PARTICIPATION IN EXERGAMES FROM AN ECOLOGICAL PERSPECTIVE

A Dissertation

by

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Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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May 2015

Major Subject: Health Education

ABSTRACT

Exergames are a relatively new addition to the physical activity literature. Exergames are activities that combine exercise with game-play and bring together virtual communities with real life to provide entertainment, exercise, and social interaction for players. We initiated the Geocaching for Exercise and Activity Research (GEAR) study, which is a longitudinal, exploratory study, to investigate the benefits of exergame participation via a frequently played exergame called geocaching. The study tracked 1002 participants across the United States for twelve-months to measure their physical activity levels while geocaching. We conducted qualitative interviews with twelve participants to understand their motivation for going geocaching, then completed an ego centric and whole network analysis with a group of individuals in a geocaching association to understand what type of social interactions and group norms are promoted during geocaching. Findings indicate that geocaching is a method of light to moderate physical activity and that individual's rates of physical activity change overtime. The primary motivations for geocaching are fun and enjoyment, skill building, spending time outdoors, exploration, challenge, and gaining knowledge. Geocachers may also receive health benefits from geocaching, but health is not an initial motivation for participation. We also found that geocaching networks develop based on shared interests in geocaching, provide social interactions for participants, and provide emotional and informational support to their members and promote group norms that direct member action. Overall, exergames, specifically geocaching, provide

an innovative perspective on physical activity that can be used to enhance individual physical activity levels through fun, social activities.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Kenneth McLeroy, and my committee members, Dr. Patricia Goodson, Dr. E. Lisako McKyer, and Dr. Bruce Thompson for guiding me throughout this research study. I would also like to thank the Center for Community Health Development at the Texas A&M School of Public Health for providing resources to conduct my study and Geocaching.com for helping me recruit participants and learn about the world of geocaching. Lastly, I would like to thank my husband for his encouragement and support over the past three years.

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INTRODUCTION

Obesity related initiatives are a common priority across public health and health education due to the dramatic increase in obesity rates within the United States (U.S.) over the past fifty-five years. In recent decades, the prevalence of obese adults in the U.S. has risen more than 20% and recently, obesity rates hit an all-time high of 35.7% of the population (Wang & Beydoun, 2007; National Center for Health Statistics, 2012). If rates continue to rise, some researchers estimate that approximately 75% of all adults will be overweight or obese within the next few years (Centers for Disease Control and Prevention, 2012; Wang & Beydoun, 2007).

Typically, obesity prevention programs utilize strategies that promote healthy diets and increase levels of physical activity. Physical activity increases energy balance, which results in increased calorie expenditure. When physical activity is coupled with food intake, it causes weight gain, maintenance, or loss (Wareham, 2007). Based on its potential to influence individual's health, physical activity was identified as a topic area in Healthy People 2020 (U.S. Department of Health and Human Services, 2012). In addition, national agendas, increased funding opportunities, and comprehensive programmatic support have been developed to decrease the prevalence of obesity through physical activity. As a result, researchers have generated a substantial knowledge base about the public health problem of obesity and physical activity interventions. However, despite the progress made, health professionals have

not made significant improvements in reducing the overall rates of obesity within the U.S. (CDC, 2010).

This lack of improvement has caused health professionals and researchers to begin to re-examine obesity prevention initiatives and call for the development of new, innovative strategies (Brock, Thomas, Cowan, Allison, Gaesser & Hunter, 2009).

New Strategy for Obesity Prevention

One emerging strategy to reduce obesity through increased physical activity levels are exergames. Exergames are activities that use game design strategies to encourage individuals to preform activities that require them to be physically active (Deterding, Sicart, Nacke, O'Hara & Dixon, 2011). Exergames combine game play with exercise and have been shown to improve individual health status and provide social benefits to participants (Staiano & Calvert, 2011).

Exergames are relatively new to the literature and only a few research studies have attempted to understand physical activity within the gaming context (Daley, 2009). Such studies have shown positive trends for health improvements, specifically among children (Daley, 2009). Two different meta-analyses reviewed the amounts of energy expended during exergames and found that the games were effective methods to facilitate light to moderate physical activity (Peng, Lin, & Crouse, 2011; Barnet, Cerin & Baranowski, 2011). Similarly, other researchers have found that exergames are associated with meeting recommendations for daily activity levels (Miyachi, Yamamoto, Ohkawara & Tanaka, 2010).

Exergame Research

The following sections describe a multi-phase research study, Geocaching for Exercise and Activity Research (GEAR), which is one of the first longitudinal studies aimed at documenting the type and intensity of physical activity completed while participating in an exergame called geocaching. GEAR examines participant's motivations to engage in exergames, as well as social aspects of the activity over a twelve months.

The GEAR study has three phases. Phase one, is aimed at understanding how much physical activity individuals complete while geocaching over a twelve month calendar year. Phase two uses qualitative methods to examine the reasons that people geocache, norms associated with participation, and social interactions that occur while geocaching. Phase three investigates specific social networks called geocaching associations that are created through participation in the sport. Together, this research provides insight into how the application of exergames can be used to promote individual health.

THE NEXT GENERATION OF PHYSICAL ACTIVITY: CAN EXERGAMES BE USED TO INCREASE PHYSICAL ACTIVITY?

Introduction

Researchers have generated substantial knowledge about the public health problem of obesity and its relationships with physical activity and nutrition. However, despite the progress made, health professionals have not significantly reduced the rates of obesity within the U.S. (CDC, 2010). Brock and colleagues (2009) state that more than half of the U.S. population do not meet the minimum guidelines for daily physical activity. Based on the overall lack of improvement, it may be time to examine why obesity rates are not decreasing by re-evaluating current initiatives and exploring new methods of physical activity (Brock et al., 2009).

Exergames

One emerging strategy to increase an individual's level of physical activity is exergames. Exergames are sports that use game-design strategies to entice individuals to engage in activities that require them to be physically active (Deterding, Sicart, Nacke, O'Hara & Dixon, 2011). By combing game-play with physical activity, preliminary research shows that exergames improve individual health status, provide social and academic benefits to participants, and are associated with meeting daily physical activity recommendations (Barnett, Cerin & Baranowski, 2011; Peng, Lin, & Crouse, 2011; Staiano & Calvert, 2011). However, most studies examining physical activity and exergames have been of short duration, ranging from 10 to 28 weeks, so

long-term effects are unknown (Biddiss & Irwin, 2010). In addition, the majority of studies have examined exergame participation among children or adolescents and ignored the benefits active games can provide adults (Graves et al., 2010).

The Geocaching for Exercise and Activity Research Study

Since few studies have systematically examined the amount and intensity of physical activity that adults receive while participating in exergames over an extended period of time, the Center for Community Health Development (CCHD) at Texas A&M School of Public Health initiated the Geocaching for Exercise and Activity Research (GEAR) study. GEAR was designed as a longitudinal, exploratory study to investigate the benefits of exergame participation via a frequently played exergame called geocaching.

Geocaching is a real-world treasure hunt that uses a GPS-enabled device to find hidden "caches" or treasures (Groundspeak Inc., 2014). It combines game-play strategies like rewards, online profiles, and skill-based activities to appeal to its participants. Through its website, Geocaching.com and its smartphone app, participants can locate the coordinates to hidden caches all over the world. After identifying a cache's coordinate, players search for the hidden cache by walking, climbing, and other forms of physical activity. Once the cache is located, players log their find online to build their player profile. Since the inception of geocaching in May 2000, more than 10 million people have become registered users.

The theoretical basis of the GEAR study includes two levels of analysis—intrapersonal and interpersonal. The intrapersonal level of analysis is expressed

through an individual perspective and is derived from traditional value-expectancy theories, specifically a stage of change model (Prochaska, Johnson, & Lee, 2008). Change processes affect an individual's decision balance. An individual's intention to change behaviors is based on the information that the individual has available to them at a specific point in time and is mediated through decision balance, that is when the pros of behavior change out weight the consequences (Prochaska, et al., 1994). In GEAR, an individual's decision to participate in exergames and continue that participation is dependent on their decisional balance and the motivation they have to participate. The interpersonal level of analysis uses social context developed through peer networks to illustrate how social interaction influence participation in exergaming (Israel, 1985). Social networks provide information about resources and opportunities for participation, as well deliver social support for group members (Israel, 1985).

The purpose of this study is to track the amount and intensity of physically active that people do while geocaching. We also attempt to understand if physical activity levels change overtime and identify potential reasons for changes.

Methods

Current geocachers living in the U.S. were recruited to participate in the GEAR study through an announcement on Geocaching.com's Facebook page in January 2013. The announcement directed interested individuals to a study information page and online consent form. Consented participants (N=1002) were assigned a study identification number and asked to track their physical activity while geocaching over a twelve month calendar year (February 2013-February 2014). Participants were mailed

study instructions, a pedometer, and log book to track the number of steps they took while geocaching, and then were sent monthly surveys to log their geocaching information through an online data collection system. All study materials were approved by the Texas A&M institutional review board prior to implementation.

Participant demographics are provided in Table 1. Participants were 47.5% male and 52.5% female with a mean age of 44 years of age (SD=11 years). Ninety-one percent of participants were White, 4.1% Hispanic/Latino, 2.6% more than one race, and the remaining participants were American Indian (1.1%), Asian (0.1%) and African American (0.2%). Fifty-four percent of the sample lived in the Western U.S., 11% in the Southwest, 23% in the South, 4% in the Northeast, and 8% in the Midwest.

Table 1: GEAR Participant Demographics

Sample Size:	**1002**
Male	47.5%
Female	52.5%
Age	
Mean	44 years, SD=11 years
Min.	18 years
Max.	77 years
Race/Ethnicity	
American Indian	1.1%
Asian	0.1%
Hispanic/Latino	4.1%
More than 1 Race	2.6%
White	91%
Geographic Location	
Midwest	8%
Northeast	4%
South	23%
Southwest	11%
West	54%

Survey Tool and Data Collection

Monthly surveys assessed physical activity by asking participants how many steps they walked while geocaching, the number of minutes spent geocaching, and to rate their activity by light, moderate or vigorous intensity. In addition, participants reported how frequently they went geocaching, the number of caches they found during each geocaching trip, with whom they were geocaching, and their motivation for geocaching defined by previous scales for motivation in exercise (Ryan et al., 1997). In addition, the survey asked participants to report on other physical activities they did during the month using CDC's National Health Survey physical fitness question and their overall health status using CDC's health related quality of life question set. The total response rate spanning the twelve month study was 63% with response rates ranging from 73% in the first survey to 33% in the eleventh and twelfth surveys.

Analyses

Physical activity was analyzed using descriptive statistics to illustrate the average amount and duration of physical activity while geocaching. To analyze the change in physical activity over time and why these changes occurred, we used a Latent Growth Model (LGM). The LGM was designed to understand if gaming and exploration factors, predict physical activity in geocaching over time. One benefit of LGMs is that they allow for growth in the dependent variable over time (Clemens, Shapiro, Wu, Taylor & Caskie, 2014). Using repeated observations, we explored the relationship between the model's intercept, slope and other variables to gain insight into the theoretical mechanisms driving exergame participation (Duncan et al., 2000).

All analyses were conducted using SPSS® software. The LGM used SPSS AMOS® and estimated model fit used a χ^2 test statistic, comparative fit index (CFI), normed fit index (NFI) and root-mean-squared error of approximation (RMSEA) (Clemens, Shapiro, Wu, Taylor & Caskie, 2014). According to past literature, excellent model fit is indicated by a χ^2 statistic that is not statistically significant (failing to reject the null hypothesis), a CFI and NIF of .95 or higher, and RMSEA .06 or lower (Hu & Bentler, 1999). Analyses were conducted using a full information maximum likelihood estimation (FIML) method to estimate the parameters of the statistical model (Enders & Bandalos, 2001).

Results

Physical Activity in Geocaching

Seventy-five percent of our sample were classified as super-users, or frequent geocachers, meaning they went geocaching once a week or more during the study. On average participants took 2859.01 steps (SD=650.97) each time they went geocaching and logged an average of 5.88 (SD=3.42) trips a month. Based on these findings, participants averaged approximately 16,811 steps/month while geocaching. Furthermore, each time participants went geocaching they reported being active for an average of 84.28 minutes (SD=73.87) at a light to moderate intensity (ranging from 94.1% in June to 98.1% in February).

The American College of Sports Medicine and the American Heart Association recommend that adults complete 150 minutes of moderate activity a week (Haskell et al., 2007). Through the GEAR study, we found that participants completed

approximately 77% of their monthly recommended physical activity while geocaching. Furthermore, we found that super-users, were 1.522 times (95% confidence interval .996-2.325, p=.035) less likely to have poor mental health compared to their non-super-user counterparts (those individuals who didn't geocache once a week or more).

Physical Activity in Geocaching over Time

To further investigate how physical activity while geocaching changed overtime, we also used a Latent Growth Model. This technique provides insight into the rationale for participation over the course of a calendar year.

Dependent Variables- To construct our dependent variables, we aggregated the amount of steps walked/geocaching trip represent the four seasons of the year: summer, fall, winter and spring. Then we adjusted the data for normality, dispersion, and cross-time correlations and set factor loadings to represent time points at three month intervals (0 at time point 1, .33 at time point 2, .66 at time point 3, and 1 at time point 4). Table 2 provides descriptive statistics for four observed dependent variables representing physical activity.

Table 2: Latent Growth Model Descriptive Statistics

Season	Transformed Means for LGM	SD	Skewness	Kurtosis
Summer	.667	.430	.489	.295
Fall	.555	.469	.929	.700
Winter	.679	.462	.832	.378
Spring	.828	.424	.328	.620

Predictor Variables- Two latent variables were used in the LGM to predict participation in exergames for physical activity. These constructs were developed

based on previous motivation in exercise measurement scale (Ryan et al., 1997). We labeled the first construct enjoyment, which was specified by the observed variables fun, refreshment, and relaxation. The second latent variable was gaming, which was measured by competition and skill variables. To verify the relationships among these variables, we conducted a confirmatory factor analysis (CFA) within the LGM. The model fit showed a CFI=.988, NFI=.981, and RMSEA=.033. These values indicate a good fit between the model and sample data. Squared multiple correlations for the variables revealed that the gaming factor explains between 24% (competition) and 95% (skills) of the variance. The enjoyment factor explains between 13% (fun) and 69% (rejuvenation) of the variance. Furthermore the correlations between the observed variables and their respective factors were all statistically significant ($p<.005$). The CFA model is included in the LGM, which is provided in Figure 1.

Model Fit- In LGM, there is no straightforward statistical test to evaluate a model. Instead, a combination of goodness of fit indices are used to judge whether a model is a good fit with the sample data (Hu & Bentler, 1999). Our identified model is shown in Figure 1. The χ^2 statistic (N=1002, 26)=63.85, $p<.0005$, falls above its critical value for alpha=.05, so typically we would reject the null hypothesis and determine that the model is not a good fit for the sample data; however, since χ^2 statistics are associated with the null hypothesis statistical significance test (NHSST) they are sensitive to sample size. As a result, they have been widely criticized in the literature (Cohen, 1994; Schmidt, 1996). Therefore, we must investigate other goodness of fit statistics from the analysis. The model's CFI=.98 and NFI=.969 and its RMSEA=.03,

which all fall within the recommended values for goodness of fit statistics (Hu & Bentler, 1999). In addition, the model has 26 degrees of freedom, which indicate that the fit statistics are not an artifact of small degrees of freedom (Hu & Bentler, 1999).

According to the model's standardized regression coefficients, the correlation between the two factors, enjoyment and gaming, and their respective observed variables are moderately high and their r^2 values range from .13to .95, which means the observed variables explained between 13% to 95% of the variance in latent variables. However, the standardized regression coefficients describing the correlation between

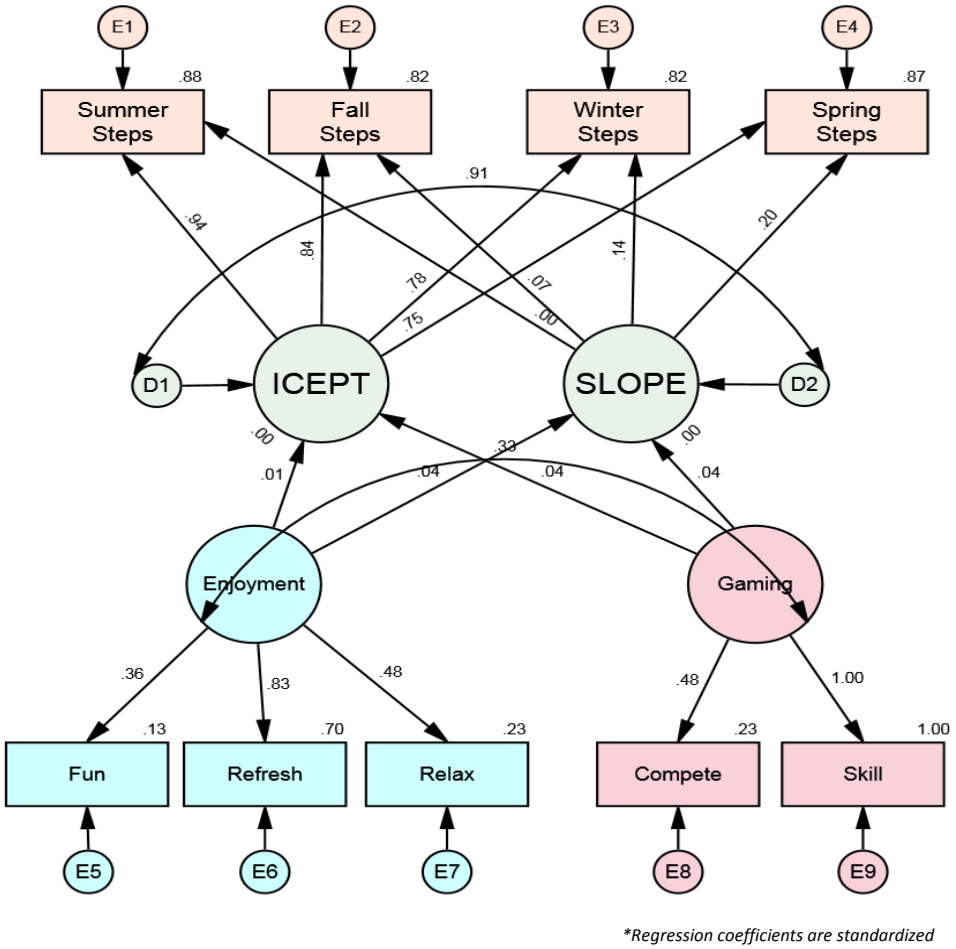

Figure 1: Latent Growth Model

the two sets of latent variables, gaming, enjoyment, and the intercept and slope are virtually non-existent. This tells us that the motivation indicators, enjoyment and gaming, are not highly associated with the slope and intercept. The correlation between the slope and intercept and steps walked over time show us that the amount of steps walked is most influenced by where an individual starts (intercept). The standardized regression weights for the slope show that it does influence steps walked in winter and spring, but not summer and fall.

Discussion

Our findings document that the exergame, geocaching, is a method of light to moderate physical activity that can be used to help individuals meet physical activity guidelines. Frequent geocaching has positive mental health benefits for players. Our study hypothesis that motivation (gaming and enjoyment) predicts steps walked while geocaching over time, was not supported by our LGM. While we attempted to control for the interactions between motivation and activity by looking at steps walked overtime and account for baseline effects, we could not fully separate the two elements. This is mainly due to the fact that our sample consisted of people who were already geocaching, thus they were already motivated to participate to some extent. As a result, the effects of interactions between the two motivation variables could not be separated out.

The model's standardized regression coefficients for intercept were high, ranging from .94 to .75, which indicates that where people start at baseline is very influential on steps walked overtime. This means that the more one walks at baseline,

the more you walk overtime. This phenomena is similar to the fan-fare hypothesis in education, which states that students who score higher in earlier grades will continue to score better as they age, which puts them at a cumulative advantage compared to lower preforming students (Walberg, & Tsai, 1983). Similarly, exergamer's starting level of physical activity is predictive of their continued performance and increased rates of activity over time. As seen in the r^2 values, or amount of variance explained ranging from 13% to 95%, we can assert that the variables used to illustrate gaming and enjoyment are decent indicators of the latent constructs. Based on these findings, we can infer that the model is useful, but not supportive of our hypothesis. This manuscript provides preliminary information about the extent geocaching can be used for physical activity, but further research is needed to explore additional predictors of physical activity while geocaching, specifically randomized control trials.

The exergame of geocaching is a unique way to gain physical activity. Based on these preliminary findings, we suggest that intervention studies be completed using geocaching as a method of physical activity. Geocaching can be a complimentary, if not a sole method, of being physically active in a fun, unique way. It has the potential to appeal to individuals who do not like to participate in traditional methods of physical activity like running or weight lifting, therefore can target a new demographic of people.

Study Limitations

As a descriptive study with a convenience sample, this study is limited in its generalizability. Our purpose was to learn more about the exergame of geocaching and

make some statements about whether or not it could be used for physical activity. While we can make some such claims, we are limited to generalizing to already active geocachers within the U.S. Due to funding limitations, the sample could not assess individuals outside of the U.S. The sample was compiled of the first 1002 individuals who responded to Geocaching.com's Facebook advertisement for the study and consisted of mostly white individuals, rather than a diverse racial and ethnic population. Based on the preliminary nature of this research, we cannot state whether this illustrates the larger geocaching population or if it is due to our convenience sampling. In addition, our response rates in later phases of data collection were low, which also limits its representativeness. Lastly, we did not recruit non-geocachers to the study to gauge the extent the sport increased their physical activity, so we cannot make causal inferences about how physical activity levels change as a result of geocaching.

A QUALITATIVE EXAMINATION OF EXERGAME MOTIVATIONS

Introduction

Exergames are a relatively new concept within the physical activity literature (Staiano, & Calvert, 2011). By definition, exergames are activities that use game-design strategies to entice individuals to play games that require them to engage in physical activity (Deterding, Sicart, Nacke, O'Hara & Dixon, 2011). Individuals play exergames during downtime, which within the United States is typically sedentary time; thus, exergames are uniquely positioned to replace traditionally inactive time periods in people's daily lives with physical activity (Daley, 2009).

By combining game strategies with exercise, preliminary research shows that exergames improve individual health and provide social and academic benefits to participants, specifically children (Daley, 2009; Staiano & Calvert, 2011). Two different meta-analyses reviewed the amounts of energy expended during exergames and found that the games were effective methods to facilitate light to moderate physical activity (Peng, Lin, & Crouse, 2011; Barnett, Cerin & Baranowski, 2011). Similarly, Miyachi and colleagues (2010) documented that exergames are associated with meeting recommendations for daily activity levels. Participants also report receiving psychosocial and physiological benefits from playing exergames (Mellecker, Lyons & Baranowski, 2013).

Research investigating the physical activity derived from exergames is still in its early stages. Preliminary studies suggest that scholars should continue to explore how exergame's game-play strategies can contribute to an individual's ability to live a healthy lifestyle (Mandryk, Inkpen, & Calvert, 2006; Graves, et al., 2010; Miyachi, Yamamoto, Ohkawara & Tanaka, 2010; Peng, Lin, & Crouse, 2011; Barnett, Cerin & Baranowski, 2011). In addition, longitudinal studies are needed to establish how physical activity levels among exergames players persist overtime (Mellecker, Lyons & Baranowski, 2013).

The Geocaching for Exercise and Activity Research Study

In response to the need for research to explore physical activity in exergames, we developed the Geocaching for Exercise and Activity Research (GEAR) study. GEAR is one of the first longitudinal studies aimed at documenting individual's physical activity while they participate in an exergame called geocaching. The study examines participant's motivations to geocache, specifically related to the fun factor of game-play strategies, and social networks that provide interaction and contribute to long-term participation.

Geocaching is often referred to as a real-life treasure hunt that uses GPS-enabled devices to located hidden treasures or "caches". It incorporates the adventure of a treasure hunt with gaming features, such as a reward system, online avatars, and skill-based categories. The game currently has approximately ten million registered users around the globe and is growing in popularity (Groundspeak Inc., 2014). Its online-interactive format is appealing to all types of people and is played by a diverse

age-range participants. Its online forum, Geocaching.com, host millions of coordinates to hidden caches that are hidden all over the world. In addition, the online site offers participants an opportunity to create a virtual persona in order to log caches found, keep track of personal records, compete in competitions, and discuss geocaching topics with fellow players. Despite its growth in popularity, limited research has investigated how the exergame works. For this reason, our research team partnered with the marketing division at Geocaching.com to conduct the GEAR study and document health benefits of exergames through geocaching. Geocaching.com used their websites, listservs, and social media accounts (Facebook and Twitter) to recruit current geocachers within the United States to take part in the study.

GEAR is a multi-phase exploratory research project conducted at the Center for Community Health Development at Texas A&M through federal funding provided by the Centers for Disease Control and Prevention (CDC). Phase one of GEAR was a longitudinal study, which started in January 2013, aimed at understanding how much physical activity individuals complete while geocaching over the course of a year. It required participants to track their physical activity while geocaching using a pedometer and logging their steps online (Garney et al., 2014). Phase two of the GEAR study is a qualitative assessment of individual's motivations and benefits from geocaching, norms associated with participation, and the social interaction experienced during game play. Phase three assesses network properties and group norms that contribute to continued geocaching participation.

In order to describe the relationship between geocaching and physical activity, this manuscript documents the results of phase two of our research, the qualitative assessment of individual's motivations and benefits from geocaching, norms associated with participation, and the social interaction experienced during game play. Phased two aimed to answer the following three research questions:

1) Why do people participate in exergames?
2) What are individual's norms pertaining to exergames?
3) What type of social interactions, if any, do people get while geocaching?

The subsequent sections describes the methodology and results of our research in detail.

Methods

In order to understand the "why" questions related to exergame participation, we chose to conduct open-ended interviews with current geocachers (Yin, 2009, p.4). This qualitative method is appropriate for settings where researchers do not have control over events. In the case of the GEAR study, we were working with and studying individuals already active in geocaching and, since there was no geocaching intervention that would allow for the modification of events based on study design, qualitative interviewing was an appropriate way to understand retrospective events and their rationale (Yin, 2009).

Sampling

Thirty-four individuals were randomly selected from participants in phase one of the GEAR study, specifically from those that participated in data collection in November 2013. Identified individuals were contacted and recruited via email, then

directed to an online website with phase two study information. After reviewing the study information online, individuals could consent to take part in an interview. Consented participants listed their contact information in a short intake survey, so the research team could schedule interviews. Twenty-two individual consented to be interviewed, but four individuals didn't record their contact information so they were dropped from the study. The remaining 18 participants were contacted to schedule interviews, however, five people did not respond to multiple scheduling attempts, so they were dropped from the study. The remaining 13 individuals were all contacted at their scheduled interview times. One person did not answer and was dropped from the study, which left 12 participants who took part in an interview.

Interview Tool

All interviews were conducted by trained members of the research team using an IRB approved interview script. The interview tool was first pilot tested with current geocachers and researchers to judge the appropriateness of the instrument. The tool was then revised based on feedback from pilot participants. Interviews lasted 10- 30 minutes and included an introduction to the study and eight questions. The two questions collected background information from each participant by asking, 1) "*how and when they first found out about geocaching*," and 2) "*how often they went geocaching*?"

The next three questions were designed to answer the study's first research question, "*why do people participate in exergames*?" They asked about outcome expectations and participant evaluations of experience. Outcome expectations allow

individuals to make decisions by weighting pros and cons associated with an activity (Prochaska, Johnson & Lee, 2008). To understand outcome expectations we asked individuals, "*what motivates you to geocaching?*" Next, we investigated individual experience by asking participants about their cognitive-based evaluations of geocaching (Triandis, 1979). This question asked, "*what are the benefits of geocaching to you?*"

The study's second research question was*, "what are individual norms pertaining to exergames*". To measure norms, we asked questions based on Fishbein's (1979) Theory of Reasoned Action (TRA). Fishbein (1979) describes subjective norms as social pressures put on an individual to preform or not perform a behavior based on how the individual believes people that are important to them think they should perform. To measure this construct, we asked participants if there were "*important people in their life that did not geocache, and if so, what was their relationship to them?*" Then we asked if their "*family or friends who did not geocache influenced whether or not they went geocaching?*" (Cohen & Willis, 1985; Ehrhart & Naumann, 2004).

Our final set of questions were based on our third research question, which was, "*what type of social interactions, if any, do people get while geocaching?*" To understand social interactions, we asked participants, "*who do you usually go geocaching with*" and "*are there any friends you have met through geocaching?*"

Interview Protocol

All interviews took place on the phone and were facilitated by one of three trained members of the research team. Training took place prior to data collection and included a review of all the interview materials and mock interviews with each of the data collectors. Each data collector practiced collecting data using a note taking template. In addition, all interviewers were asked a serious of unexpected questions to prepare them for a range of potential responses.

Data Collection and Analysis

As interviews were conducted, interviewers recorded participant responses using a standardized note taking template. The note taking template was pilot tested prior to the study to see how much information it was capable of collecting. This testing period revealed that the results generated with the note taking template were comparable to data collected using audio recordings and transcriptions; thus, the note taking template was determined to be a good fit for the study due to its utilization ease, time constraints, and the comprehensive data that it captured.

To evaluate the interview data, we conducted a thematic analysis. During the thematic analysis, we identified the themes salient in the interviews, then organized them into relevant categories. The analyses took place in three steps: first, we coded the data to dissect the information into manageable, meaningful segments using a coding framework; second, we identified themes from the coded segments; and third, we constructed a network of themes that arranges text into meaningful groupings (Attride-Stirling, 2001).

Three of our research team members independently coded and analyzed each of the interviews for common themes, then compared their findings and generated an inter-rater reliability coefficient of .945. In the event of disagreements on coding, the research team conducted a majority vote. During thematic analysis, the research team determined that data saturation was met, as common themes occurred more frequently and eventually, no new themes were identified. Since data saturation was met, we decided not to do follow-up interviews with participants because we felt that the data represented adequate and quality information to generate the research findings (Morse, 1995).

Results

Overall, participants were frequent geocachers, meaning they all went geocaching at least one time a month. In terms of demographic characteristics, participants were 58.3% male and 41.7% female, 91.7% white and 8.3% more than one race, with a mean age of 54 years old (SD=6.9 years). Almost all of the participants had been geocaching for five or more years, with only one individual reporting geocaching for three years. The following sections describes identified themes pertaining to each of the three research questions.

Why do People Participate in Exergames?

We identified a total of six primary themes and four secondary themes that were related to why individuals go geocaching. We combined the results of questions three and four because participants tended to give the same answers for both questions. The six primary themes were fun/enjoyment, skill building, being outdoors,

exploration, challenge, and gaining knowledge. Less frequently heard secondary themes were excitement, health, companionship, and adventure.

Fun and enjoyment: The most common theme among participant's motivation and benefits from geocaching was fun and enjoyment. The majority of participants interviewed said that they went geocaching because it was pleasurable and they enjoy the activity. Multiple participants said they specifically enjoyed "hunt of trying to find caches". Another participant said that geocaching complemented his hobbies, so he enjoys finding caches while going hiking or other activities.

Skill: Individuals can compete in various aspects of geocaching. For instance, one common activity for geocachers is to be the "first to find" (FTF) for new caches that have been recently placed. Activities like FTF are for more skilled geocachers who have already found a lot of the more traditionally placed caches. During interviews, multiple participants reported enjoying these type of competitions and the skill-building element they provided. Participants liked to try to get FTF caches, as well as build their profile on Geocaching.com by finding more difficult caches.

*Spending time outdoors: S*pending time outdoors was another common theme identified by interviewees as both a motivation for geocaching and benefit they received from geocaching. Participants liked to be outdoors and experience nature as they geocached. One participant said, "geocaching helps him motivate his children to spend more time outside, instead of indoors in front of the TV."

Exploration: Another theme that participants frequently mentioned was exploration. Geocaches are hidden all over the world and in different types of

locations, so participants are able to explore places they have never been while they geocache. Through the process of searching for caches in an unknown area, they are able to discover new things and add to their geocaching experience.

Challenge: There are many different challenges that geocaching can bring, whether it is finding a difficult cache or expand your personal records. Many interviewees mentioned they liked geocaching because it was challenging. One interviewee went geocaching for the mental challenge and a sense of accomplishment they feel after finding a hard cache. Another participant said he went geocaching for 1600 consecutive days and challenged himself to keep his streak going, regardless of the weather or other difficulties.

Knowledge: One-third of the participants identified knowledge as a reason for geocaching. One interviewee mentioned that learning the history behind each cache motivates her to continue to participate. Another said that caches are frequently placed at historical sites and markers, which allows her to gain historical knowledge while geocaching.

Secondary themes: Some other themes that emerged out of interview conversations were the excitement that finding a cache brings, health benefits of geocaching, and companionship. These characteristics were each mentioned less frequently than the primary themes, but are important insights none-the-less.

Some participants went geocaching for excitement, not related to exploration, adventure, or challenge. Other participants said that geocaching provides health benefits, specifically through physical activity. One geocacher said he does not go

geocaching to be healthy, but recognizes the health benefits that it brings. Another person said that geocaching is a positive benefit on her mental and physical health. Companionship was another theme that interviewees mention. As discussed in the results for our third research question, participants said they had met friends and formed relationships through geocaching. Social interaction was a big reason they kept geocaching.

What are Individual Norms Pertaining to Exergames?

Every interviewee, except one, said that they had important people in their life that did not geocache. Important non-geocachers were family, significant others, and friends. However, most people said that while their loved ones may not geocache, they didn't stop them from going. One participant said that their family supports geocaching because it is important to him. Another said that she was their own person and didn't let others influence her decisions. Of the few individuals who said that their loved ones did influence if they went geocaching or not, it was mostly due to time constraints. They wanted to spend time with family and friends, so they chose not to go geocaching since others didn't enjoy the activity.

What Type of Social Interactions, if any, do People get While Geocaching?

The majority of interview participants went geocaching with other people. Most frequently family members accompanied them; however, friends and significant others also often joined. In addition to their geocaching partners, participants frequently met new friends while geocaching. Most participants met friends while hunting geocaches, at geocaching events, or through online interaction at Geocaching.com. Most

importantly, participants characterized their relationships with fellow geocachers as a "community". They valued the social interaction they received while geocaching and the relationships they formed.

Discussion

Exergames provide many positive experiences for their participants, as seen through this qualitative assessment of geocaching. Geocaching is a convenient, low cost activity that engages individuals of all ages in active game play. Geocachers have fun outdoors and gain new knowledge through exploration and skill-building tasks. They get social interaction and become part of a unique community specific to the activity. Furthermore, individuals who are important to geocachers support their participation, which reinforces their likelihood to engage in the activity.

These study findings reinforce findings in past research, which suggest exergames are enjoyable alternatives to traditional physical activity mechanisms that provide mental and physical health benefits for participants (Boulos & Yang, 2013). Geocaching is a sport that has the potential to improve individual health. As seen through the study's interview responses, geocachers cite health as an effect of geocaching; however, not something that they necessarily set out to achieve. This unique aspect of geocaching has tremendous potential in terms of physical activity because it appeals to individuals who do not like traditional physical activity (Sherwood & Jeffery, 2000). Therefore, some researchers think that exergames could become one of the most popular, widespread, and health-promoting activities of the 21st century (Staiano & Calvert, 2011).

It is important to note that our theoretical assumptions are based in a critical realist paradigm. Ontologically, we believe that a real world exists, yet we recognize that the knowledge generated from the study is based on a socially constructed view of the participants and researchers, thus it is not an objective view of reality (Maxwell, 2012). All of our research methods are based on these assumptions and operate within this paradigm.

Study Limitations

As with all research, our study has its limitation. First and foremost, the sample was selected from participants in phase one of the GEAR research study and represents individuals who are frequent geocachers. Additionally, since the sample was drawn from the participant pool of the GEAR study, interviewees were already aware of some potential health benefits from geocaching. The sample only represents individuals in the United States who are mostly white and does not characterize geocachers who live abroad. Geocaching is a multi-national activity and has a large client-base oversees, since these individuals were not involved in the GEAR study their perspective is not included in this analysis. Lastly, we had a relatively small sample size. Adequate sample size in qualitative research is a matter of judgment (Sandelowski, 1995). Sample sizes that are too small may not sufficiently support research claims, whereas in sample sizes that are too large it is difficult to complete detailed analyses (Sandelowski, 1995). Our sample size provided comprehensive information and we were able to reached data saturation. However, the majority of our participants reported being frequent geocachers, which resulted in our data only representing a particular

aspect of geocachers, rather than a diverse range of participation. A larger sample size would have provided us with occasional geocachers, who could have provided information on other forms of motivations for participation.

Future research is needed to further explore the social interaction component in geocaching, which could have important implications on how geocaching is promoted and diffused to other potential participants. Therefore, additional research is needed to understand how social networks among geocachers influence their participants and norms related to geocaching and physical activity. Lastly, if geocaching is shown to be a good source of physical activity, intervention studies are needed to determine the extent it can promote weight loss and health.

SOCIAL NETWORKS IN EXERGAMES: AN EGOCENTRIC EXAMINATION OF GEOCACHING

Introduction

Exergames are activities that combine exercise with game-play. They are a novel concept that brings together virtual communities and real life to provide entertainment, exercise, and social interaction for players (Boschman, 2010; Jin, 2010). Preliminary research suggests that exergames provide positive physical and psychological benefits for participants (Krause & Benavidez, 2014). Recently, researchers have begun to examine how exergames produce physical activity and identified social interaction as one mechanism that influence exergame activity (Krause & Benavidez, 2014). However, more information is still needed to examine social interactions within exergames to better understand how players benefit from game-related relationships and how they gain relationships through participation (Hamari & Koivisto, 2013).

Social Networks

People are connected, thus their health is interconnected (Smith & Christakis, 2008). Relationships in social networks transfer information about resources and opportunities for participation, provide social support, and teach their members about new behaviors (Israel, 1985; Valente, 2010). We study social networks to understand the extent that an individual (or ego) receives social support from their social contacts

(known as alters), as well as ways that the type of relationships (friend/close friend/significant other) between individuals vary (Smith & Christakis, 2008).

There are two primary ways to understand social ties among individuals— ego-centric or whole network analysis. Ego-centric networks describe relationships from an individual (or ego) perspective, in which the ego is the "hub of a wheel, with the rim delineating his/her social contacts and the spokes the ties that connect them" (Smith & Christakis, 2008, p 408). This type of analysis is useful when studying direct links from one individual. Networks in which "all or nearly all members of a community or group and their linkages to each other are represented," are called sociometric or whole networks (Smith & Christakis, 2008, p 408). Sociometic networks describe an entire sample's direct and indirect ties, which allows them to acquire greater information and study overall network quality.

This study investigates network properties in exergames by using an egocentric network approach to examine relational ties among members of a geocaching association. The research question we aim to answer is "*how social networks influence exergames?"*

Geocaching the Exergame

Geocaching is an exergame that creates a real-world treasure hunt for its players using a GPS-enabled device and an online interactive forum, Geocaching.com, which hosts the coordinates of hidden caches and allows players to build user profiles (Groundspeak Inc., 2014). Players use GPS coordinates to navigate to hidden caches, then return to their online profile at Geocahcing.com to log their finds. Caches are

located all over the world and can be hidden anywhere ranging from a nature trail in a city park to underwater in a pond (Groundspeak Inc., 2014). In addition, geocachers can join geocaching associations, which are formed based on common interests and/or geographic proximity. Hundreds of geocaching associations exist across the world and are independently operated to support the geocaching community (Groundspeak Inc., 2014). These associations organize geocaching events, provide socialization opportunities for members, and promote awareness of the sport.

Methods

Geocaching associations are a reasonable unit of analysis for this project because they are formally organized networks of individuals who participate in geocaching. To explore network characteristics we conducted an egocentric network survey with a state-wide geocaching association in Wisconsin.

Sample and Recruitment

We recruited ten individuals (N=10) serving on the geocaching association's board of directors to complete an egocentric network survey instrument. The Wisconsin Geocaching Association (WGA) was identified by Geocaching.com based on their participation in past activities. The entire WGA consists of hundreds of individuals who are engaged to varying extents which would make it difficult to complete a whole network survey in which each member of the network reports on each other member. The ten individuals in the network's leadership were recruited because of their ability to represent a subset within the larger geocaching association's network leadership. All ten of the network members agreed to participate in the study.

Thirty percent of the participants were female and 70% were male. On average, the participants had been geocaching for 8.30 years (SD=2.36).

Interview Tool

The survey tool used to assess the geocaching network was based on an egocentric approach in which each respondent reported on their personal network (Valente, 2010). Specifically, it asked respondents to list up to seven individuals, or alters, that they knew from their geocaching association. Then the survey asked a series of questions about the respondent's geocaching activity and personal interactions with each alter. All materials were approved by our university's institutional review board prior to distribution.

Data Collection and Analysis

All data collection took place online. Individuals were sent a recruitment letter from the geocaching association's president, which contained a link to an online survey. Once an individual completed the online consent, they were given a series of questions about their geocaching participation and alter ties. All ten participants agreed to participate and answered each of the survey questions, so there were no non-respondents and no missing data. Egocentric network characteristics were analyzed using parametric statistics.

Results

Each participant reported up to seven individual alter ties, which resulted in 64 total ties reported in this study. Almost all of the reported relationships started while geocaching, with 95.3% of the egos reporting they had met their alters through

geocaching. Among those ties, the duration of relationship between ego and alter averaged 4.98 years (SD=2.60 years). Egos described the closeness of their relationship with each alter as an *acquaintance, friendship, close friendship*, or *significant other*. The majority of relationships were *acquaintances* (57.8%), followed by *friends* (20.3%), *close friends* (20.3%), and then *significant others* (1.6%).

The majority of egos interacted by talking to their alter ties *one to three times a month* (29.7%). Another 28.1% percent said they talked to their alters between *four to six times* a month, 23.4% said *ten or more times*, 9.9% said *seven to nine times*, and 9.4% said they *didn't talk to their alters at all* in an average a month. Over 40 percent of ego's reported geocaching with their alters *zero times a month* (42.2%), followed by 45% reporting *one to three times a month* (45.3%) , about 9% reporting *four to six times* per month (9.4%), or 3% reporting *seven to nine times per month* (3.1%).

Predicting Closeness

To address the issue of closeness between egos and their alters, we conducted a simple linear regression predicting closeness (dependent variable) by the duration of relationship, interaction by talking, and the frequency of geocaching between ego and alter (independent variables). Closeness describes the intimacy of relationship between ego and later, for example is the relationship described as a friendship, close friendship, or significant other (Marsden & Campbell, 1984). Our null hypothesis was that there was no relationship between the dependent variable and independent variables (slope=0).

Our results showed that 49.6% of the variance in closeness can be explained by the independent variables. In predicting closeness, we identified two statistically significant predictors, duration of relationship (Beta=.255, p=.008) and interaction by talking (Beta=.595, p<.001), and one non-statistically significant predictor, frequency of geocaching (Beta=.180, p=.064).

Discussion

Analysis of our ego-alter ties among geocaching leadership in the WGA indicates that the reported social networks and ties exist mainly due to a shared interest in geocaching. Additionally, while the ego's averaged 8.30 years (SD=2.36) geocaching, they had only known their alter ties on an average of 4.98 years (SD=2.6 years), which means that they were active geocachers long before they became part of a social network with other geocachers.

The majority of egos described their ties with alters as weak (Granovetter, 1973). The presence of weak ties between ego and alters may allow egos to have access to more information than they would if all their ties were strong. As Granovetter (1983, p. 205), states, "acquaintances, as compared to close friends, are more prone to move in different circles than oneself," which provides the ego access to more diverse information.

The results of our linear regression are consistent with previous literature in that the intimacy of relationship, or closeness between ego and alter, can be predicted by the amount of time in the relationship and their frequency of contact (Marsden & Campbell, 1984). We were not able to add statistically significant information by

including the frequency of interaction while geocaching. Although, it is important to know that more than half of ego and alters went geocaching once or more a month (57.8%). This provides contextual information about the nature of the relationship. These relationships are characterized more by talking about geocaching-related activities, than actually engaging in the activity together.

The findings with this leadership network of geocachers suggest that the social ties among geocachers are more useful in sharing information among those with ties than promoting joint activity. Furthermore, as the majority of ties between ego and alters had existed for 4.98 years (SD=2.6) these relationships seem to be long-term.

Study Limitations

It is important to note that these findings come from an egocentric network collected from geocachers on the board of directors of a geocaching association. Thus, the findings may not be representative of all network ties in this network or among geocachers in general due to their leadership position among the association. In addition, because this was an egocentric network study we are not able to analyze the relationships among alters and overall network characteristics. An important issue for further research is how these findings may compare to network relationships outside of geocaching leadership and network structure and relationships among alters.

SOCIAL SUPPORT AND GROUP NORMS PROMOTED THROUGH EXERGAMES

Introduction

Traditional video games provide interactive experiences for participants through competitive game play against other users, both virtually and in-person (Lieberman, 2006). This social interaction is ranked as one of the top motivations among young adults who participate in video games (Liberman, 2006). Interactions between players can foster friendships, which provide positive psychosocial outcomes by reducing social isolation and loneliness (Mueller, Agamanolis & Picard, 2003). These interactive experiences extend to exergames, which combine gaming with exercise, to facilitate fun physical activity for participants.

Social interactions are a strong component to many games, including exergames, because they provide social support to its members through relationship building. Social networks deliver social support to its members in varying degrees and functions, including 1) emotional support, 2) instrumental support, 3) informational support, and 4) appraisal support (Weiss, 1974; Heaney & Israel, 2002). Emotional support "involves the provision of empathy, love, trust, and [care]" and it is helpful during stressful times in a group member's life (Heaney & Israel, 2002, p. 190). Instrumental support assists individuals in times of need (Heaney & Israel, 2002). Informational support is the provision of advice and information and appraisal support

provides feedback and affirmation (Heaney & Israel, 2002). These types of social support influence an individual's ability and decision to participate in exergames.

Another socially constructed concept that influences participation in games is group norms. Group norms are both psychological mediators between an individual's intent to participate in a group and actually participating. They exist at the group level and are developed through interactions between group members (Ehrhard & Naumann, 2004). Group norms accumulate in the accepted or unaccepted behaviors endorsed by the group, as well as the implied standards that govern group members' behaviors (Ehrhard & Naumann, 2004). There are two different types of group norms—descriptive and injunctive. Descriptive norms are based on observations of what group members do in certain settings (Ehrhard & Naumann, 2004). They reveal patterns of group behavior. The second type of norm, injunctive norms, are the formal or informal standards set for group members. These standards result in members conforming to group behavior in order to receive social approval from other group members (Ehrhard & Naumann, 2004). Group norms result in rewards and punishment, group acceptance or non-acceptance of an individual or their behavior, and are delivered by the larger group based on individual's behaviors.

To better understand how social interactions contribute to exergames, we conducted a study to measure relationships among ten individuals in a social network developed through exergame participation. The exergame we studied was geocaching, a real-world treasure hunt that uses GPS-enabled devices to locate to hidden caches.

Cache coordinates are listed on an interactive website, Geocaching.com, which allows players to build user profiles and log their finds (Groundspeak Inc., 2014).

Methods

To investigate network properties and norms associated with the exergame, geocaching, we worked with Geocaching.com to identify a group of geocachers engaged in a geocaching association. Geocaching associations are located all over the world and serve as a community forum for players to socialize, participate in group events, and promote awareness of the game.

Sample

Since the member roster of the entire geocaching group consists of hundreds of individual members, we worked with a subgroup of individuals who serve on the identified association's leadership team. This subgroup was comprised of ten individuals (n=10) and was bounded by the entire membership on the association's board of directors. Participants were 30% female and 70% male. On average, the participants had been geocaching for 8.30 years (SD=2.36).

Interview Tool

To collect network information, we developed a saturation survey, which is designed to capture all the relational ties between members from the whole, or complete, network (Hawe, Webster & Shiell, 2004). In order to analyze all the relationships between members and the resources embedded within these ties, our survey collected information from each network member about their ties with the other members (Hawe, Webster & Shiell, 2004). The survey asked participants about their

relationships with other members in the network, the social support they received, and their group's norms. Questions were derived based on previous network literature and group theory literature (Marsden & Campbell, 1984; Ehrhard & Naumann, 2004). All materials were approved by our university IRB prior to distribution.

Data Collection and Analysis

Data were collected online using Qualtrics® survey software. All selected respondents agreed to participate, all responded to the survey, and all items were completed by respondents. Whole network data was analyzed using sociometics, and network diagrams were created in UCINET®.

Results

Strength of Ties

Each of the respondents reported on their relationship with each of the other respondents. Information collected included the duration of the relationship, recoded in the number of years each individual had known one another; the intimacy of the relationship or tie, described by if they were *acquaintances, friends, close friends or significant others*; and the frequency of contact (by talking) they had with one another in an average month. These three measures were used as indicators of dyadic and overall tie strength among members of the network (Marsden & Friedkin, 1994). Table 3 lists the responses for each measure of tie strength.

Table 3: Measures of Tie Strength

Length of relationship	M=3.81 yrs., SD=1.87 yrs.
Closeness	Density=1.88, SD=.82
Frequency of interaction (talking)/ month	0-3 times: 58.0% 4-10 times: 28.4% 10+ times: 13.6%

On average, members in the exergame network had known each other for approximately four years. To measure intimacy of relationship, or the closeness of group members, we asked each person characterize their relationship with other members as an *acquaintance*, *friend*, *close friend*, or *significant other*. We coded these responses on a scale of one to four, so the ordinal closeness of the tie was entered into the analysis. The network density, or the extent that network members were closely connected to each other, was 1.88 (SD= .82). This is seen in that 41% of alter ties were reported as acquaintances, 39% were friends, 17% were close friends, and 3% were significant others. Next, we asked how frequently members spoke with each other in an average month, with possible responses ranging from zero times to ten or more. The majority of members spoke to each other between zero and three times a month, but approximately one-sixth of the group talked to each other ten or more times a month.

Due to the large variation in frequency of interaction among group members, we conducted a subgroup analysis and identified two clusters among the ten member network. One subgroup consisted of four tightly connected network members (density=12.5) and the other subgroup had six less connected members (density=.733). The members of the first subgroup interacted frequently with each other and frequently with members of the second group (density=7.17); however, the members of the second subgroup reported less frequent interactions with group one (density=3.75) and even fewer among themselves. Figure 2 represents the two subgroups' interaction by talking.

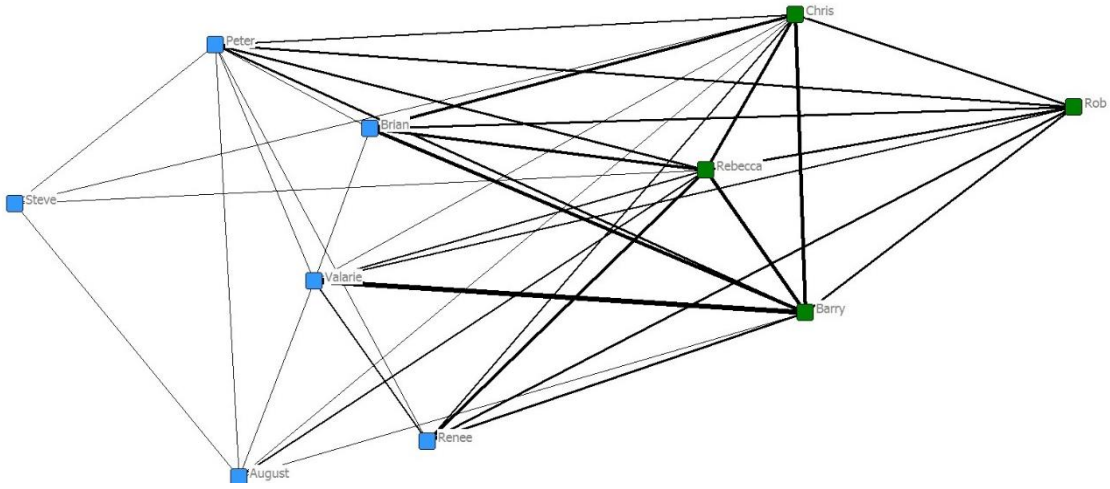

Figure 2: Interaction by Talking

Social Support

To measure social support, we asked two sets of questions. The first was aimed at investigating emotional and informational support, which the literature suggests are highly interrelated (House & Kahn, 1985) and the second was to explore appraisal support. We gained valuable information regarding emotional and informational support among the network members; however, the data generated from questions about appraisal support did not yield as much information because there was not enough variation among responses, which suggests that members did not receive this type of support from the exergame network. After averaging and transforming our data as suggested by Sherbourne and Stewart (1991), we found that members reported receiving an average 36% (on a scale of 1-100) emotional/informational support from ties with other network members. Respondents reported that the majority of their ties (36.25%) with network members delivered low social support or no social support

(21%) whatsoever. Fifteen percent of ties delivered moderate support to members and 27.5% of ties provided a lot of social support.

To better understand how social support was characterized based on duration of relationship, we created a network diagram. The diagram in Figure 3 shows the amount

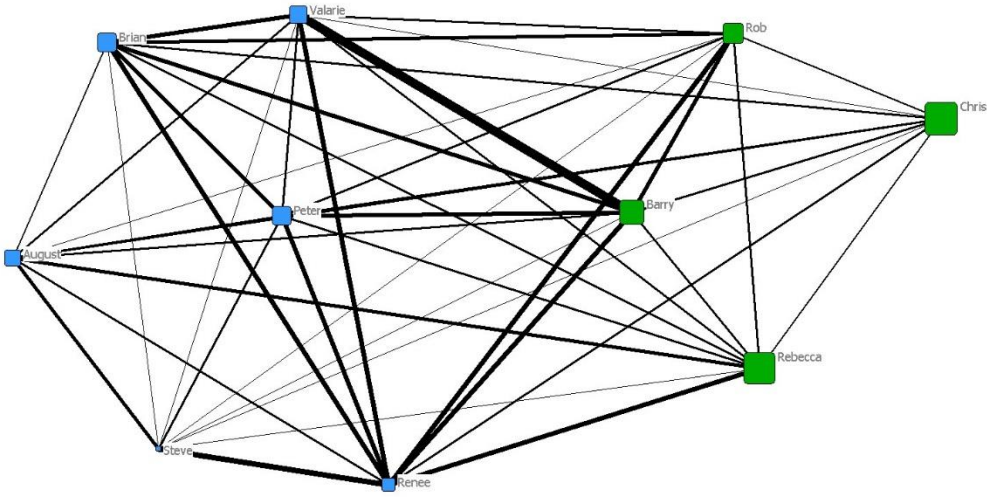

Figure 3: Length of Relationship by Social Support

of social support received by each person based on how long they have known each other. The size of each node represents aggregated amount of social support received by each member and the strength of the ties represent how long they have known each other. Therefore, the thicker the tie, the longer the relationship between individuals.

Group Norms

Lastly, we collected normative data to understand what group norms the exergame network supported. Overall, the entire geocaching group either *strongly agreed* or *agreed* that their group planned geocaching events and promoted

geocaching, advocated for the sport and their organization, and spread information about geocaching. The majority of members (90%) said their group recruited new people to the sport of geocaching and 80% said their group geocached for health benefits.

Discussion

Since exergames provide fun and exercise to their participants, as well as social interaction, they have the potential to influence health both through physical activity and social experiences. However, the extent they influence health through social interactions is uncertain; although previous studies have documented that social networks may influence health though 1) social support, 2) social influence, 3) access to resources, 4) social involvement, and 5) person-to-person contagion (Smith & Christakis, 2008).

Our analyses reveal that geocaching leadership receives a considerable amount of emotional and informational support through their exergame relationships. However, the tie strength among network members was relatively weak, as illustrated by the measures for relationship intimacy and duration (Marsden & Campbell, 1984). This suggests that while network members exchange social resources, they do not describe their network ties as particularly close or intimate. That said however, weak ties are frequently important sources for information and can provide important social benefits (Granovetter, 1973). It would certainly be interesting to compare and contrast the strength of ties among geocaching leadership networks with the strength of ties among other members of respondent's social networks.

Group norms provide direction to network members (Marsden & Friedkin, 1994). Marsden (1994) asserted that members receive guidance by comparing their attitudes with those of other members in their group and when attitudes are reinforced by their peers, members are more likely to continue behaviors (Marsden & Friedkin, 1994). Shared norms in the exergame network center primarily on planning geocaching activities, advocating for the group and game, and disseminating gaming information, however, the network also has norms surrounding recruiting new members and going geocaching for health benefits. Based on these shared beliefs among network members, healthy behaviors may be promoted more through social influence, rather than primarily social support from network relationships.

Smith and Christakis (2008) call for a link between network ties and mechanisms affecting health. Based on this study, we assert that group norms are one characteristic of networks that could mediate health. The social norms created and sustained within networks, are an important influence on health as they reinforce behaviors and provide intuitive controls for deviant behaviors among members within the network. This influence may be another way to promote health, which has not been highlighted sufficiently through past literature.

Study Limitations

A limitation to this study is that our whole network data was collected from geocachers on the board of directors of a geocaching association. These individuals were in positions of leadership, so their network relationships were formalized. We do not have information from individuals in more casual geocaching groups, who do not

organize for formal purposes. As a result, our findings might not be representative of all geocachers networks. In addition, we only explored two aspects of social support, informational and emotional support. While we asked questions regarding appraisal support, our data did not provide any useful information. This does not mean that individuals in geocaching networks do not receive appraisal support, rather our measurement model did not adequately capture the information.

CONCLUSION

This research provides an innovative perspective on physical activity. The exergame of geocaching is a fun way to be physical active at light to moderate intensity and has the potential to appeal to individuals who do not like to participate in traditional methods of physical activity.

Study findings support past research, which claim that exergames provide mental and physical health benefits for participants (Boulos & Yang, 2013). Our LGM shows that the amount of physical activity individuals engage in while geocaching changes overtime and that the more active people are at baseline, the more active they will be over time.

As seen through our qualitative interviews with geocachers, people participate in exergames like geocaching for a variety of reasons. We identified the primary motivations for geocaching as fun and enjoyment, skill building, spending time outdoors, a way to explore, challenge, and a way to gain knowledge. Geocachers also cite health as an effect of geocaching; but not something that initially motivated them to participate.

Since exergames provide fun and exercise to their participants, as well as social interaction, they have the potential to influence health both through physical activity and social experiences. Our egocentric network findings reveal that social ties among geocachers are useful in sharing information. In addition, network relationships develop through shared interests in geocaching and exist for relatively long periods of

time. In addition, our whole network analysis revealed that a considerable amount of emotional and informational support was delivered through exergame ties. Tie strength among the network was moderately weak, but allowed for members to share social resources. Previous research shows that these weak ties are often important sources for information for individuals (Granovetter, 1973).

Lastly, group norms in the geocaching network provide direction to its members (Marsden & Friedkin, 1994). Group norms in the geocaching network focused on planning geocaching activities, advocating for the group and game, and disseminating gaming information. The group has other weaker norms surrounding recruiting new members and going geocaching for health benefits. These norms are another way networks can mediate health outcomes for their members. Social norms that are created and enforced among networks are important influences on member's actions and can support healthy behaviors.

Future research is still needed in the area of exergames. Specifically, intervention studies that introduces individuals who have never participated in exergames to the activity. The GEAR study was exploratory in nature and provides a great deal of insights into how exergames, specifically geocaching, can be tailored to intervention studies. We suggest conducting intervention research to determine how exergames increase physical activity levels among participants, who have not previously engaged in exergames. Studies should use a comparison group and measure social interactions that develop through the joint activity. Lastly, long term tracking of

participants is necessary to understand how rates of activity change over time and how social aspects modify individual's health.

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