Pokémon GO:

A Socio-Technical Exploratory Study

by

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ABSTRACT

PURPOSE: This study aimed to identify whether increased Pokémon GO use resulted in increased daily steps, compared to days when an individual did not play. In addition, this study examined Pokémon GO as a use case for for the study of gamification, particularly whether traditionally identified game mechanics in gamification literature were successfully identified as elements players enjoy when playing Pokémon GO. METHODS: A mixed methods approach, with 17 participants taking part in a daily physical activity tracking study and 14 participants participating in semi-structured interviews. In the use study, participant steps were tracked for one week using the Apple Health Kit application, and participants were also asked to provide daily answers to a variety of questions assessing game preferences and daily use of Pokémon GO - using the application called PACO. The semi-structured interviews examined self-reported physical activity, and asked questions pertaining to use of Pokémon GO, such as motivation to play. RESULTS: Results assessed by t-test indicate a small but non-significant trend towards increased steps taken on days when a participant played vs. did not play ($t(72)=-.56$, $p=.57$, $m_{play}=5{,}015\pm3220$, $m_{nonplay}=4{,}515\pm2{,}959$). This was confirmed with a mixed model test showing that when controlling for time and participant's baseline level of steps, there was no significant effect on steps/day. Results from the daily surveys and also the semi-structured interviews, indicated that nostalgia (i.e., catching ones' favorite childhood Pokémon), was a strong motivator for many to play the game, which was counter to theoretical expectations. In line with previous theory, results suggested that operant conditioning principles appeared to be at work in terms of fostering game play use. DISCUSSION: Results of this study, which was a

primarily hypothesis generating endeavor, indicated possible trends toward increased steps on days when a person plays Pokémon G), but - with such a small sample, and short-term length of study - no firm conclusions can be drawn. Further, results indicate the particular value of nostalgia as a driver towards game play for Pokémon GO.

Dedication:

For Greg, Barbara, & Natalie Biel.
If it weren't for your support, who knows where I would be.

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Please note, there are no uses of the word "usage" in this paper
because "usage is electric, not research."

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Chapter 1: Introduction

The state of health in America today is less than adequate. It was reported in 2014, that more than one-third of adults and 17% of youth in the United States classify as obese by height and weight standards - body mass index (BMI) - with almost two thirds of adults included who are obese.[84] The effects of obesity on the human body are well documented. The physiological definition of obesity is the accumulation of excess body fat.[20,27,35,39] Excess accumulation of body fat, specifically visceral (VAT) and intrahepatic fat (IHTP), have been shown as a significant predictor of a wide range of sub-optimal health conditions including stroke,[22,27] coronary heart disease,[18,27] overall mortality,[27,47] type 2 diabetes mellitus (T2DM),[27] systematic hypertension,[27] dyslipidemia,[27] obstructive sleep apnea, [27] osteoarthritis, [27] depression, [27] gout, [27] nonalcoholic fatty liver disease, [27] reproductive-endocrine disorders, [27] some types of cancers, [27] and psychosocial[39] and economic difficulties.[39] Alternatively, it has been shown that a 10% reduction in ones' body weight (a proxy of excessive body fat accumulation), can result in in decreased low-density lipoprotein cholesterol,[29,69] systolic and diastolic blood pressure,[82,97] total-cholesterol, very-low-density-lipoprotein cholesterol,[29] and triglycerides.[29] Recent studies have focused on examining the determinants of obesity, of which there are many. Reviews have shown portion size,[104-105] sleep apnea,[86,104] lack of sleep,[104] and sedentary behavior[55] (i.e., prolonged sitting) have all been linked as factors that feasibly influence body weight.

Of particular relevance for this work is physical activity (PA),[3] which has been a significant priority in America since the 2008 Physical Activity Guidelines for Americans were released.[7] The report stated that, for substantial health benefits, adults should

engage in 2 hours and 30 minutes of moderate-intensity aerobic activity OR 75 minutes a week of vigorous activity OR an equivalent mix of moderate - and vigorous - intensity aerobic activity, weekly.[7] Since the report, there has been substantial coverage of initiatives such as First Lady Michelle Obama's "Lets's Move"[8] and Healthy People 2020[1] campaigns, stressing the importance and benefits of PA. These benefits include decreased body mass,[58] decreased fatness,[58] lower cardiovascular disease risk factors,[58] increase fitness,[91] and many more. Despite efforts, thousands of American's still remain inactive. There is substantial literature showing the low proportions of PA in youth,[30,3349,79,94,99] similarly, the percent of America's youth that was meeting the national PA guidelines in 2014 was 25%.[64] Adults are even worse at meeting PA guidelines. Approximately only 20% of Americans reportedly met the 2008 Guidelines in 2014.[5] Factors that appear to impact a person's ability to be physically active include violence,[2] traffic,[2] pollution,[2] the built-environment,[2,59,90] and barriers to activity such as not enough time, inconvenience, lack of self-motivation, boredom, low self-efficacy, and lack of social support.[6]

Based on the ubiquity of individuals who are physically inactive, scalable intervention strategies are being sought. One particularly promising medium for this is the delivery of PA, is via digital technologies such as smartphones (e.g. apps), text messaging, websites, or social media. Recent studies suggest the feasibility of digital technologies, particularly mobile or "mHealth." These mobile interventions have shown to be particularly effective in promoting PA.[65,75,96] While these results are promising, there is still a paucity of evidence establishing which types of mHealth interventions are particularly efficacious for whom.[56-57,67,80-81]This is based on the inherent complexity

often required for designing an intervention to work in the real-world context, a key advantage of mHealth interventions, but also a key challenge in terms of establishing an evidence-base strategy.[56-57,80-81] Based on this, a great deal of work is currently taking place on establishing the theoretical recommendations for design and evaluation of methods in mHealth interventions.

For example, Spring et al., identified 4 m's to help guide researchers in the development of behavioral interventions monitoring, modeling, motivating, and modifying.[96] Spring et al defined the terms as such 1) motivating involves the participant's willingness to adhere to a change, 2) monitoring is the ability to collect data in real-time (or near-real-time) 3) modeling is defined as the linkage between psychological, sociological, environmental, and physiological states, and 4) modifying is the adjustment of techniques, based on what is modeled as plausibly influencing the efficacy of an intervention, to increase the likelihood of the intervention producing the desired effect. Motivation to engage in the desired behavior is important because, without motivation, it is unlikely that a behavior - particularly a volitational behavior such as PA - will occur. Not only does one need to be motivated though, but previous evidence suggests the value of monitoring the desired behavior - a separate action in itself. When self-tracking does not occur, previous evidence indicates reduced likelihood of behavior change of the target behavior.[65] With motivation and monitoring taking place, the next task of the researcher becomes the need to model how various factors (e.g. psychological, sociological, environmental, and physiological states) might interact to influence if the intervention will produce the desired effect.[56] This could then be translated into modifications over time - into intervention - to increase the likelihood that the

intervention will produce the effect. This work is designed to increase the specificity and, by extension, the potency of the behavior change technique created within a given digital technology (e.g., a goal-setting intervention).

An emerging behavior-change technique is the concept of gamification.[37] Gamification has been described in multiple ways. The trend can be described as a "rapid proliferation of mass-market consumer software that takes inspiration from video games,"[37] while the process has been described as "using game thinking and game mechanics to solve problems and engage users."[36] Related to engagement, the recently released mobile application Pokémon GO has established itself to be one of the most downloaded games in history, with 9.5 million daily users as of July 2016.[10] Pokémon GO is one of the first mobile games to successfully use augmented reality (AR) to integrate game elements – in this case Pokémon – into ones natural environment. With this element, Pokémon GO also requires persons to move throughout ones environment in order to play the game - using global positioning systems (GPS) - Pokémon GO has inadvertently prompted millions to move in order to play the game, making it a potential source to increase physical activity. However, little is known of what has made Pokémon GO such a groundbreaking success in terms of initial downloads. The phenomena presented an interesting use case to study gamification, particularly whether traditionally identified game mechanics in gamification literature were successfully identified as elements players enjoy.

The purpose of this mixed methods study was to examine whether use of the Pokémon GO application had resulted in increased steps on days when a person plays Pokémon GO compared to days when they self-report not playing Pokémon Go. In

addition, this study also sought to identify which game elements were being used by players, and by extension, assess whether there are similarities between elements that players describe and theoretically important gamification elements suggested by the literature.

Chapter 2: Literature Review

Gamification

The concept of gamification has evolved out of literature that has classically placed great emphasis on the detrimental impact of games.[50] For example, the Substance Use Disorder Work Group (SUDWG), recommended that the Diagnostic and Statistical Manual for Mental Health Disorders (DSM-5) include Internet Gaming Disorder.[51] Further, others have conceptualized video games as the excessive use of video games, resulting in negative psychosocial and/or physical consequence.[87] Addictive qualities associated with games include salience, mood modification, tolerance, withdrawal symptoms, conflict, and relapse.[68] While it is important to remain mindful of these plausible detrimental effects of games, the intention of gamification is focused on taking advantage of these "addictive" elements for the purpose of producing favorable real-world outcomes."[60]

One particularly important strategy commonly used in "gamification" is the concept of "affordances." The term affordances refers to the benefit that an animal receives from engaging in a behavior.[48] Studies have examined the following as affordances - points, leaderboards, achievements/badges, levels, story/theme, clear goals, feedback, rewards, progress, and challenge.[54] Rewards are one of the most well-documented affordances, because of their grounding in classical behavior theory and operant conditioning.[108] Research on digital badges alone are unclear[12] or highly disagreed upon.[53] With that said, some studies have shown that gamification strategies, like points, are useful for improving measures such as engagement during learning.[24,43,54] However, other studies have had mixed responses as to whether the students actually

learned more while engaged.[24] A variation on affordances that include a social element is a leaderboard, which lists ones progress in a game relative to others. Feedback can be seen in leaderboards as a form of reinforcement,[24] and a mechanism for teaching. Through feedback, players get a sense of their performance relative to others.[24] Leaderboards have been useful for increasing time-on-task, which has shown to be positively related to improving student academic performance[70] and motivation.[38]

Most of the existing literature related to gamification has focused on "exergames," or "serious games." Exergames are defined as exertion-based interfaces that promote physical activity and fitness.[10,73] Although promising, exergames that promote physical activity have been met with skepticism by some. In particular, research conducted by Ferrara believes that gamification strategies - like incorporation of affordances/positive reinforcements - minimize the strength of a game itself.[45] Ferrara's argument centers around the premise that the entire game/overall experience must be taken into account to inspire an engaging and useful experience, not just the "gamified" elements.

Researchers have been skeptical as to whether traditional or gamified games are a better experience.[25,73] In example, Pokémon GO. The Ferrara school of thought is that all elements incorporated in Pokémon GO make Pokémon GO a great experience (i.e., augmented reality, physical activity, badges, and any other elements within the game), and that no elements can be extracted and studied independently. Other researchers – particularly Deterding et al. - in favor of gamification would suggest that game elements (i.e, augmented reality, physical activity, and badges) are all independent elements used to make Pokémon GO successful, and can be studied independently. Despite mixed

views, a significant amount of research has shown games can promote physical activity, which would support traditional gamification literature.[25,72] Interestingly, Pokémon GO has never been framed as a physical activity promoting application, which could meet Ferrara's argument of an "entire game as being useful," with the health benefits largely as an afterthought. This fits with previous research suggesting the possible advantages of not "gamifying" a health behavior but instead, "healthifying" a game to ensure the full game elements are carefully thought out.[21] Based on this line of reasoning, a key observation we sought was to better understand, within our interviews and use study, was how the integrated and "complete" Pokémon GO was experienced, and if there appears to be any possibility for "dissecting" the game into its component parts. Questions addressed in this paper to assess this experience could be, what is motivating people to play? What is making people not want to play? Which contexts of the game do people enjoy? Can a game with a higher social element integrate more external controls? Finally, what is the role of social interactions for supporting game play? These questions will be addressed below.

Gamification and Physical Activity

In general, results of previous studies that have examined the utility of gamification on increasing physical activity are mixed, but the control condition is particularly important to be mindful of. In particular, when comparing exergames to other video games, results do tend to suggest there are increased levels of physical activity. When comparing a "gamified" intervention (both ones that appear to just add game elements to a physical activity intervention and ones that appear to be more

explicitly designed as a game) to more rigorous controls, such as providing a self-tracking device, the results are more mixed.

Related to the question of an exergame vs. a video game, as an example, a study by Lanningham-Foster examined the effect of playing a game seated compared to playing the same game under physical activity enhanced conditions. Researchers studied 25 healthy children's energy expenditure under a few different conditions - sitting watching a video-tape, playing a video game while seated, watching a video while walking on a treadmill, and while playing dance dance revolution. Results of the study showed that energy expenditure almost doubled from seated screen measures to active screen measures.[71]

When more rigorous controls were included, results were more mixed, in general. An example of a trial that indicates value for gamifying physical activity interventions was conducted by Chung et al., in 2016. In this study, they incorporated "gamified" elements into a physical activity intervention,[25] which used a combination of self-monitoring (daily logs), social support (positive Twitter messages), and reinforcement techniques (photos of healthy options). Results of the study suggest that the intervention did produce significant increases in steps and fruit and vegetable intake, and decreases sugar-sweetened beverages relative to those that did not engage in daily food logs or use their Fitbit.[25] For our purposes, the gamification elements were not well specified. Researchers provided the "use of gamification principles," but the principles used were not mentioned besides "periodic challenges to beat personal best scores" by researchers.

In contrast, other research is less convincing about the use of gamification and more complete games. Related to gamification, "Beat the Street"[26] focused on

gamification targets identified as plausibly addictive.[26] Gamified elements in the study were called 'Beat Boxes.' Beat boxes were equipped on lampposts around the city, so that each time a participant would go for a walk, they would touch the sensor - which would count as a point. Points could then be traded in for books prizes. The study also used more behavioral elements such as feedback, self-monitoring, and socialization among peers. The study did not significantly impact children's physical activity during active travel relative to those that had many Beat Box touches compared to those that did not participate as frequently

Finally, Step City was a trial that more actively examined differences between self-monitoring only vs. a "gamified" physical activity intervention, and what could arguably be a more complete game experience. The study was a three-arm randomized trial with the following three conditions: 1) wearing Fitbits as usual without change 2) one intervention used a social network that included friend and messaging features to complement Fitbit and 3) a third condition that translated Fitbit steps into a currency, that could be traded into build buildings, similar to SimCity.[100] A metric of success for the city was crime, which was determined based on the quality of the buildings that the player created, high quality (high currency) buildings equated to low-crime - and vice - versa. A unique feature about Step City is the ability to play as much as one wants, the only catch is that one must be physically active to accumulate the necessary currency to play. The study showed no significant difference between the three conditions related to physical activity levels.

As Pokémon GO has only been available for about half a year, empirical studies are limited. That said, a study by Serino et al. explored the literature on augmented

reality, and thus framed the potential benefits and adverse effects of Pokémon GO as an augmented reality video game. Results of their work indicated increased exercise, and increased socialization and outdoor activities as benefits, and risk of injury, abduction, trespassing, violence, and cost as adverse events.[92] In another study, results showed that Pokémon GO is one of most downloaded mobile application in history, suggesting that individuals like the game. [44] Further, results of this work also indicated that users have reported walking 1,000 steps more daily on days when they play, compared to days when the are not playing.[44] Based on this previous work, there is potential promise for gamification and games as tools for supporting physical activity, and for the potential benefits of Pokémon GO in particular. However, at present it is unclear what active ingredients may be the potential value of Pokémon GO itself. These equivocal results provide justification for this study.

Behavioral Theories Relevant to Pokémon GO and Gamification

There are several relevant behavioral theories relevant to Pokémon GO and gamification including Operant Conditioning,[46] Self Determination Theory (SDT) and Organismic Integration Theory (OIT) - a subset of the SDT.[83] Operant Conditioning consists of several terms including contingencies, antecedents, consequences, negative and positive reinforcement, and negative and positive punishments. [10] The first term, antecedents refer to the events (i.e., a prompt to play a game) that come before a behavior (an action, i.e., a person deciding to play the game). Contingencies refer to the relationship between antecedents (the prompt), the behavior, and consequences of that behavior.[10] For the purposes of this study, the affodances discussed above will always be

considered consequences of gameplay. Negative and positive reinforcement (rewards) refer to the different kinds of processes that aid in increasing behavior, while negative and positive punishments decrease the likelihood of behavior.[10] The terms listed above work in the following way. The antecedent (i.e. a sign saying press play to begin), prompts a behavior (i.e. follow the fox), which results in a consequence (i.e. "way to go, you did it") when a specific action, called the contingency rule, occurred (i.e., the fox was followed in alignment with the rules). In the same example, the reinforcement of "way to go, you did it," could be positive reward to entice the player to play the game the same way next time. If the player did not follow the fox, the game could display "wrong way," on the screen until the player walked the correct direction (negative reinforcement). An example of negative punishment, if the player did not follow the fox, the game would start over - making the player lose all progress. In theory, the loss of progress would prompt the player to play differently next time, thus reducing the undesirable behaviors (e.g., wandering and not following the fox). An example of positive punishment would be that if the player did not follow the fox, the game added extra levels that the player would have to complete prior to continuing the game. In theory, the adding of extra levels (positive punishment) would decrease the likelihood of the player wandering rather than following the fox. Due to the ability to shape behavior, which is what is occurring across all of these actions as a person's behavior is "shaped" to conform with the desired actions of the game maker, researchers have sought out ways to increase physical activity through exergames.

The gameplay of Pokémon GO can be organized using the framework above. Specifically, key antecedents within Pokémon GO are prompts to help key players and

receiving a notification (or information from someone else) that a rare Pokémon is nearby. The key behavior in Pokémon Go is playing the game, which involves moving in a real-world environment to find and catch Pokémon within the app (e.g., Pokémon are displayed on a map that overlays the real-world environment). The key consequences are experience points (XP), badges (i.e. collector), combat power level ups, candy, stardust, bragging rights, the feeling of success from catching Pokémon, being able to evolve and improve Pokémon, and winning battles.

This theory established a logical target for the key variables to measure within our ecological momentary assessment (EMA) portion of the user study. Specifically, we measured antecedents by the question "Why did you start playing Pokémon Go?" Answers such as "family, or friends," gave insight into what types of events preceded the playing the game the first time and across multiple times playing (i.e. "Hey John, have you checked out Pokémon GO? It is a really fun game!" OR" Pokémon is coming out with a brand new game! I loved Pokémon when I was younger, I have to play that game!"). Behaviors that were assessed through the EMA study were length of daily gameplay, and whether gameplay occurred. Finally, perceived positive and negative consequences of gameplay were also assessed (i.e. I caught a Pokémon OR I did not catch a Pokémon) that shaped the personal framing of the experience.

Self Determination Theory (SDT) has been used by some as a guiding principle for understanding the use of gamification within physical activity interventions, but its application to gamification is under-specified. SDT distinguishes between two types of motivations intrinsic and extrinsic.[89] Intrinsic motivation is when someone is interested in something because they are entertained or interested in the action itself. This differs from

extrinsic motivation, which is when a person is motivated to engage in a task or activity. When intrinsic motivation is increased, extrinsic motivation is decreased and vice-versa.[31] This presents an interesting debate for present gamification studies, as many of the strategies used within gamification - particularly "affordances" - are explicitly targeting extrinsic motivation, not intrinsic motivation.

Organismic Integration Theory (OIT) - another subset of the SDT[83] - specifies a structure for understanding the extent to which external locus' of control can be internalized by the person. This is important for Pokémon GO because it could explain the relationship between gameplay and walking. In theory, if someone plays the game more, they will likely walk more (unless they play the game as a passenger in transport). Thus, it is an interesting target to examine whether someone who has had increased PA resulting from gameplay, has had any resulting increase in internalized motivation to be regularly active. It is important to note here that physical activity is not necessarily the targeted behavior of the game but instead, occurs as a nice side effect of the game. As such, it is plausible that while the game elements and affordances are extrinsic motivators for game play, it is feasible that inspiring someone to walk and be more active might foster increased intrinsic motivation to play.

OIT is meaningful to gamification for the same reason as SDT, if the external locus of control cannot be internalized, the behavior may not become self-sustained.[83,89] The literature clearly speaks to the importance of making the game meaningful to the user so that there is a better chance of the action (in this case remaining physically active) being internalized. Based on SDT, people typically do not engage in activities that are extrinsically motivated tasks unless there is a strong social component to it.[89]

Specifically, people engage in actions that are not intrinsically motivating when social groups value the actions the individual takes.[89] Connecting this back to OIT, it is plausible that the mechanism for internalizing both the motivation and locus of control to be regularly active via Pokémon GO could require a social relatedness component. Interestingly, Pokémon GO does include a robust social engagement piece with several individuals, including strangers, meeting up and interacting with one another when they find a common Pokémon. Based on this, it is plausible that Pokémon GO could foster internalization of being physically active via this social connection facet of OIT/SDT but empirical work is required to examine this assertion.

One of the main arguments against gamification comes from Jull's "classic game model."[61] For an activity to be considered a game it must be rule-based, have quantifiable outcome, require player effort, and players must be emotionally invested in the outcome of the game (i.e. if someone sees a Pokémon they have been searching for on the map - and then the Pokémon disappears – they must have an emotional response to that Pokémon disappearing).[62] Pokémon GO successfully incorporates these rules in the following ways. For one, Pokémon GO requires movement. The game uses kilometers traveled as a quantifiable outcome. When a player achieves this outcome, they are rewarded with candies and power ups to evolve their Pokémon. Assuming that players are not hacking the game - and are walking while playing - movement requires effort. Thus, Pokémon GO successfully incorporates three out of the four qualifications of a game. This work suggests the following question "do players have an emotional investment in the outcome?" We examined this and the other questions already delineated in our study.

Augmented Reality

Pokémon GO is built on a platform with two distinct elements compared to previous exergames. The first, augmented reality, is a variation of virtual reality. Virtual reality immerses the user in a fictional 3-dimensional (3D) environment. Augmented reality, however, does not have the same immersive qualities as virtual reality. Instead, augmented reality places 3D objects (i.e. Pokémon) into the real-world context of a person in real-time (e.g., one could feasibly see a Pokémon within their screen sitting on their desk). Pokémon Go uses real-world global positioning systems (GPS) that shows user placement on a map, within the game. Pokémon are spread throughout the map, and in order to catch Pokémon, one must move in real-life to the locations where Pokémon are present. Based on this, an important unique question about Pokémon GO is the potential value (or not) of this augmented reality feature to Pokémon GO.

Recently AR was used to cater to the needs of mentally and physically handicapped children.[72] Using AR, researchers were able to cater 3 profoundly handicapped children, each with different disabilities, using the same software. When the children completed the desired movement, AR provided dynamical sounds and cartoons to entertain the children, which resulted in significant positive effects on physical activity at an extremely low cost.[72] This study is an example of a location-based AR, which uses GPS and/or other player-tracking measures to promote a desired behavior. [15] Pokémon GO is an example of a location-based AR. Few studies have engaged in using location-based ARG's,[15] which makes this study exciting. Based on this work on AR, an important question related to Pokémon GO is if the AR feature is a particularly important

game element for fostering increased physical activity. This will be a key target of our exploration.

Summary of Key Questions Related to Pokémon GO

Based on this previous work, there are several questions that we explored within this mixed methods, hypothesis generating endeavor. Does Pokémon GO increase PA? Do the "affordances" within Pokémon GO appear important for fostering Pokémon Go? Building on this point, what can be gleaned about the possibility of being able to separate the Pokémon GO game into its elements (Deterding's perspective) vs. a requirement that the entire game remain intact (Ferrara's perspective)? How do the social elements, as a logical extension of the leaderboard literature, impact game play and enjoyment of the game? Can the current Pokémon GO application features feasibly be organized according to operant theory and, if so, how might that help to delineate the "active ingredients" on how and why the game might foster increased engagement and physical activity? Are there unintended consequences of the game, particularly as a mechanism that primarily uses extrinsic motivators? Will this results in potential issues with fostering intrinsic motivation to be active? How might the game elements, particularly the social elements potential foster increased intrinsic motivation to be physically active? Finally, does the AR feature appear to be a particularly important element for fostering engagement and feasibly physical activity via Pokémon GO? The next section will assess the methods that will attempt to answer these questions.

Chapter 3: Methods

Subjects and Recruitment

The study aimed to recruit up to 50 active users of Pokémon GO, and up to 10 users for semi-structured interviews. Participants were recruited from the general population, that were 18 and older who had either actively used Pokémon GO in the past month, or within the semi-structured interview portion only, have knowledge of Pokémon GO but have not yet played. Participants were recruited via an e-document (Appendix B), and community advertising techniques (e.g., emails to student listservs, word-of-mouth). Specifically, recruitment was mostly conducted during the day on the Tempe campus of Arizona State University. Prospective participants were mostly students, and were approached individually, and asked if they play Pokémon GO. If they play Pokémon GO actively, they were asked if they would like to hear more about the study. If they were interested in participating, they were giving the link bit.ly/pokemongostudy and filled out the screener survey either at the time of recruitment or at a later time. If the prospective participant wanted to sign up immediately, they were instructed on how to sign up. Participants were only excluded if 1) they were under the age of 18, 2) did not play Pokémon GO, or for the use study only 3) did not have an iOS device (as Apple's HealthKit was used to track PA. If eligible for the interview, participants were sent the consent document (Appendix D) and scheduled. If eligible for the use study, participants were sent the use study instructions (Appendix E), and consented via the research service www.openhumans.org.

User Study

The user study provided insight into the daily gameplay of participants and its relation to physical activity levels. This portion of the study focused on documenting use of Pokémon GO, via an ecological momentary assessment (EMA) application called personal analytics companion – PACO - an application designed to engage users and record data in real-time. The study also the used of Apple's Health Kit – an application designed to record user steps and other useful health data - to measure physical activity. Data from HealthKit was able to be uploaded through an application designed for the Open Humans website, www.openhumans.org. Note that the HealthKit App automatically tracks steps per day

Table 1: Ecological Momentary Assessment Questions/Answer Choices

Question	Answers
1) How many times did you play Pokémon GO today?	Answer Choices 1) 0 2) 1 3) 2 4) 3 5) 4 6) 5 7) More than 5 times today
1a) Conditional: If participant reported not playing; Why not?	1) Bad weather 2) No one to play with 3) Too busy 4) Didn't feel like playing 5) Other (Continues to text saying please explain)
2) How much time did you play today (in minutes)	1) 30 minutes or less 2) 1 hour 3) 1.5 hours 4) 2 hours 5) 3 hours or more
3) Where did you play?	1) In my neighborhood 2) In a park 3) In a car, bus, light-rail, etc. 4) In my home 5) I ventured into the unknown (continues to text saying please explain)
4) Which of these feelings best describe your Pokémon GO experience today	1) Powerful 2) Heroic 3) Social 4) Happy 5) None of the above (Continues to text :Please explain, how do you feel?)
5) What prompted you to play Pokémon GO today?	1) Someone asked me to play with them 2) I just wanted to 3) To catch em' all 4) Because I still haven't caught a stupid rare Pokémon 5) Other (Continues to text: Please explain)
6) What did you really enjoy getting/completing in Pokémon GO today?	1) I caught an awesome Pokémon 2) I evolved a Pokémon 3) I won battles 4) I gained some combat power levels 5) I received an impressive badge 6) I spent time with someone I care about 7) I still can't get over there are Pokémon in front of me 8) I got some serious steps in 9) I went somewhere new to catch Pokémon 10) I captured a specific Pokémon before anyone else I know 11) Other (continues to text: Please explain)

via the iPhone's built-in accelerometer. The target of the research was one week of self-reported use of Pokémon and its features (see questions in Table 2) as well as daily steps taken, as measured via the iPhone's HealthKit app.

The EMA portion of the quantitative descriptive study provided data to support exploration of real-world use of Pokémon GO, if that appears to translate into PA, and the underlying plausible mechanics for achieving those changes based on a basic operant conditioning framework. Specifically, the EMA portion explored how antecedents (question 5) might trigger game play and then how various elements predicted by the gamification literature (i.e., questions 4 and 6) might influence future use of the game and increased potency of the antecedent for triggering engagement in the game. As this is an AR game, we also included items about the context whereby the game was played (question 3), to glean insights on if context played a role in when and where individuals played. For days when participants did not play, a follow-up question delineating why they did not play was also asked (question 1a). Participants were sent PACO prompts to respond per PACO's default setting of 8 PM.

Semi-Structured Interviews

The semi-structured interviews covered questions related to popular gamification techniques and their incorporation, or lack thereof, within Pokémon GO. The semi-structured interviews also provided self-reported physical activity history. More specifically - the interviews - regarding physical activity, gave a brief history of physical activity in regards to dispositions and past habits. These semi-structured interviews, which were designed to last approximately 30 minutes (Table 2), were designed to enable some initial qualitative data to be gathered related to the questions summarized at the

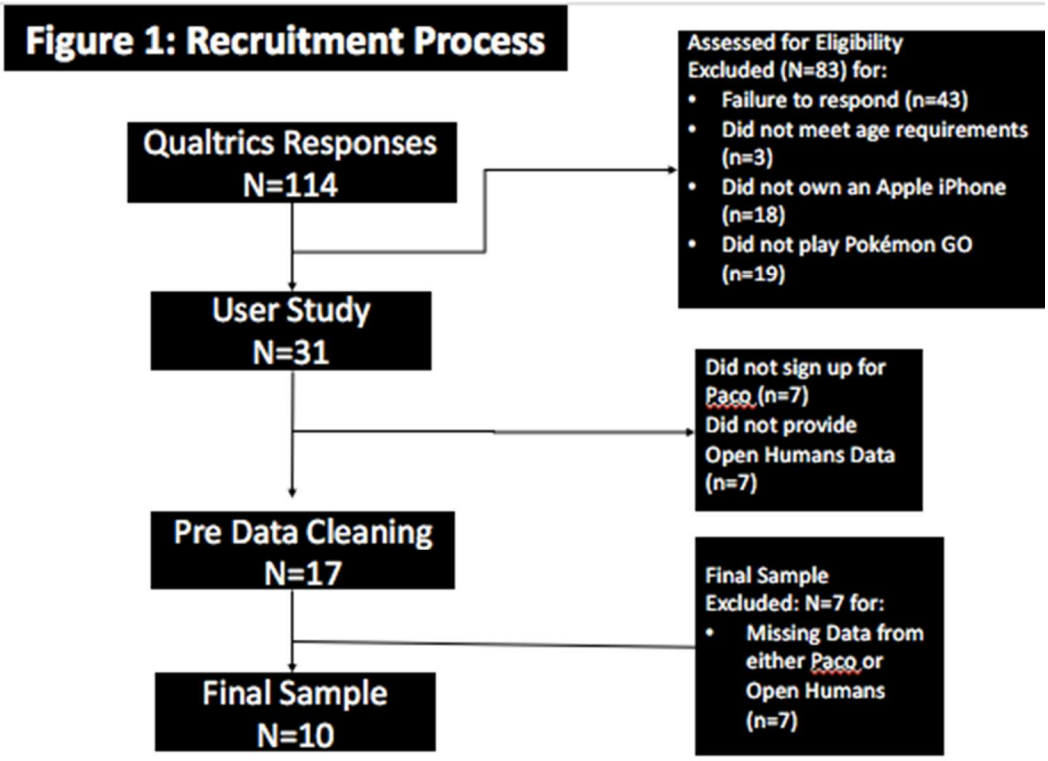
conclusion of chapter 2. Interview questions were asked as specified, however, IRB specifications gave flexibility in the ability to expand on responses given, if the participant answer was unclear or warranted an explanation. Interviews were recorded by the iPhone application tape-a-call, and were subsequently transcribed post-interview.

Table 2. Interview Questions (N=10).
1) Why do you Play Pokémon GO? Why do you not?
2) What features of Pokémon GO do you enjoy?
3) What would you change about Pokémon GO?
4) Can you tell me a story of your favorite memory playing Pokémon GO?
5) When, where, and how do you most often play Pokémon GO?
6) What got you started playing Pokémon GO?
7) How much walking and other physical activity did you do prior to playing Pokémon GO?
8) Do you think Pokémon GO changed how active you are? If so, how? If not, why do you think it didn't impact your physical activity level?
9) What is your favorite feature of Pokémon GO? What is your least favorite part of playing Pokémon GO?
10) Tell me a bit how active you were last week? For example, did you intentionally exercise at all? About how much walking did you do on any given day? Does your walking differ on the weekends v. weekdays? If so, how?

Chapter 4: Results

User Study

The user study consisted of 17 participants – however – due to missing data from the PACO experiment and individual's who did not upload step data to Open Humans, this sample was reduced to 10 participants for the purposes of our analysis (Figure 1). Demographics of the included sample, excluded sample, and final sample can be found in Table 5 and 6. The two aims of the study were to 1) study elements of Pokémon GO, with a particular emphasis on quantify the features that individuals report using/enjoying as part of Pokémon Go, and 2) to assess whether or not gameplay frequency influences physical activity as measured via the iPhone step tracker feature from Health Kit. Results of popular elements used daily can be found in Table 5. Out of 41 total days of self-



reported gameplay across the participants, the question of whether increased Pokémon GO play influences physical activity can be found in Tables 3 and 4. T-test results (Table 3) showed that when comparing the variable "did play today" to the sum of each participants steps, there was little effect, t(72)=- .56, p=.57, m_{play}=5,015±3220, $m_{nonplay}$=4,515±2,959. These results were verified by a Mixed Model Analysis (Table 4) showing that when controlling for time and play, Pokémon GO did not show any significant effect on steps/day, $F_{play}(1,61)=.83, p=.37$.

Table 3. T-Test: Did Play Today*Sum of Steps. Table 3.

Did Play Today	N	Mean	Std Dev	Std Err	Min.	Max.
0	33	4515.8	4389.9	764.2	29.0000	18490.0
1	41	5015.7	3220.2	502.9	688.0	17398.0
Diff (1-2)		-499.9	3785	885.2		

Did Play Today	Method	Mean	95% CL Mean		Std. Dev	95% CL Std. Dev	
0		4515.8	2959.2	6072.4	4389.9	3530.3	5806.5
1		5015.7	3999.3	6032.1	3220.2	2643.9	4120.3
Diff (1-2)	Pooled	-499.9	-2264.5	1264.7	3785.0	3255.0	4522.7
Diff (1-2)	Satterthwaite	-499.9	-2331.7	1331.9			

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	72	-0.56	0.5740
Satterthwaite	Unequal	57.145	-0.55	0.5869

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	32	40	1.86	0.0638

Table 4. Mixed Models Test of Fixed Effects.

Effect	Num DF	Den DF	F Value	Pr > F
Time	1	61	0.00	0.9727
Did Play Today	1	61	0.83	0.3657
Time*Did Play Today	1	61	0.000	0.9801

The second question the elements most enjoyed on a daily basis were catching awesome Pokémon, evolving a Pokémon, the evolution of Pokémon, winning battles (one goes to a "gym" to fight other Pokémon from rival teams), and gaining power all at 15% response rates. Feelings reported from daily Pokémon GO play were almost exclusively to feeling happy with a 67% response rate. Examples of "other" feelings reported by

Table 5. Demographics User Study

Total Sample N= 17	
Total Participants	17
• Males (4/17)	24%
• Females (13/17)	76%
Mean Age	21 ± 4.92 years
Excluded Sample N=7	
Total Participants	7
• Males (2/7)	29%
• Females (5/7)	71%
Mean Age	23 ± 6.68 years

Table 6. Descriptive Statistics Final Sample. N=10.

Variable	Mean	Std. Error
Males (2/10)	20%	--
Females (8/10)	80%	-
Mean Age	19.5 ± 2.51 years	-
Days Reported for Sample	41 days	
Average Days Played	7.4 ± 2.54 days	.81
Range of Days	2-11 days	
Average Times Played	2.42 ± 1.65 times per day	0.15
Did Play Today	59% ± .49	.044
Average Minutes Played	33.36 ± 42.7 min	3.81
Average Steps Daily	4793 ± 42.7 steps	438

participants were indifferent, annoyed, and bored. Prompts to play Pokémon GO were primarily that of just wanting to play, and wanting to catch 'em all. Finally, the locations participants most often played Pokémon GO daily were in ones' neighborhood, ones' home, and in transit. Further variables and results can be found in Table 5.

Qualitative Study

The semi-structured interview portion of the study yielded 14 interviews (n=14), of these participants, 2 participated in the user study. There were 5 male and 9 female participants with an average age of 26.5 (SD ± 6.98 years (Table 28). The interview questions consisted of 10 questions (Table 1) addressing questions such as

Table 7.
PACO Descriptive Statistics.

Variable	Mean
Feelings Described By Daily Gameplay	
Feels Happy	67%
Feels None of the Above	16%
Feels Social	14%
Feels Powerful	8%
Feels Heroic	1%
What Prompted You to Play Pokémon GO Today?	
Wanted to Play	66%
To Catch 'Em All	31%
Rare Pokémon	19%
Was Asked to Play	18%
Where Did You Play Pokémon GO Today?	
My Neighborhood	65%
Home	41%
Transit	31%
Park	24%
What Did You Really Enjoy in Pokémon GO Today?	
Awesome Pokémon	42%
Evolved a Pokémon	15%
Won a Battle	15%
Gained Power Levels	15%
Got Serious Steps in	14%
Excited About AR	14%
Spent Time with Someone	7%
Received Impressive Badge	5%
Went Somewhere New	4%
Caught a Rare Pokémon Before Anyone Else	1%
Why Didn't You Play?	
Too Busy	47%
Didn't Feel Like Playing	39%
No One To Play With	16%
Bad Weather	14%

"Why do you play Pokémon Go?" to address themes such as: motives for playing, game mechanic preferences, modes and locations of play, and prior physical activity habits. Self-reported exercise the week prior to physical activity can also be found in Table 8. The most common mode of exercise among participants was cardiovascular exercise; specifically biking, and/or running.

The first question asked participants why they play Pokémon GO (Table 9). The most common themes among players in their motivations for gameplay were: family and friend influences, and feelings of nostalgia. Examples of family and friend influence were: participants feeling as though Pokémon GO gave them common ground with younger family

Table 8. Demographics of Interview Participants. (N=14)

• Males (5/14)	36%
• Females (9/14)	64%
Mean Age	26.5 ± 6.98 years

Did You Intentionally Exercise Last Week? (N=14)

Self-Reported Exercise Levels Among Participants the Week Prior to Study (Most Popular to Least Popular)

Theme	% of Sample
Cardiovascular Exercise (6/14)	43%
No Exercise (5/14)	36%
Exercised More Than Once (4/14)	29%
Exercised Once (1/14)	7%

Table 9. Why Do You Play Pokémon GO? (N=14).

Themes and Percent of Sample That Mentioned the Specified Theme (Most Popular to Least Popular)

Theme	% of Sample
Friends/Family (7/14)	50%
Nostalgia (6/14)	43%
Moving Around 5/14	36%
Being Outside (4/14)	29%
Pleasure/Enjoyment (4/14)	29%
Hype/Popularity (2/14)	14%
Augmented Reality/Immersion (2/14)	14%
Competition (2/14)	14%
Novelty (1/14)	7%
Distracting (1/14)	7%
Linking Generations (1/14)	7%
"Catch the Critters" (1/14)	7%

members, giving friends a mode to escape from boring social events, and giving friends an activity to do outside. An example of nostalgic feelings resulting from gameplay among multiple participants were persons catching their favorite childhood Pokémon for the first time. These results were consistent with Table 10 which shows why participants began playing Pokémon GO.

Table 10. Why Did You Start Playing Pokémon GO? (N=14)

Common Reasons Participants Began Playing Pokémon GO and the Percent of the Sample That Mentioned Each Reason (Most Popular to Least Popular)

Theme	% of Sample
Family/Friends (6/14)	43%
Nostalgia/Fans (5/14)	36%
Hype/Fad (4/14)	29%

Table 11. How Do You Play Pokémon GO? (N=14)

Method of Play and Percent of Sample That Mentioned the Specified Method (Most Popular to Least Popular)

Theme	% of Sample
Walking (12/14)	86%
Driving: Passenger (5/14)	36%
Biking (1/14)	7%
Bus (1/14)	7%
Running (1/14)	7%
Driving: Operator (1/14)	7%

The most common mode of Pokémon GO play are shown in Table 11. The most frequently reported mode of play was walking. Examples of players walking while playing Pokémon GO were walking downtown to go eat, walking to parks before school,

and walking around ones neighborhood to relieve stress after work or school.(Table 12). Examples of participants' playing in the passenger's seat while driving were: kids playing Pokémon GO while their parents were driving and simply playing while others were operating the vehicle. Times of reported play can be found in Table 13.

Table 12. Where Do You Play Pokémon GO? (N=14).

Locations and Percent of Sample That Mentioned the Specified Location(Most Popular to Least Popular)	
Theme	**% of Sample**
Around Town/Downtown (8/14)	57%
Parks (5/14)	36%
Residence/Neighborhood (4/14)	29%
Work (4/14)	29%
College Campus (3/14)	21%
Playgrounds (1/14)	7%
Lake (1/14)	7%
Crowded Areas (1/14)	7%
In Transit (1/14)	7%
Along the Coast (1/14)	7%

Table 13. When Do You Play Pokémon GO? (N=14)

Time played and Percent of Sample That Played at the Specified Time (Most Popular to Least Popular)	
Theme	**% of Sample**
Evening (8/14)	57%
Day (7/14)	50%
Late Afternoon (5/14)	36%
Morning (3/14)	21%

The most common features that participants enjoyed (Table 14) were: the fun of catching Pokémon, the challenge catching all of the Pokémon, playing the game with others, feelings of nostalgia, and discovering new landmarks. Examples of the fun participants had of catching Pokémon were: catching their favorite Pokémon, and simply the joy of seeing and catching different Pokémon. "Gotta catch 'em all" – the slogan of

Pokémon – referred to the challenge of catching all of the Pokémon. Examples of participants that enjoyed "catching 'em all," included on participant that wanted to beat her brother-in-law in finding rare Pokémon, and simply the competition between friends on who could find the coolest Pokémon. Feelings of nostalgia – described above- were also found in features that persons enjoyed, participants felt as though they received nostalgic feelings of childhood and being prior fans among daily Pokémon GO play. Examples of the last feature – landmarks – included those participants who enjoyed the novelty of not knowing certain landmarks in their

Table 14. What Features of Pokémon GO Do You Enjoy? (N=14).

Features and Percent of Sample That Mentioned the Specified Features (Most Popular to Least Popular)	
Theme	**% of Sample**
Fun to Catch Pokémon (4/14)	29%
Catching 'Em all (3/14)	21%
Playing With Others (3/14)	21%
Nostalgia (3/14)	21%
Landmarks (3/14)	21%
Simple/User Friendly (2/14)	14%
Evolving (2/14)	14%
Hatching (2/14)	14%
GPS (2/14)	14%
Forcing Oneself to Go on A Walk	14%
Augmented Reality (1/14)	7%
Novelty/Different (1/14)	7%
Open World (1/14)	7%
Battles/Gym (1/14)	7%
Leveling Up (1/14)	7%
Mystery (1/14)	7%
Distraction (1/14)	7%
Belonging (1/14)	7%
Competition (1/14)	7%
Comparing Pokémon (1/14)	7%
Going Into the Community	7%

community, with Pokémon Go providing "an excuse to go see landmarks." These findings were partially consistent with Table 15 in which one additional person described the social aspect of the game as being their favorite feature of Pokémon GO. Other favorite features of Pokémon GO were the buddy system in which trainers can choose a Pokémon to be their walking buddy and augmented reality, which one participant felt "made the world more exciting."

Table 15. What is Your Favorite Feature of Pokémon GO? (N=14).

Favorite Features and Percent of Sample That Mentioned the Specified Features (Most Popular to Least Popular)	
Theme	**% of Sample**
Social Aspect (4/14)	29%
Buddy System (2/14)	14%
AR (2/14)	14%
Being Outside (2/14)	14%
Stress Relief (2/14)	14%
Competition (1/14)	7%
Sense of Community (1/14)	7%
Conversation Starter (1/14)	7%
Seeing Family Happy (1/14)	7%
Different Pokémon in Different Geological Locations (1/14)	7%
Fitness Tracking (1/14)	7%
Resources (1/14)	7%
Nostalgia (1/14)	7%
Challenge of Catching 'Em All (1/14)	7%
Seeing All the Critters (1/14)	7%

The least favorite features of Pokémon GO can be found in Table 16. The most reported least favorite feature of Pokémon GO was the battery drain resulting from extended gameplay. Other least favorite features were: location accuracy, some Pokémon being too rare, and scarcity of gyms in certain locations. Gyms in Pokémon GO are the location in which trainers (Pokémon GO players) go to congregate and battle other trainers - in order to level up Pokémon. Examples of location accuracy issues including a problem at the beginning of play of the game. Specifically, when the game first became

popular, participants received indicators that showed how far away they were from certain Pokémon – due to the overload on the servers from the wave of hype surrounding the beginning of the game – these indicators were turned off. Participants indicated that when the indicators were turned off, the difficulty of finding Pokémon nearby became much harder. Examples of Pokémon being too rare are the Pokémon that Niantic deems are not often found. Participants felt that rare Pokémon were too rare, and that they did not have enough control over their ability to find these Pokémon. Examples of

Table 16. What is Your Least Favorite Feature of Pokémon GO? (N=14)

Least Favorite Features and Percent of Sample That Mentioned the Specified Features (Most Popular to Least Popular)	
Theme	**% of Sample**
Battery (3/14)	21%
Location Accuracy (2/14)	14%
Rare Pokémon Are Too Rare (2/14)	14%
Scarcity of Gyms in Certain Areas (2/14)	14%
Scarcity of Pokéstops in Certain Areas (1/14)	7%
Scarcity of Resources in Certain Areas (1/14)	7%
Can't Play Without Moving (1/14)	7%
Can't Play at Times Without Buying Resources (1/14)	7%
Too Many of the Same Pokémon (1/14)	7%
No Profile (1/14)	7%
Can't See Pokémon They Already Have (1/14)	7%
Being Bad at Battling (1/14)	7%
Too Many Glitches (1/14)	7%
Application Start-Up Takes Too Long 1(/14)	7%
Too Little Social Interaction (1/14)	7%
Can't Add Friends (1/14)	7%
Can't Trade (1/14)	7%
Can't See Friends Pokémon (1/14)	7%
Embarrassing to Play (1/14)	7%

scarcity of gyms in certain areas were described by participants as: having an abundance of gyms in locations that were more populated, and less gyms among less populated areas. These results were in line with responses participants reported, in terms of the features of Pokémon GO that they would like change (Table 17).

Table 17. What Would You Change About Pokémon GO? (N=14).

Themes and Percent of Sample That Mentioned the Specified Theme (Most Popular to Least Popular)	
Theme	**% of Sample**
Battery Drain (3/14)	21%
Location Accuracy (3/14)	21%
Battle Other Trainers (2/14)	14%
No Trading Option (2/14)	14%
Rare Pokémon too Rare (2/14)	14%
Game is too Static (2/14)	14%
Want to See Others in the Room (1/14)	7%
Too Little Social Interaction (1/14)	7%
Cant Add Friends (1/14)	7%
Implement Team Battles (1/14)	7%
Rarity of Gyms in Certain Locations (1/14)	7%
More Control of Which Pokémon One Finds (1/14)	7%
Too Many of the Same Pokémon (1/14)	7%
Fix Bugs That Kick Players Off the Game(1/14)	7%
Too Few Updates (1/14)	7%
Faster Leveling Process (1/14)	7%
Game Takes Up too Much Memory (1/14)	7%
Application Takes too Long to Startup(1/14)	7%

The last two questions assessed favorite stories of Pokémon GO (Table 18) and whether or not participants felt as though Pokémon GO changed their physical activity. Favorite stories of Pokémon GO were consistent with Table 14 in which participants most enjoyed the fun of catching Pokémon and catching ‘em all. However, the most common theme in stories of Pokémon GO involved meeting new strangers while playing the game. Examples of participants meeting strangers include: 1) an entire organization of persons congregating around a fountain outside in order to set up modulators to gain more resources; 2) a person walking up to strangers to take back gyms nearby, and 3) simply having something to talk about with random people playing on their phones.

The final question asked persons if they thought that Pokémon GO changed their activity (Table 19). Results showed that 64% of people felt as though Pokémon GO added walking or running. Examples of walking and running activities added by users include: 1) mid-day work breaks in order to find Pokémon nearby; 2) adding a run every morning in order to catch Pokémon while playing and cover a great distance; and 3) adding walks downtown with family to play Pokémon GO with loved ones. Results also showed that two persons indicated that they felt as though Pokémon GO was just an accessory – or something to do – during exercise that was already occurring.

Table 18. Favorite Stories of Pokémon GO? (N=14).

Common Themes in Participants Favorite Story of Pokémon GO and the Percent of the Sample That Mentioned Each Theme (Most Popular to Least Popular)	
Theme	**% of Sample**
Involving Strangers (6/14)	43%
Involving Catching Em' All (6/14)	43%
Involving Friends (5/14)	36%
Involving Family (2/14)	14%

Chapter 5: Discussion

Results of this small pilot study did not indicate a significant effect on increased steps on days when reported playing compared to days when they did not based on either t-tests or mixed model analyses controlling for individual intercepts and time. This was a small pilot, thus making any p-value estimates suspect. Descriptive analysis, looking at mean differences, suggest a possible trend towards increased steps during days when individuals played vs. did not play Pokémon Go, in the realm of approximately 500 more steps per day, though these results need to be further explored with a larger sample. In addition, qualitative results from the semi-structured interviews, suggested that individual perceive that they have increased their physical activity when playing, thus lending justification for a larger study. Results from both the semi-structured interviews and user study about Pokémon Go usage indicate that the most common reasons individuals appear to play Pokémon Go are nostalgia, social interactions, and to catch Pokémon and the happiness resulting from gameplay. These findings were consistent across both qualitative interviews and a quantitative user study by EMA. With that said, there were some inconsistencies between the interviews and the user study. Specifically, results showed that participants favorite feature of Pokémon GO was the social aspect in the semi-structured interviews. However, in the daily EMA study, people only reported feeling social 14% of the time. This discrepancy could partially show that social interactions are appreciated among participants but do not occur frequently.

Our first question was if Pokémon Go could be used to foster increased steps. Results of the work are equivocal based on the small sample size. This is in line with previous work of Chung et al. and Coombes and Jones, suggesting limited understanding,

at present, on the use of exergames for fostering physical activity.

With regard to our second and third questions, the two schools of thought about affordances in general and how to implement a "gamification" strategy are either: 1) Ferrara et al,[45] who suggest that games themselves are useful, and game elements cannot be extracted and studied independently, or 2) Deterding et al,[36] who suggest that games have elements that are more useful than others, and these elements can be studied independently. Results from the study are inconclusive. In terms of Ferrara's perspective, the interviews do suggest that the overall game experience is important, not just the individual features. This is an argument behind the wide-scale adoption of this overall game compared to other exergames generated. In addition, the primary target of the game is "catching Pokémon" was emphasized by many as one of the most enjoyable parts of the game. This could be indicative of the importance of the overall game experience rather than any of the sub-features of the game as particularly valuable for fostering continued engagement and, possibly, physical activity. With that said, there were specific features that individuals appeared to appreciate, as per Deterding's perspective.[36] For example, participants indicated that they would change the static nature of difficulty in the game (indicating the need for challenge), and that the leveling process was faster (indicating the need for levels) (Table 12). From Deterding's view, this could indicate some affordances being more important than others. Since badges were not mentioned - but levels were – game developers could feasibly put more emphasis on levels and less emphasis on badges in the Deterding school of thought. Overall, affordances do seem to play a part in fostering Pokémon GO play. However, a difficult question to ask is whether researchers would see similar results, if less indicated

affordances were left out of the game. It is not clear whether more enjoyable affordances would fill the void if other affordances were not present.

With regard to the potential social elements and operant theory, the top antecedents for Pokémon GO play were family and friend influence, and being previous fans of the game. However, there were mixed consequences to gameplay. For some, the least favorite element of the game was lack of social interactions, such as, for example, if a player engaged in Pokémon GO play (behavior) and the player did not catch his favorite Pokémon (consequences), the contingent framing of the experience would feasibly be negative. In regards to positive and negative reinforcement, and positive and negative punishment, there was evidence to say that these principles were extremely important in the success or failure of the game. **Example 1**: Person A played Pokémon GO (behavior), and caught his favorite Pokémon (consequence). The contingent framing of that experience was positive. However, shortly after playing the game Person A's phone died (acts like a negative punishment for extended gameplay).
Example 2: Person A played the game (behavior), and caught his favorite Pokémon (consequence), but in order to do so he had to walk an extra 15 kilometers because the game has inaccurate GPS locations (positive punishment to catching the Pokémon).

Thus, the question is, "How much did Person A value catching the Pokémon?" The defining factor that seemed to be shaping play was whether or not there was perceived social benefits (i.e., playing with friends) and game elements that players enjoyed (i.e., catching ones favorite Pokémon). For the participants in the study, this seemed to outweigh the perceived negative and positive punishments of playing the game (i.e., phone dying, poor location accuracy, boredom). This seemed to be the defining of

factor player engagement and enjoyment.

The above are examples of unintended consequences of the game. The internal motivation to nostalgically catch ones favorite Pokémon was normally accompanied by the extrinsic motivation to play the game in order to fulfill that desire. As such, physical activity was mostly an extrinsic reward of playing the game. There was one participant that reported he was more likely to go on a run, however, the reasoning was to cover more ground to catch Pokémon. A future study could entice non-players to use the game for a year. Their baseline physical activity could be measured, and they could be measured for six months after playing the game. It would be interesting to see if activity increased due to receiving rewards, and whether motivation to be active increased as a result, post intervention.

A likely scenario is that Pokémon GO facilitated social engagements that may result in person's desire to be physically active. In example, one participant reported walking downtown with her daughter to catch Pokémon every weekend. Prior to Pokémon GO, she and her daughter only went downtown when they needed to run errands, and they would always drive. It is certain that Pokémon GO facilitated this new outing, however, it is uncertain whether or not the mother and daughter would continue to be physically active if they did not have a game to play while walking.

Further social elements within leaderboard literature, suggested that leaderboards gave participants a sense of accomplishment. It could be argued that the Pokédex – or the resource in which players can see their list of Pokémon they have caught – is an individual leaderboard. However, this was not measured or mentioned. Social elements outside of leaderboard literature (i.e. conversing with strangers) seemed to play a

profound role in player enjoyment and gameplay, especially within families. Two participants mentioned that having a game that both they and their children enjoy playing, gave them a form of common ground with their child.

The final question we sought to answer was whether the AR feature seemed important in fostering engagement and physical activity. It does seem as though the AR feature was important in fostering engagement, particularly between generations based on our interviews. Within the interview portion, there were multiple participants that indicated the joy of having Pokémon in the same room as their nieces and nephews. Further, one of the older participants indicated the joy of having random Pokémon appear in their office. Whether an enjoyable application is always more engaging is unclear, but it seemingly would be. As far as facilitating physical activity, the study did not receive any answers that give could insight to this question but our work indicates the possible value of AR as a tool for fostering physical activity and justification for additional research on the topic.

There were multiple surprising finds from the study. The first example of a surprising finding was that the feeling of nostalgia increased gameplay, thus was a contingency strengthening daily gaming experience. Another interesting find was that 43% of people were influenced by family or friends to begin playing Pokémon GO, however, only 36% of interviews involved friends, 14% involved family, and players only felt social 14% of the time in the user study. This finding is especially surprising because the top answer for favorite stories involved mingling with strangers. Being one of the most downloaded games of all time, along with the hype surrounding the game, may have heightened people's comfort level around strangers. This finding was

specifically interesting as a potential antecedent for gameplay.

This work is primarily a hypothesis-generating, as opposed to hypothesis-testing endeavor. As such, no firm conclusions should be drawn from this study, though the work does highlight potentially interesting hypotheses for future work. First, the study was a non-representative convenience sample of users mostly recruited from a major US university – and was mostly teens/students from a major university. Second, the study had limited statistical power, thus limiting firm conclusions from the quantitative analyses conducted. Related to the interview study, the question framed in the interview study was not well-phrased and thus resulted in uninterpretable data related to steps taken per day from the semi-structured interviews (i.e., no validated measure was used when many do exist and should have been used such as the Stanford Brief Activity Survey).

The study also had difficulty in recruitment. The Qualtrics screener survey had 114 responses, however the recruiter was only able to sign up 31 participants for the Open Humans, and of those participants 24 signed up for PACO. This could mean a couple of things. First, the sign up process should have been simplified. There were obvious discrepancies in: 1) the expectations of what applications the participants were supposed to sign up for; and 2) how the participants signed up for each of those applications. Of those 24 participants that signed up for PACO and Open Humans, 17 of those people gave data. This could have meant that the instructions for how to use each of those applications were poorly designed. Lastly, from the 17 participants, 10 of those persons gave enough data from both Open Humans and PACO for the user study testing the effects of the relationship between game play and steps. This signifies a poor execution of the study, not having suitable measures to prompt inactive participants to

give data. There were some initial technical glitches, but were ultimately overcome, and seemingly did not have an impact on the low sample size. A strength of this study is the mixed methods approach that included both interviews and EMA for understanding outcomes and the use of objectively measured steps as per the iPhone. With that said, further work is needed on defining the validity of the iPhone as a tool for measuring steps. In addition, total wear time was not provided from the data, thus creating a potential bias in the steps estimate.

In future work, the interview portion of the study will include a validated self-report questionnaire and more participants will be interviewed. In addition, additional questions that better explore some of the theoretically implied questions of the work (as delineated at the conclusion for Chapter 2) will be incorporated into the new semi-structured interview. For the user study, the protocols have now been updated and simplified to enable more participants to be recruited for the study. The study will be opened to the general public, and open for Open Humans members to join to further explore these issues.

In summary, results of this study were inconclusive. No firm conclusions can be drawn, as this study was primarily hypothesis-generating, and not hypothesis testing. However, the study produced several interesting findings. The first interesting finding was the users produced a trend of walking 500 steps more than non-users. The study also produced several noteable trends towards Pokémon GO's potential for nostalgic value for adults, and increasing commonality between familial generations. The study also produced a firm test of methods linking www.openhumans.org and PACO, to document trends in the future. Further work is needed to assess the true value of Pokémon GO as a

source for increasing PA.

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APPENDIX A

SHORT CONSENT: USE STUDY

Design Protocol for Pokémon GO: A Socio-Technical Exploration Study

I am a professor in the College of Health Solutions at Arizona State University. I am conducting a research study to explore how best to design a videogame that can provide you with real-life benefits such as increased physical activity.

I am inviting your participation, which will involve a usability study. The aim of the usability study will be looking to gain a better understanding of how often you play Pokémon GO and your overall physical activity level. We will be recording information about Pokémon GO use via daily survey questions that we will ask you at the end of each day, delivered via a mobile app called "PACO." We will gather information about how many steps you take each day from the mobile application HealthKit, which is already included in your iPhone. You will be asked to participate for at least a minimum of one week. If you so choose, you can opt in to continue to provide both step data from HealthKit and/or fill out the evening survey questions on your phone for as long as you have the interest. You have the right to not answer any question, or stop participation in the study at any time. Although there is no compensation, your data will be used to help implement future studies that could benefit others.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. You must be 18 or older to participate in the study.

Although there is no direct benefit to you, results will aid in the development of new applications that provide entertainment to users while possibly enhancing physical activity or other health benefits. There are no foreseeable risks or discomforts to your participation.

Your responses will be confidential. We will ensure confidentiality by keeping all identifying information in a separate file to all of the data and information you provide us via the interviews or usability study. The results of this study may be used in reports, presentations, or publications but your name will not be used. Results will only be shared in the aggregate form.

For the semi-structured interviews, I would like to create an audio/video recording of the interview. The interview will not be recorded without your permission. Interviews will take place via phone, video-conference, such as Skype, FaceTime, or Google Hangouts, or in-person at Arizona Biomedical Collaborative Building 1. Please let me know if you do not want the interview to be recorded; you also can change your mind after the interview starts, just let me know. This interview is being recorded so that we can review the discussion at a later date to identify patterns and themes across people we interview.

If you have any questions concerning the research study, please contact the primary investigator Eric Hekler at (602)-827-227, or email at ehekler@asu.edu. You may also contact the research team: Alex Biel, School of Nutrition and Health Promotion at (913)-

484-3674, or email PokémonGOSTStudy@gmail.com. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

By singing below you are agreeing to be a part of the usability study:

Signature:

Date:

APPENDIX B

EMAIL ADVERTISEMENT

Dear Participant:

My name is Alex Biel, a student in Obesity Prevention and Management in the School of Nutrition and Health Promotion at Arizona State University.

I am conducting a research study focused on gaining a better understanding of what aspects of Pokémon GO have made it such a great success. I am inviting your participation, which will involve completing a short interview. The interview has its own set of instructions. Please read the instructions completely before filling out each questionnaire. To help me out, all you will need to do is complete an interview should take 15-30 minutes.

All you need to do is email me alexbiel12@gmail.com to schedule an interview when you have some free time. For example:

- Between classes or meetings
- Before you GO home for the day
- On your light rail ride home
- First thing in the morning
- During your lunch break

Participants will also be asked to be involved in a volunteer usability study. All you need to do is allow researchers to access your HealthKit information on your phone for one week!

I need these data to graduate. Further, these data are important for me to improve our knowledge of designing success games that may benefit individual's physical activity in the future.

As a thank you for your participation, you will have my eternal gratitude and I will send you an abundance of GO od karma.

Again my email is alexanderbiel1212@gmail.com

Thanks again,

Alex Biel

APPENDIX C

COVER LETTER

Design Protocol for Pokémon GO: A Socio-Technical Exploratory Study

Dear Participant:

I am conducting a research study focused on gaining a better understanding on the strategies for designing a successful smartphone game that can provide real-life benefits. I am inviting your participation, which will involve a brief interview. The following interview you are about to contains its own set of instructions. Please read the instructions completely before beginning the interview. The interview should not take longer than 30 minutes to complete. Your participation in this study is voluntary. You can skip questions if you wish. If you choose to not participate or to withdraw from the interview, you can do so at any time.

While there are no direct benefits to you participating, results in this study will aid us in the development of new strategies to promote new games that may provide health benefits, particularly increased physical activity. There are no foreseeable risks or discomforts to your participation.

Your responses will be anonymous. The results of this study may be used in reports, presentations, or publications but your name will not be known. At the end of the interview you will have the option to continue with the Use Study.

If you have any questions concerning the research study, please contact the research team at:
Alex Biel, School of Nutrition and Health promotion, alexbiel12@gmail.com. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the chair of the Human Subjects Institutional Review Board, through ASU Office of Research Integrity and Assurance at (480) 965-6788

Completion of the interview will be considered your consent to participate.

Best Regards,

Alex Biel

APPENDIX D

INTERVIEW CONSENT

Design Protocol for Pokémon GO : A Socio-Technical Exploration Study

I am a professor in the College of Health Solutions at Arizona State University. I am conducting a research study to explore how best to design a videogame that can provide you with real-life benefits such as increased physical activity.

I am inviting your participation, which will involve a semi-structured interview which will take approximately 30 minutes of your time. Within this, we will ask you questions about your perceptions and use of Pokémon GO , physical activity habits prior to Pokémon GO , as well questions asking about your history playing video games.

Your participation in this semi-structured interview is voluntary. If you choose not to participate or to withdraw from the interview at any time, there will be no penalty. You must be 18 or older to participate in the interview.

Although there is no direct benefit to you, results will aid in the development of new applications that provide entertainment to users while possibly enhancing physical activity or other health benefits. There are no foreseeable risks or discomforts to your participation.

Your responses will be confidential. We will ensure confidentiality by keeping all identifying information in a separate file to all of the data and information you provide us via the interviews or usability study. The results of this study may be used in reports, presentations, or publications but your name will not be used. Results will only be shared in the aggregate form.

For the semi-structured interviews, I would like to create an audio/video recording of the interview. The interview will not be recorded without your permission. Interviews will take place via phone, video-conference, such as Skype, FaceTime, or GO ogle Hangouts, or in-person at Arizona Biomedical Collaborative Building 1. Please let me know if you do not want the interview to be recorded; you also can change your mind after the interview starts, just let me know. This interview is being recorded so that we can review the discussion at a later date to identify patterns and themes across people we interview.

If you have any questions concerning the research study, please contact the primary investigator Eric Hekler at (602)-827-227, or email at ehekler@asu.edu. You may also contact the research team: Alex Biel, School of Nutrition and Health Promotion at (913)-484-3674, or email PokémonGOSTStudy@gmail.com. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

By signing below, you agree to be a part of the semi-structured interview

Name:

Signature:

Date:

By signing below, you are agreeing to be videotaped and/or recorded

Name:

Signature:

Date:

APPENDIX E

PACO INTSTRUCTIONS

Dear [PERSON'S NAME]

Thanks again for taking part in this study about when, where, and how people play Pokémon GO !

Please follow these steps to get set up in the study. The first is to download an app called "PACO." PACO is used to ask you questions about when, where, and how often you played Pokémon GO!

1) Navigate to iOS app store
2) Search "PACO"
3) Click on "PACO" by "PACO Developers"
    a. Download
4) Open PACO
5) A prompt will come up to sign in with GO ogle Account
    a. If you have an account:
        i. Enter email; click next
    b. If you DO NOT have an account
        i. Create an account
6) A prompt will then say: "PACO would like to:
    a. Know who you are on GO ogle
    b. View your email address"
    c. Click Allow
7) Click Find Public Experiment
8) Scroll to Pokémon GO : A Socio-Technical Exploratory Study

The second step is to get set up in Open Humans. This allows us to gather data from your phone about your physical activity via the HealthKit app.

Open Humans Download Process

1) GO to Apple's App Store on your iPhone
2) Navigate to search
    a. Search "Open Humans"
3) Click to download "Open Humans Uploader" by Black Bear Software, LLC
4) Once downloaded, open the application.
5) To begin you must authenticate your account in order to integrate HealthKit data (which will provide us with insights about your physical activity) to Open Humans; click "GO to Open Humans website"
6) Click "Create an account"
    a. Enter username, name, email, and create a password (note that we will not see any of this information, it is used within Open Humans).
    b. Agree to terms of use
7) Navigate to email; accept confirmation

8) Click Authorize Project at the bottom of the page
9) Navigate to Pokémon GO: A Socio-Technical Exploratory Study
    a. If you are having difficulty; use this link to sign up directly.

After you've completed this, we ask that you self-report on your Pokémon GO use for at least one week. While this is going on, we will be gathering information passively about your activity based on Health Kit. Please feel free to continue to provide data for as long as you would like. When you no longer wish to participate, feel free to uninstall the two apps.

If you need any additional help with this, please contact us as Pokémon GO STStudy@gmail.com

Thanks again,

Alex Biel

APPENDIX F

GLOSSARY OF TERMS

Affordances – the benefit an receives from engaging in a behavior

Antecedent- The stimulus that occurs prior to a behavior

Augmented Reality – Places 3D objects in ones' environment in real-time

Behavior – An action

Consequence – The stimulus that occurs after a behavior

Contingency – The linkage between an antecedent, a behavior, and a consequence

Exergames – Exertion-based interfaces that promote physical activity

Gamification – the real-world benefits a user receives from playing a video game

Healthkit- An application developed by Apple that automatically records user-steps, and also gives the user the ability to record a variety of other health-related variables

Negative Punishment- Taking away an pleasant stimulus in order to decrease the likelihood of a behavior occurring

Negative Reinforcement – Taking away an unpleasant stimulus in order to increase the likelihood that a behavior occurs

PACO- Personal Analytics Companion

Positive Punishment – Adding an unpleasant stimulus in order to decrease the likelihood of a behavior occurring

Positive Reinforcement – Adding a pleasant stimulus in order to increase the likelihood that a behavior occurs

Virtual Reality- The immersion of a user in a 3D environment