-statistics/

Business of Apps. (2021). *Pokémon GO Revenue and Usage Statistics (2020)*. Retrieved from: https://www.businessofapps.com/data/pokemon-go-statistics/

Chang, R. C., Chung, L. Y., & Huang, Y. M. (2014). Developing an interactive augmented reality system as a complement to plant education and comparing its effectiveness with video learning. *Interactive Learning Environments*, 1-20.

Chen, B., Vansteenkiste, M., Beyers, W., Boone, L., Deci, E. L., Van der Kaap-Deeder, J., ... & Ryan, R. M. (2015). Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motivation and Emotion*, *39*(2), 216-236. doi: 10.1007/s11031-014-9450-1

Chen, C., Lee, I., & Lin, L. (2016). Augmented reality-based video-modeling storybook of nonverbal facial cues for children with autism spectrum disorder to improve their perceptions and judgments of facial expressions and emotions. *Computers in Human Behavior*, *55*, 477-485. doi: 10.1016/j.chb.2015.09.033

Csikszentmihalyi, M. (1998). *Finding Flow: The Psychology of Engagement with Everyday Life*. New York, NY: Basic Books.

Das, P., Zhu, M. O., McLaughlin, L., Bilgrami, Z., & Milanaik, R. L. (2017). Augmented reality video games: New possibilities and implications for children and adolescents. *Multimodal Technologies and Interaction*, *1*, 8. doi: 10.3390/mti1020008

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry,* 227-268.

Duda, J. L. (1989). Relationship between task and ego orientation and the perceived purpose of sport among high school athletes. *Journal of Sport & Exercise Psychology*,318-335.

Duda, J. L., & White, S. A. (1992). Goal orientations and beliefs about the causes of sport success among elite skiers. *The sport psychologist*, *6*(4), 334-343. doi: 10.1123/tsp.6.4.334

Gagne, M., Ryan, R. M., & Bargmann, K. (2003). Autonomy support and need satisfaction in the motivation and well-being of gymnasts. *Journal of Applied Sport Psychology, 15,* 372-390. doi: 10.1080/10413200390238031

Hauser, D., Paolacci, G., & Chandler, J. (2019). Common concerns with MTurk as a participant pool: Evidence and solutions. In *Handbook of research methods in consumer psychology* (pp. 319-337). Routledge.

Hays, R. D., Sherbourne, C. D., & Mazel, R. M. (1993). The RAND 36-item health survey 1.0. *Health Economics*, 217-227.

Hoermann, S., Hale, L., Winser, S. J., & Regenbrecht, H. (2014). Patient engagement and clinical feasibility of augmented reflection technology for stroke rehabilitation. *International Journal on Disability and Human Development, 13*(3), 355-360. doi: 10.1515/ijdhd-2014-0328

Kim, S. Y. S., Prestopnik, N., & Biocca, F. A. (2014). Body in the interactive game: How interface embodiment affects physical activity and health behavior change. *Computers in Human Behavior*, *36*, 376-384. doi: 10.1016/j.chb.2014.03.067

Laine, T. H., & Suk, H. J. (2015). Designing mobile augmented reality exergames. *Games and Culture, 11*(5), 548-580. doi: 10.1177/1555412015572006

Mackintosh, K. A., Standage, M., Staiano, A. E., Lester, L., & McNarry, M. A. (2016). Investigating the physiological and psychosocial responses of single- and dual-player exergaming in young adults. *Games for Health Journal*, 375-381. doi: 10.1089/g4h.2016.0015

Niemiec, C. P., Ryan, R. M., & Deci, E. L. (2009). The path taken: Consequences of attaining intrinsic and extrinsic aspirations in post-college life. *Journal of Research in Personality*, 291-306. doi: 10.1016/j.bbr.2011.03.031

Pew Research Center. (2015). *Gaming and Gamers*. Retrieved from: http://www.pewinternet.org/2015/12/15/gaming-and-gamers/

Poquadeck, M. & Ryan, R. M. (2014). Predicting well-being outcomes as a function of motivational orientations. *6th International Self-Determination Theory Conference*.

Przybylski, A. K. (2014). Who believes electronic games cause real world aggression? *Cyberpsychology, Behavior, and Social Networking*, *17*(4), 228-234. doi: 10.1089/cyber.2013.0245

Przybylski, A. K., Deci, E. L., Rigby, C. S., & Ryan, R. M. (2014). Competence-impeding electronic games and players' aggressive feelings, thoughts, and behaviors. *Journal of personality and social psychology*,*106*(3), 441. doi: 10.1037/a0034820

Przybylski, A. K., Rigby, S. C. & Ryan, R. M. (2010). A motivational model of video game engagement. *Review of General Psychology,*154-166. doi: 10.1037/a0019440

Przybylski, A. K., Ryan, R. M., & Rigby, S. C. (2009). The motivating role of violence in video games. *Personality and Social Psychology Bulletin,*243-259. doi: 10.1177/0146167208327216

Przybylski, A. K., Weinstein, N., Murayama, K., Lynch, M. F., & Ryan, R. M. (2012). The ideal self at play the appeal of video games that let you be all you can be. *Psychological science*, *23*(1), 69-76. doi: 10.1177/0956797611418676

Przybylski, A. K., Weinstein, N., Ryan, R. M., & Rigby, S. C. (2009). Having versus wanting to play: Background and consequences of harmonious versus obsessive engagement in video games. *Cyber Psychology & Behavior,* 485-492. doi: 10.1089/cpb.2009.0083

Reinboth, M., & Duda, J. L. (2004). The motivational climate, perceived ability, and athletes' psychological and physical well-being. *The Sport Psychologist,* 237-251.

Reinboth, M., & Duda, J. L. (2006), Perceived motivational climate, need satisfaction and indices of well-being in team sports: A longitudinal perspective. *Psychology of Sport and Exercise,* 269-286. doi: 10.1016/j.psychsport.2005.06.002

Ryan, R. M. (1982). Control and information in the intrapersonal sphere: An extension of cognitive evaluation theory. *Journal of Personality and Social Psychology,* 450-461.

Ryan, R. M. & Deci, E. (2017) *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. New York, NY: Guilford Press.

Ryan, R. M., Rigby, S. C. & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion,* 344-360. doi: 10.1007/s11031-006-9051-8

Silberman, M. S., Tomlinson, B., LaPlante, R., Ross, J., Irani, L., & Zaldivar, A. (2018). Responsible research with crowds: Pay crowdworkers at least minimum wage. *Communications of the ACM*, *61*, 39-41. doi: 10.1145/3180492

Smith, A., Ntoumanis, N., & Duda, J. (2007). Goal striving, goal attainment, and well-being: Adapting and testing the self-concordance model in sport. *Journal of Sport & Exercise Psychology,* 763-782.

Tscholl, M., & Lindgren, R. (2016). Designing for learning conversations: How parents support children's science learning within an immersive simulation. *Science Education*. 877-902. doi: 10.1002/sce.21228

Vansteenkiste, M., & Deci, E. L., (2003). Competitively contingent rewards and intrinsic motivation: Can losers remain motivated? *Motivation and Emotion,* 273-299. doi: 10.1023/A:1026259005264

Williams, G. C., & Deci, E. L. (2001). Activating patients for smoking cessation through physician autonomy support. *Medical care*, *39*(8), 813-823.

Williams, G. G., Gagné, M., Ryan, R. M., & Deci, E. L. (2002). Facilitating autonomous motivation for smoking cessation. *Health Psychology*, *21*(1), 40. doi: 10.1037//0278-6133.21.1.40

Wittek, C. T., Finserås, T. R., Pallesen, S., Mentzoni, R. A., Hanss, D., Griffiths, M. D., & Molde, H. (2015). Prevalence and predictors of video game addiction: A study based on a national representative sample of gamers. *International Journal of Mental Health and Addiction*, 1-15. doi: 10.1007/s11469-015-9592-8

Yilmaz, R. M. (2016). Educational magic toys developed with augmented reality technology for early childhood education. *Computers in Human Behavior, 54*. doi: 10.1016/j.chb.2015.07.040

Table 1

Participant Demographics

Factor	Light Exercise Group	ARG Group
Gender		
N	198	209
% Male	62.1	62.7
% Female	35.9	37.3
% Did not answer	2.0	0
Age		
Mean in Years	36.15	32.27
Excluded from analysis		
N	1	0

Table 2

Descriptive Statistics of Variables by Groups

	LE		ARG		*t*	*p*
	M	*SD*	*M*	*SD*		
BPNS scores	4.92	1.14	4.79	1.00	1.171	.051
Task scores	3.67	.82	3.87	.64	-2.763	.004
Ego scores	3.16	.99	2.63	.80	5.918	.003
PENS scores	3.24	.79	3.57	.66	-4.461	.045
Physical well-being	74.1	22.1	70.74	21.21	1.519	.560
Psychological well-being	67.18	22.59	63.55	20.73	1.644	.250

ARG = Augmented reality games; LE = light exercisers; BPNS = Basic psychological needs satisfaction (trait-level); PENS = player experience of needs satisfaction (state-level)

Table 3

Combined Group Correlations Between Variables

Variable	*N*	*M*	*SD*	1	2	3	4	5	6
1. Overall BPNS scores	383	4.85	1.07	_					
2. Overall task scores	398	3.77	.74	.386**	_				
3. Overall ego scores	399	2.89	.94	.062	-.379**	_			
4. PENS scores	398	3.41	.74	.442**	.536**	-.271**	_		
5. Physical well-being	379	72.39	21.72	.554**	.106**	.159**	.171**	_	
6. Psychological well-being	385	65.34	21.71	.698**	.166**	.059	.275**	.749**	_

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4

LE Group Correlations Between Variables

Variable	*N*	*M*	*SD*	1	2	3	4	5	6
1. Overall BPNS scores	185	4.92	1.14	_					
2. Overall task scores	182	3.67	.82	.388**	_				
3. Overall ego scores	183	3.16	.99	.080	-.409**	_			
4. PENS scores	183	3.24	.79	.551**	.473**	-.281**	_		
5. Physical well-being	175	74.13	22.17	.546**	.087	.150*	.222**	_	
6. Psychological well-being	177	67.18	22.59	.716**	.170*	.009	.362**	.752**	_

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

LE = Light exercise

Table 5

ARG Group Correlations Between Variables

Variable	*N*	*M*	*SD*	1	2	3	4	5	6
7. Overall BPNS scores	198	4.79	1.00	_					
8. Overall task scores	197	3.87	.64	.410**	_				
9. Overall ego scores	195	2.63	.80	.003	-.280**	_			
10. PENS scores	194	3.57	.66	.354**	.597**	-.127	_		
11. Physical well-being	186	70.74	21.21	.558**	.161*	.134	.166*	_	
12. Psychological well-being	187	63.55	20.73	.675**	.188**	.080	.220**	.740**	_

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

ARG = Augmented reality games

Table 6

Psychological Predictors on Physical Well-Being Outcomes; Task Before Ego Orientation

Effect	Estimate	*SE*	95% CI		*p*
			LL	*UL*	
Group	-.027	2.035	-5.179	2.825	.063
BPNS	.594	1.042	10.083	14.184	.000
TO	-.044	1.687	-4.655	1.983	.051
EO	.099	1.179	.022	4.659	.040
PENS	-.021	1.663	-3.906	2.634	.702

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; Group = exercise vs. ARG; BPNS = basic psychological needs satisfaction; EO = ego orientation; TO = task orientation; PENS = player experience of needs satisfaction

Table 7

Psychological Predictors on Physical Well-Being Outcomes; Ego Before Task Orientation

Effect	Estimate	*SE*	95% CI		*p*
			LL	*UL*	
Group	-.027	2.035	-5.179	2.825	.063
BPNS	.594	1.042	10.083	14.184	.000
EO	.099	1.179	.022	4.659	.008
TO	-.044	1.687	-4.655	1.983	.317
PENS	-.021	1.663	-3.906	2.634	.702

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; Group = exercise vs. ARG; BPNS = basic psychological needs satisfaction; EO = ego orientation; TO = task orientation; PENS = player experience of needs satisfaction

Table 8

Psychological Predictors on Psychological Well-Being Outcomes; Task Before Ego Orientation

Effect	Estimate	*SE*	95% CI		*p*
			LL	*UL*	
Group	-.046	1.715	-5.370	1.376	.093
BPNS	.755	.898	13.638	17.171	.000
TO	-.101	1.442	-5.873	-.201	.022
EO	-.019	.998	-2.413	1.513	.650
PENS	.001	1.430	-2.795	2.832	.990

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; Group = exercise vs. ARG; BPNS = basic psychological needs satisfaction; EO = ego orientation; TO = task orientation; PENS = player experience of needs satisfaction

Table 9

Psychological Predictors on Psychological Well-Being Outcomes; Ego Before Task Orientation

Effect	Estimate	*SE*	95% CI		*p*
			LL	*UL*	
Group	-.046	1.715	-5.370	1.376	.093
BPNS	.755	.898	13.638	17.171	.000
EO	-.019	.998	-2.413	1.513	.597
TO	-.101	1.442	-5.873	-.201	.023
PENS	.001	1.430	-2.795	2.832	.990

Note. CI = confidence interval; *LL* = lower limit; *UL* = upper limit; Group = exercise vs. ARG; BPNS = basic psychological needs satisfaction; EO = ego orientation; TO = task orientation; PENS = player experience of needs satisfaction

Figure 1

Scatterplot of Total Physical Well-being ratings by BPNS ratings

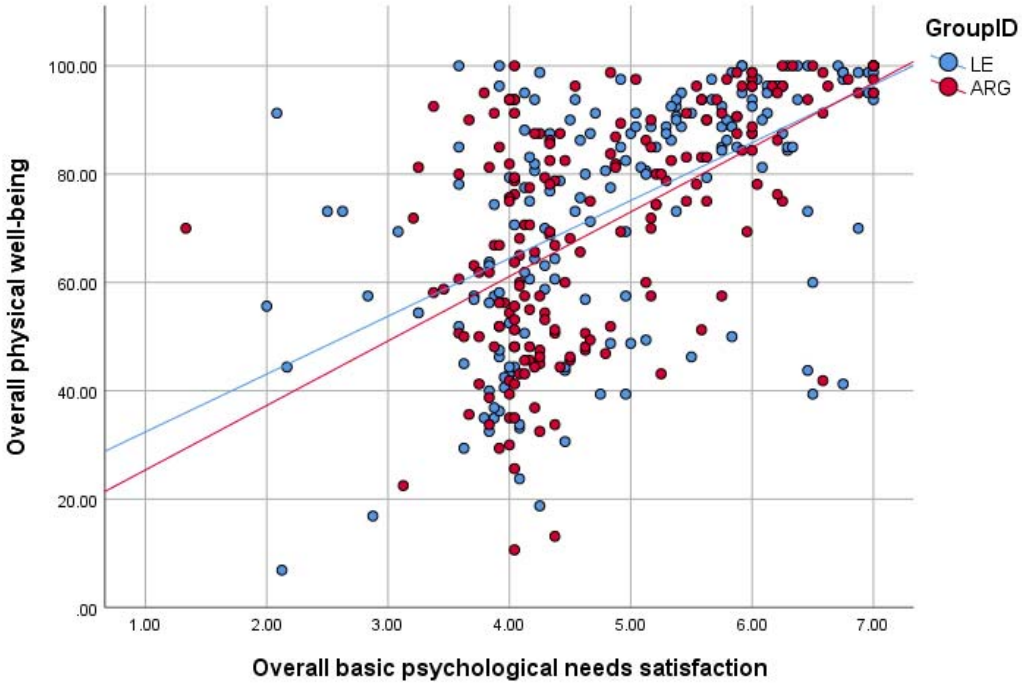


Figure 2

Scatterplot of Total Psychological Well-being ratings by BPNS ratings

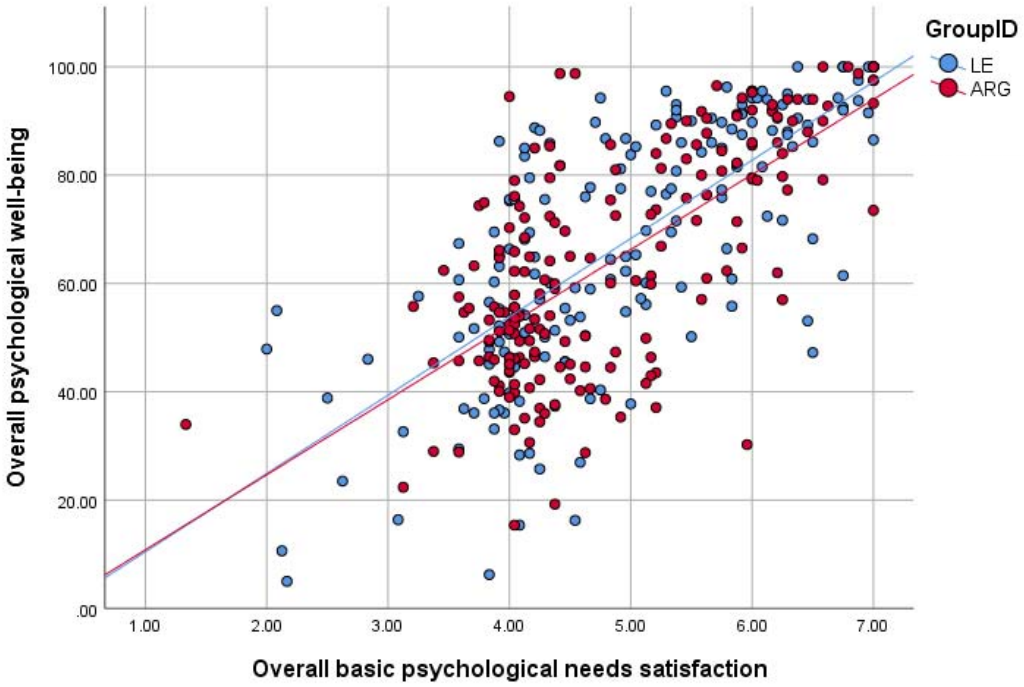


Figure 3

Scatterplot of Total BPNS ratings by Overall Task Orientation

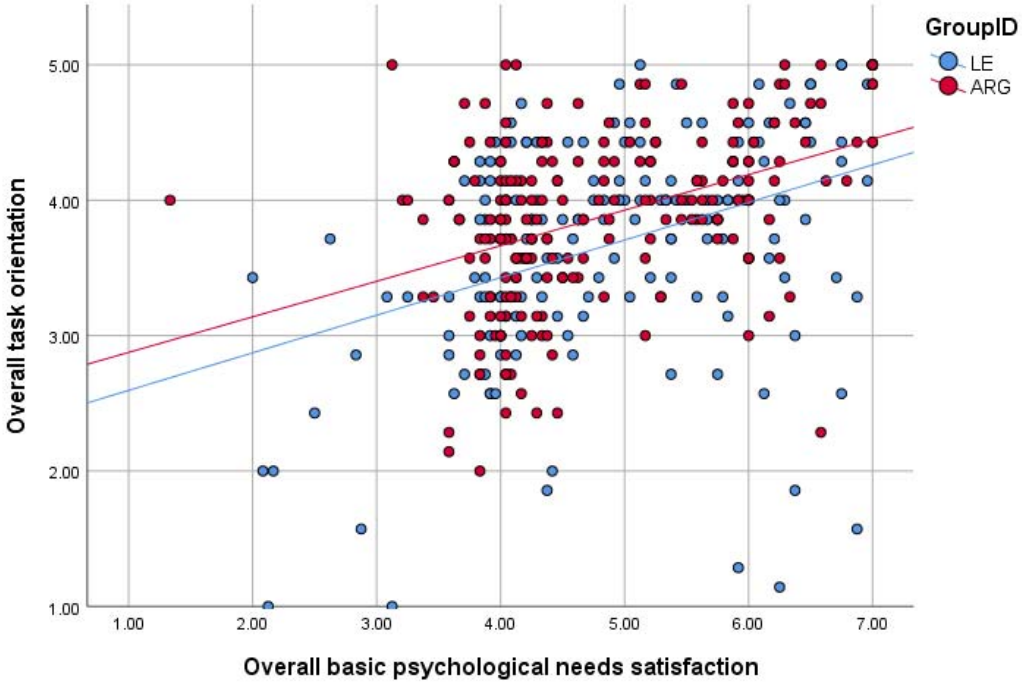


Figure 4

Scatterplot of Total BPNS ratings by Overall Ego Orientation

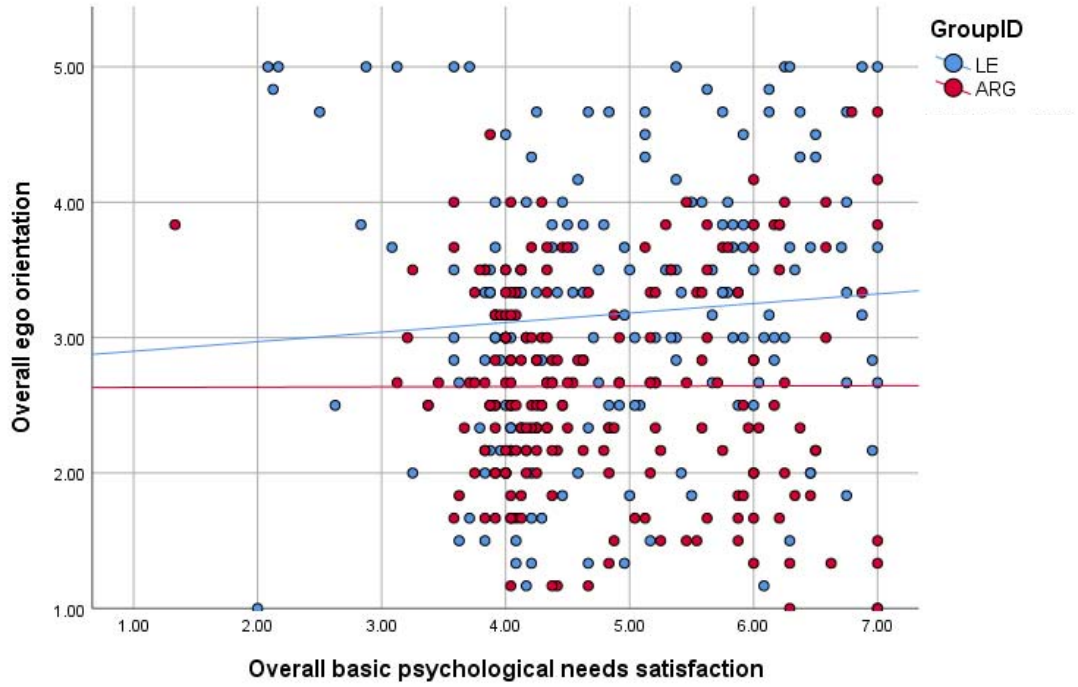


Figure 5

Scatterplot of Task orientation by Physical well-being

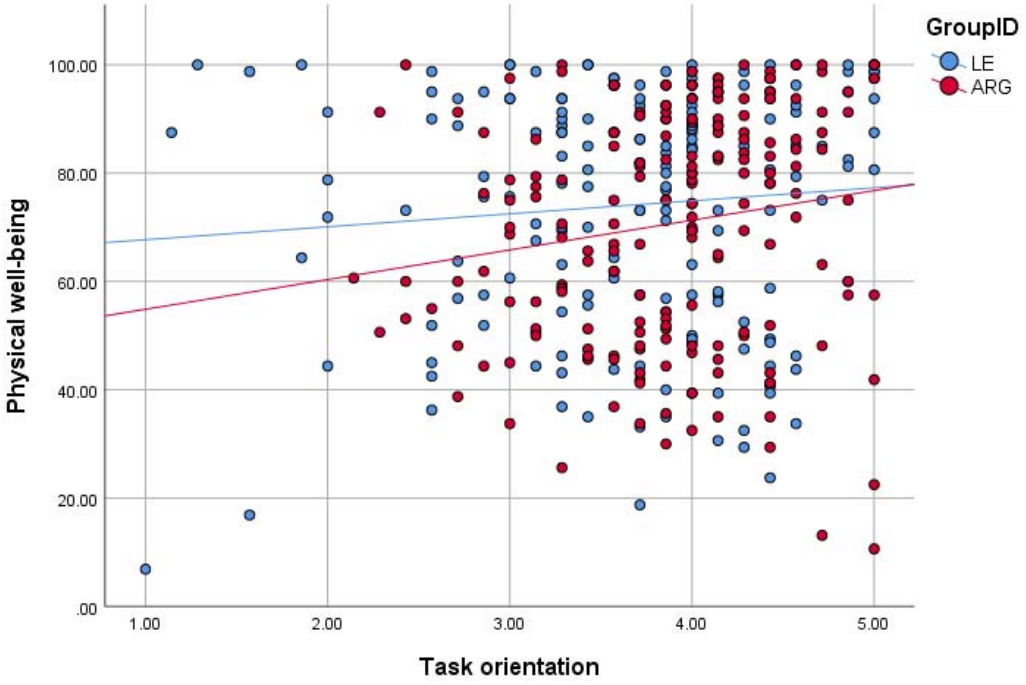


Figure 6

Scatterplot of Task orientation by Psychological well-being

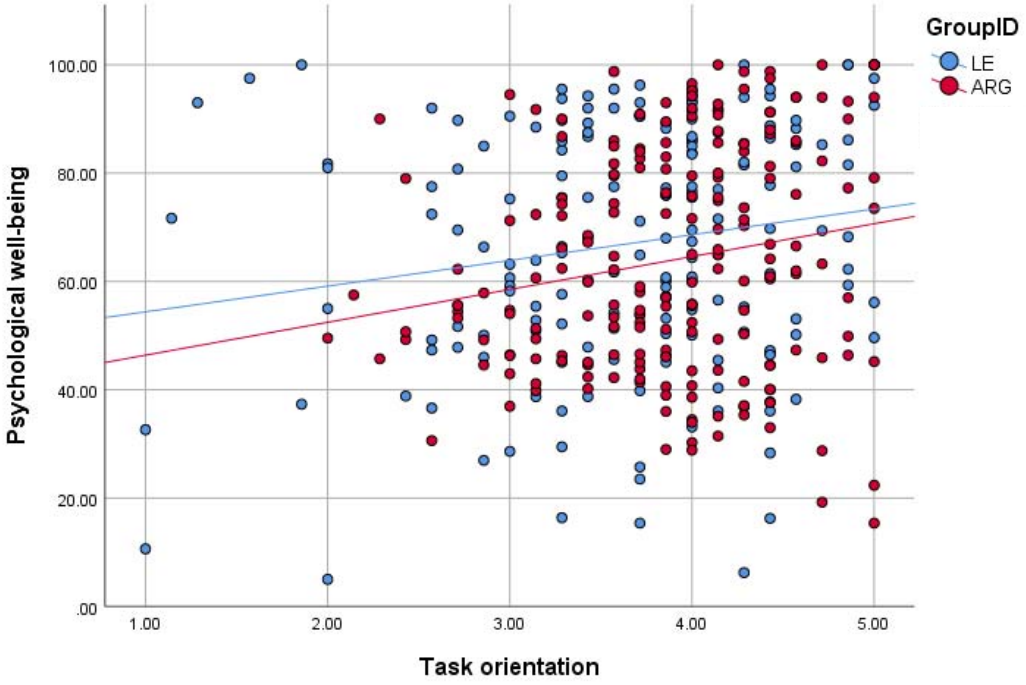


Figure 7

Scatterplot of Ego orientation by Physical well-being

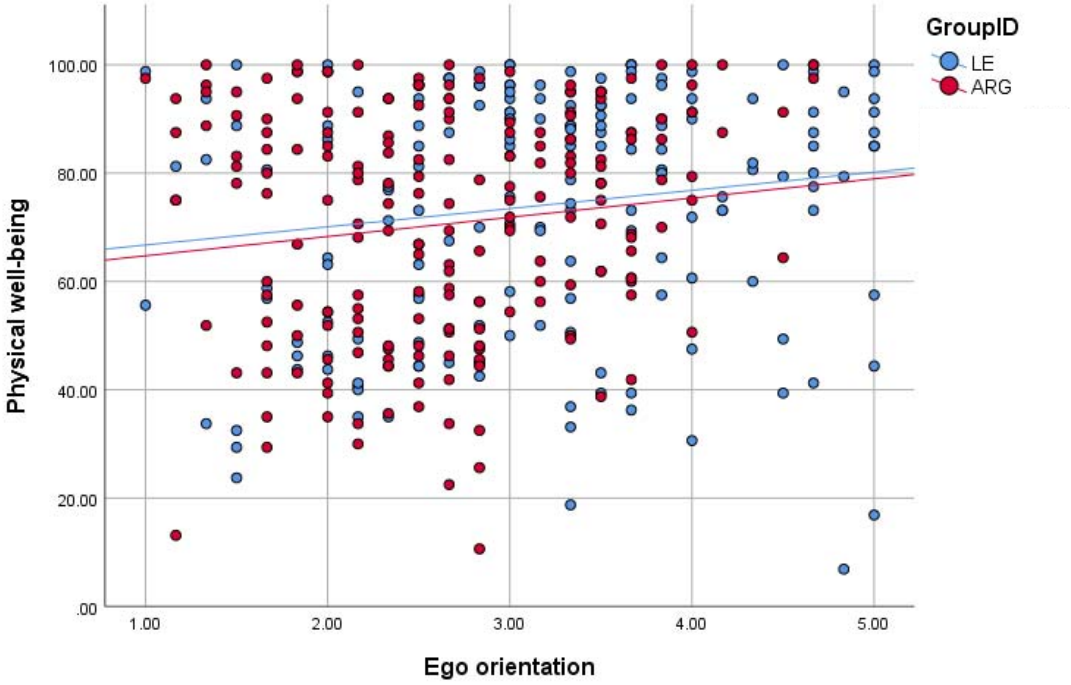


Figure 8

Scatterplot of Ego orientation by Psychological well-being

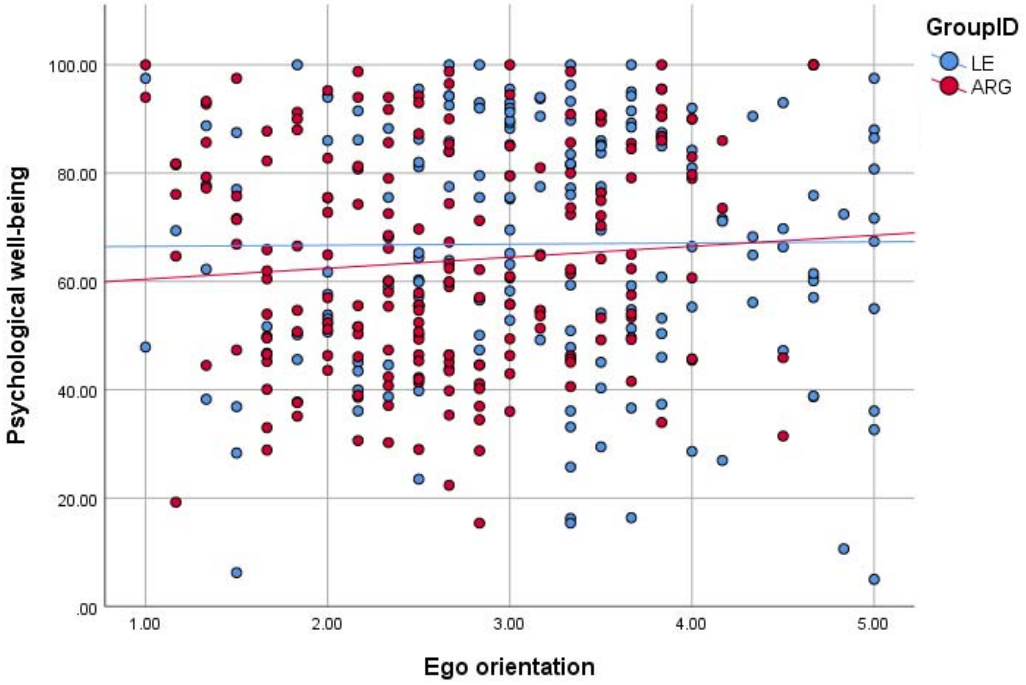


Figure 9

Scatterplot of PENS ratings by Physical well-being

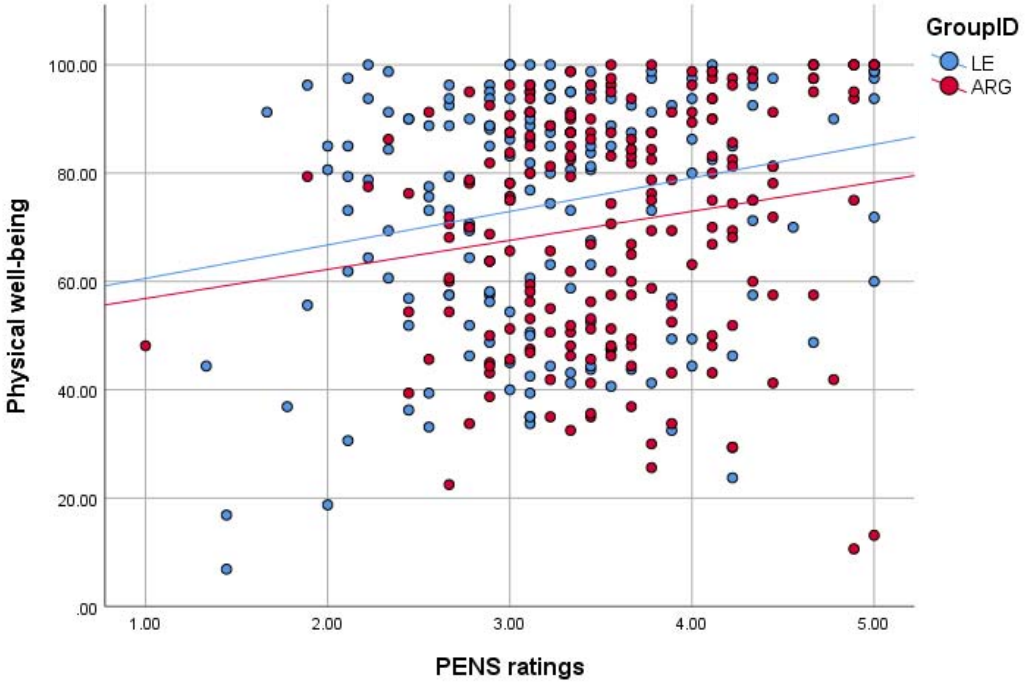


Figure 10

Scatterplot of PENS ratings by Psychological well-being

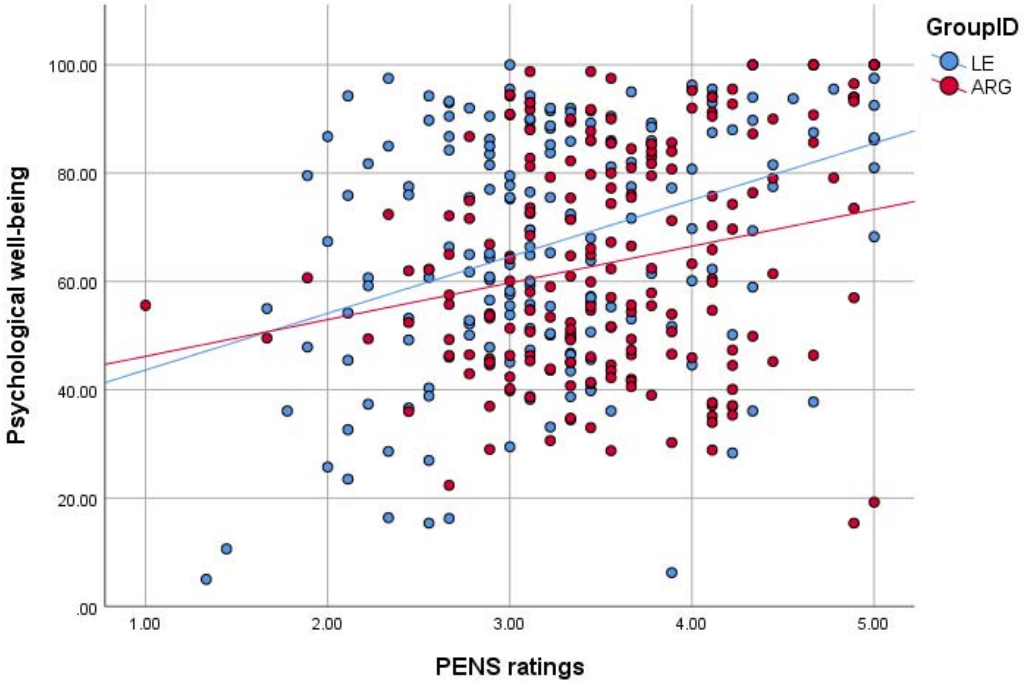


Figure 11

Physical Well-Being Mean Comparisons with High vs. Low PENS Ratings Between Groups

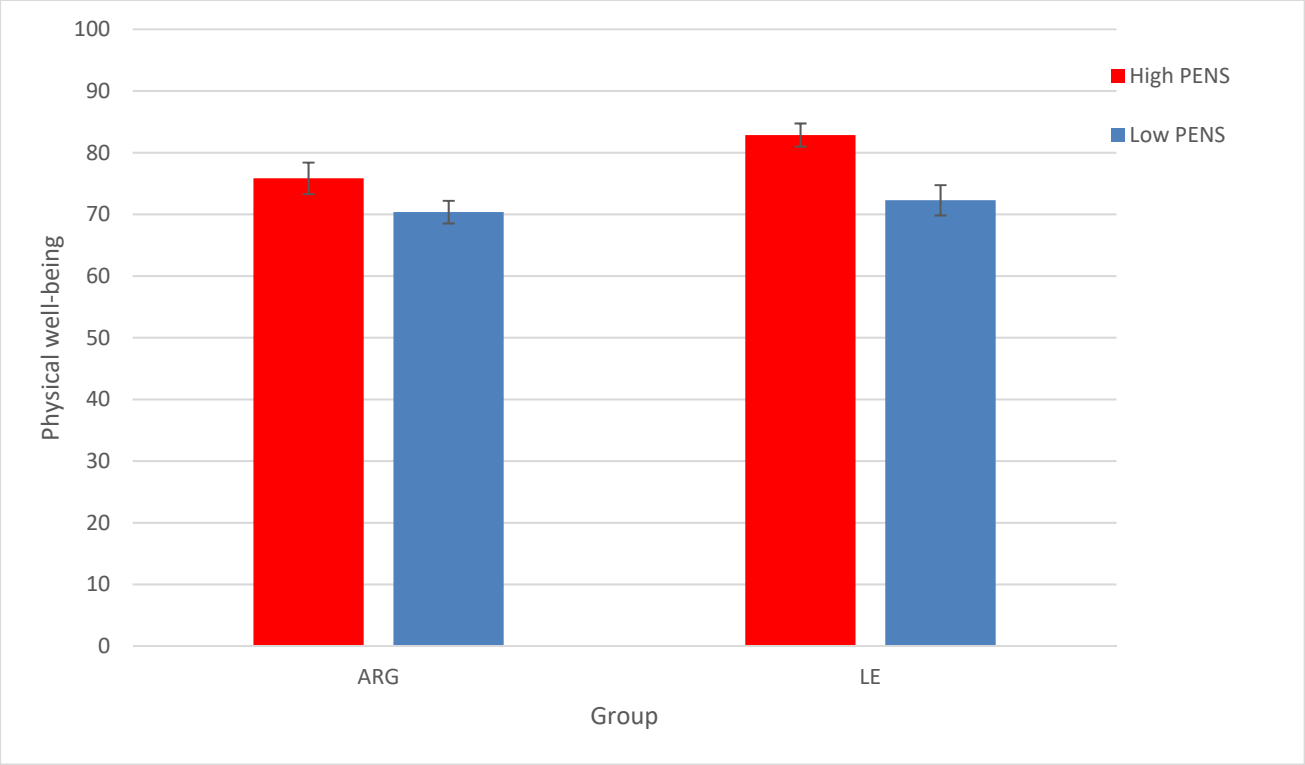
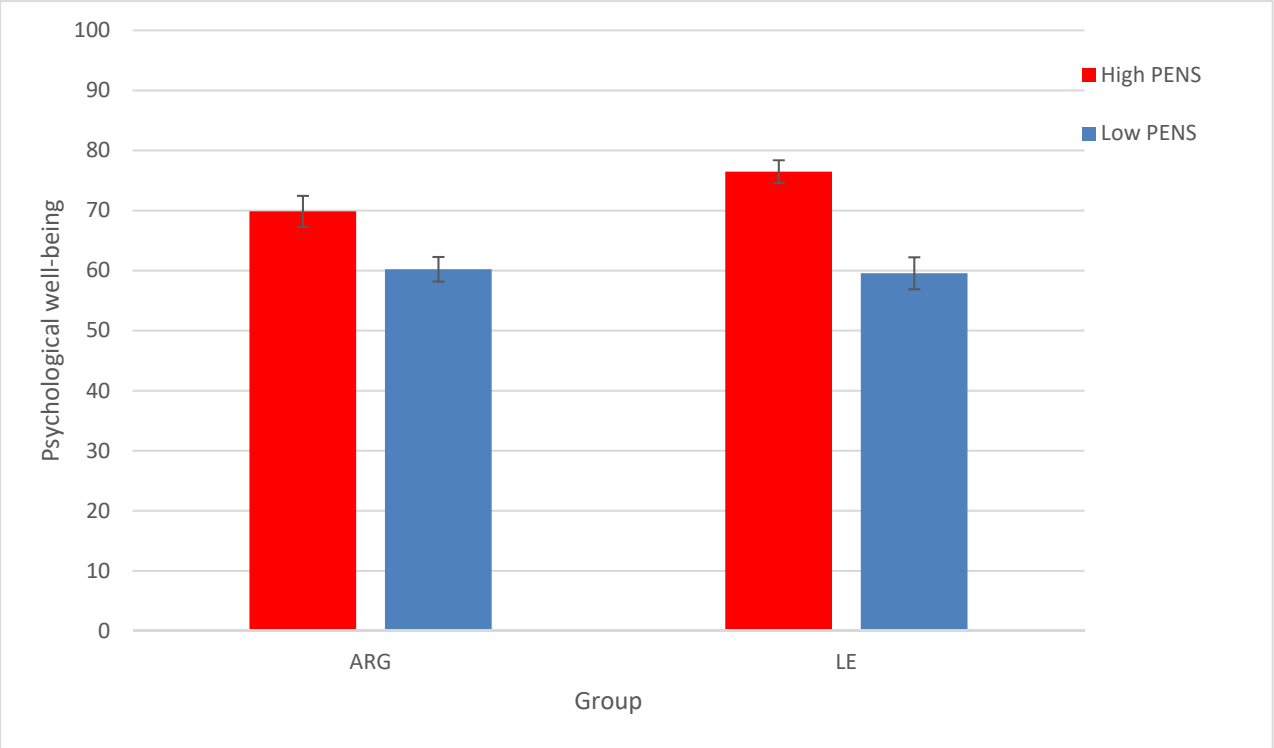


Figure 12

Psychological Well-Being Mean Comparisons with High vs. Low PENS Ratings Between Groups



Appendix A

Player Experiences of Need Satisfaction (Ryan et al. 2006)

Not at all	A bit	Somewhat	Quite a bit	Very much
1	2	3	4	5

In my most recent competitive play…

My ability to play the game was well matched with the activity's challenges
I felt very capable and effective when playing
I felt competent at the game
I experienced a lot of freedom in the game
I could always find something interesting in the game to do
The game provided me with interesting options and choices
I find the relationships I form in this game important
I find the relationships I form in this game fulfilling
I didn't feel close to other players

Appendix B

Basic Psychological Needs Satisfaction (Chen et al., 2015)

Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

In general…

1. I feel a sense of choice and freedom in the things I undertake
2. I feel excluded from the group I want to belong to
3. I feel confident that I can do things well
4. I feel that the people I care about also care about me
5. Most of the things I do feel like "I have to"
6. I have serious doubts whether I can do things well
7. I feel that my decisions reflect what I really want
8. I feel that people who are important to me are cold and distant towards me
9. I feel capable at what I do
10. I feel forced to do many things I wouldn't choose to do
11. I feel disappointed with my performance
12. I feel connected with people who care for me, and for whom I care for
13. I feel my choices express who I really am
14. I feel competent to achieve my goals
15. I feel pressured to do too many things
16. I feel close and connected with other people who are important to me
17. I feel insecure about my abilities
18. My daily activities feel like a chain of obligations
19. I feel I have been doing what really interests me
20. I have the impression that people I spend time with dislike me
21. I feel I can successfully complete difficult tasks
22. I feel the relationships I have are just superficial
23. I feel like a failure because of the mistakes I make
24. I experience a warm feeling with the people I spend time with

Appendix C

Task and Ego Orientation in Sport Questionnaire (Duda, 1989)

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

I feel most successful in sport when…

1. I am the only one who can do the play or skill
2. I learn a new skill and it makes me want to practice more
3. I can do better than my friends
4. The others cannot do as well as me
5. I learn something that is fun to do
6. Others mess up but I do not
7. I learn a new skill by trying hard
8. I work really hard
9. I score the most points/goals/hits, etc.
10. Something I learn makes me want to go practice more
11. I am the best
12. A skill I learn really feels right
13. I do my very best

Appendix D

Medical Outcomes Inventory, Short Form (Hays et al. 1993)

1. In general, would you say your health is:
    a. 1-Excellent
    b. 2-Very good
    c. 3-Good
    d. 4-Fair
    e. 5-Poor
2. Compared to one year ago, how would you rate your health in general now?
    a. 1-Much better than one year ago
    b. 2-Somewhat better than one year ago
    c. 3-About the same
    d. 4-Somewhat worse now than one year ago
    e. 5-Much worse now than one year ago

The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

Yes, limited a lot	Yes, limited a little	No, not limited at all
1	2	3

3. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports
4. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf
5. Lifting or carrying groceries
6. Climbing several flights of stairs
7. Climbing one flight of stairs
8. Bending, kneeling, or stooping
9. Walking more than a mile
10. Walking several blocks
11. Walking one block
12. Bathing or dressing yourself

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

Yes	No
1	2

13. Cut down the amount of time you spent on work or other activities
14. Accomplished less than you would like
15. Were limited in the kind of work or other activities
16. Had difficulty performing the work or other activities (for example, it took extra effort)

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

Yes	No
1	2

17. Cut down the amount of time you spent on work or other activities
18. Accomplished less than you would like
19. Didn't do work or other activities as carefully as usual

During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

a. 1-Not at all
b. 2-Slightly
c. 3-Moderately
d. 4-Quite a bit
e. 5-Extremely

How much bodily pain have you had during the past 4 weeks?

a. 1-None
b. 2-Very mild
c. 3-Mild
d. 4-Moderate
e. 5-Severe
f. 6-Very Severe

During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

a. 1-Not at all
b. 2-A little bit
c. 3-Moderately
d. 4-Quite a bit

e. 5-Extremely

How much of the time during the past 4 weeks…

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
1	2	3	4	5	6

23. Did you feel full of pep?
24. Have you been a very nervous person?
25. Have you felt so down in the dumps that nothing could cheer you up?
26. Have you felt calm and peaceful?
27. Did you have a lot of energy?
28. Have you felt downhearted and blue?
29. Did you feel worn out?
30. Have you been a happy person?
31. Did you feel tired?

During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?
a.1-All of the time
b. 2-Most of the time
c. 3- Some of the time
d. 4-A little of the time
e. 5-None of the time

Definitely true	Mostly true	Don't know	Mostly false	Definitely false
1	2	3	4	5

33. I seem to get sick a little easier than other people
34. I am as healthy as anybody I know
35. I expect my health to get worse
36. My health is excellent