When the Mind Moves Freely, the Body Follows

Exergame Design, Evaluation, and the Curious Case of Pokémon GO

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ABSTRACT

Exergames, video games that mediate physical exercise, have been used with demonstrable success to improve physical fitness. However, the health impact that exergames can achieve is not restricted to increasing the amount of players' physical activity. These games have been used in other aspects of healthcare, such as cognitive training and mood-improvement, and may reduce the burden of treatment experienced by patients. To measure such parameters, researchers require different kinds of methodologies that can assess the subjective perceptions of patients *and* take into account the social relatedness, autonomy, and sense of competence offered by good exergames. This article provides an overview of the health benefits of exergames that have been measured to date, the methods by which the data on these benefits has been obtained, and the design principles that maximize the self-motivation that serious games can evoke from their players. We provide an analysis on the factors that propelled *Pokémon GO* (Niantic, 2016a) into becoming one of the most successful exergames in recent memory and the apparent decline of interest towards the game. By assessing the lessons learned from *Pokémon*

GO, as an example of successful exergame design, and by developing innovative and comprehensive methodologies for evaluating effects, this paper suggests how exergames more broadly may better serve the holistic health benefits of players at a large scale.

INTRODUCTION

Exergames, defined as video games that mediate physical exercise (Oh & Yang, 2010), are one of the earliest examples of video games used for purposes beyond entertainment. From the 1987 Nintendo Entertainment System title *World Class Track Meet* (Human Entertainment, 1987) to Wii and Xbox Kinect systems that drove wide public adoption of exergames, to phone-based exergames and virtual and augmented reality—the experience offered by exergames continues to encourage players to perform physical activities by giving these activities meaning. Exergames used for the purposes of physical therapy or to promote physical exercise have been shown to be beneficial in observational studies (Fogel, Miltenberger, Graves, & Koehler, 2010), mixed-methods studies (Maloney et al., 2012), calorimetric studies (Graves, Ridgers, & Stratton, 2008; Graves, Stratton, Ridgers, & Cable, 2008), and in randomized-controlled trials (RCTs) (Primack et al., 2012; Rahmani & Boren, 2012). Because of studies such as these, exergames are one of the stable examples that demonstrate the benefit of video games in healthcare. Even off-the-shelf exergames on the Wii and Xbox Kinect platforms have been utilized for therapeutic as well as preventative purposes (Boulos, 2012; Cameirão, Badia, Oller, & Verschure, 2008; Williams, Doherty, Bender, Mattox, & Tibbs, 2011; Wollersheim et al., 2010; Yli-Piipari, Layne, McCollins, & Knox, 2016).

While exergames found success augmenting exercise and physical therapy, these successes are not always consistent in the literature. The games' effects are commonly measured outside the environments in which they were designed to be played. One of the core reasons for using video games in healthcare is to take advantage of the various mechanisms by which games elicit player motivation (Burguillo, 2010; Erhel & Jamet, 2013), resulting in health consumers being more willing to engage with the game in their free time (Savazzi et al., 2018). However, the controlled laboratory settings in which exergames are usually assessed do not reflect this play environment, and thus do not reflect the true behaviors and motivations of participants when they access the game in on their own. As such, despite quantitative RCTs being considered the 'gold standard' for producing evidence in health research, their inability to capture the full extent of the health effects of these games in the context of everyday use creates significant drawbacks.

Purely quantitative methodologies struggle with taking into account the individual characteristics of participants and the subjective, qualitative context surrounding health-related actions (Jüni, Altman, & Egger, 2001; Nelson, Macnaughton, & Goering, 2015; Porter, McConnell, & Reid, 2017; Rothwell, 2005; Weiss, Koepsell, & Psaty, 2008), both of which can affect the burden of treatment experienced by health consumers. Medical therapies intrude into people's existing daily routine, demanding both material and mental resources from the patient and their environment (Mair & May, 2014; May et al., 2014). The investigation of the physical, cognitive, and opportunity costs for engaging in health therapy is a growing field of research (Corbin & Strauss, 1985; Leppin, Montori, & Gionfriddo, 2015). Exergames—and serious games in general—are interventions poised in-between voluntary entertainment and regimented therapy, and their effects on reducing treatment burden deserve to be explored.

It is important to remember that for all their therapeutic benefits, most exergames are still fundamentally designed first as games, employing mechanisms such as competition and narrative to motivate participation and increase retention. For example, *Wii Sports* (Nintendo EAD, 2006), one of the most commonly used exergames for health today, was created to be a social game. The presence of a community (and the social support derived from it) greatly impacts whether or not an individual who tries an activity or lifestyle will continue with it for any length of time. Other games, such as *Zombies, Run!* (Six to Start, 2012), instead increase immersion by integrating exercise into the game narrative. During this game, a player is placed in the role of a zombie apocalypse survivor tasked with retrieving supplies for a settlement of fellow survivors. As they run, gathering supplies and accomplishing objectives, they unlock more of the story and interact with other survivors, fostering a sense of competence and connection that goes beyond the satisfaction of the activity itself. There would be little point to creating an exergame without utilizing these mechanisms given that interactive media in and of itself has no inherent ability to motivate people. Utilizing the elements of interactive design transforms blind repetitive activities, such as exercises, into engaging experiences.

Despite the positive results of purpose-built exergames, one of the most successful exergames in recent years is *Pokémon GO* (Niantic, 2016a; on its success: Althoff, White, & Horvitz, 2016), with more than 147 million players at its zenith. Though not promoted as such, as a *de facto* exergame physical activity (walking) is required to progress in *Pokémon GO*, yet the lack of emphasis on exercise in any messaging reduced the sense of cognitive burden experienced by players reluctant to exercise. It also should not be discounted how much *Pokémon GO*'s success lay in its ability to create a sense of community among its players, especially by using something other than competition via the quantified health paradigm upon which most conventional exercise apps are built (Clark & Clark, 2016). A reduction of burden (Greene & Monahan, 1989) and a sense of community (Hystad & Carpiano, 2012) are known to positively correlate with health behavior change and are utilized frequently in community-based care in the form of patient support groups.

This paper provides an overview of the current methodologies that have been used to examine the effectiveness of exergames. Just as exercise is known to bring more to holistic health than just physical enhancement, the contribution of exergames to players could well lay beyond simple improvements in physiological parameters. Common strategies employed by games to increase intrinsic motivation will also be discussed as fostering patient motivation for achieving health goals is one of the fundamental reasons for using games in healthcare.

HOLISTIC BENEFITS OF EXERGAMES

Exergames have been compared extensively to sedentary activities and standard exercise, assessed through a variety of parameters such as heart rate (Bonetti, Drury, Danoff, & Miller, 2010), oxygen consumption (Penko & Barkley, 2010), electrocardiograms (Maddison et al., 2007), and self-reported duration of exercise (Warburton et al., 2007). These studies concluded that exergames bring about measurable physiological benefits. Specifically, RCT studies show that exergames have the potential to improve physiological parameters to an extent comparable to light exercise (Rahmani & Boren, 2012). There is ample evidence regarding the impact of exergames on physical health and fitness, as long as participants spend enough time playing such games on a regular basis.

The physiological benefit may vary depending on the type of exergame. In their meta-analysis, Peng, Lin, and Crouse (2011) found that exergames did not produce more physiological changes than standard moderate-intensity physical activity and are potentially not suitable as replacement for vigorous exercise. Exergames that mainly involve movement of the lower body have greater physiological effects than games that involve only upper body movement (Graves, Ridgers, et al., 2008). Also, studies show that child participants have higher energy expenditures than adult participants (Graves, Ridgers, et al., 2008; Graves, Stratton, et al., 2008). These findings suggest that games involving larger, more full-body movement have the highest potential to increase player energy expenditure and elevate exercise intensity, particularly for children.

Exergames have been used to improve higher cognitive function for patients recovering from stroke while also providing equal or better physiological improvements compared to standard rehabilitation (Lee, 2013; Rozental-iluz, Zeilig, Weingarden, & Rand, 2016; Şimşek & Çekok, 2016), making exergames a possible alternative therapy for these patients. Similarly, exergames were used for cognitive treatment in Parkinson's Disease, Alzheimer's Disease, and other health conditions with neurological disabilities (Mura, Carta, Sancassiani, Machado, & Prosperini, 2018). The games were found to yield comparable results to conventional therapy and participants reported a good sense of satisfaction following exergame use (Şimşek & Çekok, 2016),

Exergames can be effective for mood improvement (Li, Theng, & Foo, 2016), similar to other forms of exercise. In fact, mental health is one aspect of healthcare where serious games are known to make a significant impact (Li, Theng, & Foo, 2014; Primack et al., 2012). Exergames were specifically found to have a beneficial effect on the mood of geriatric patients (Chao, Scherer, Montgomery, Wu, & Lucke, 2015; Rosenberg et al., 2010). In their meta-analysis, Li et al. (2016) noted that exergames that were more 'playful' (e.g., *Wii Sports*) had a significantly larger effect size for improving mood compared to exergames that were less 'playful' (e.g., *Wii Fit*, which consists of explicit fitness activities such as yoga).

Exergames may also be of interest to the growing field of 'burden of treatment' and 'patient work,' which, acknowledging that medical treatment is a major disruption to the patient's life, examine the contextual barriers that prevent patients from obtaining maximum benefit during health treatment. 'Burden of treatment' (Mair & May, 2014; May et al., 2014) and 'patient work' (Holden, Valdez, Schuber, Thompson, & Hundt, 2017) refer to the tasks—and costs—patients receiving health services or health-product consumers must undertake themselves as part of their care. As the very foundation of game-based therapy rests upon the idea that games can overcome barriers to behavioral modification by providing fun and incentives, exergames are uniquely positioned to address this emerging recognition of treatment burden. After all, patients are much more likely to adhere to therapy when they are self-motivated and do not feel an immense cognitive burden from the treatment.

SELF AND SOCIALLY-DERIVED MECHANISMS OF MOTIVATION IN EXERGAMES

With games, much like activities such as sports or exercise, *sustained* participation is rooted in how well an activity satisfies three fundamental human needs: competence (sense of efficacy), autonomy (volition and personal agency), and relatedness (social connectedness) (Przybylski, Rigby, & Ryan, 2010; Sheldon & Filak, 2008). In fact, the Cognitive Evaluation Theory (CET), a sub-theory of Self-Determination Theory (Ryan & Deci, 2000), suggests that the extent to which an activity satisfies these psychological needs strongly influences the extent to which they affect player well-being.

Drawing on the CET, the Motivational Model for Video Game Engagement (MMVGE) (Przybylski et al., 2010; Ryan, Rigby, & Przybylski, 2006) posits that two additional factors play a role with games: mastery of controls and the experience of immersion. Mastery of controls is defined here as the learned ability to perform intended actions in a game's environment, a necessary but not sufficient condition for achieving psychologically need-satisfying play. Immersion, on the other hand, is a key moderating construct which reflects an illusion of non-mediation between a player and the gaming context, so that a player feels directly embedded within a virtual environment (Lombard & Ditton, 1997). In the MMVGE, immersion is trifurcated into the dimensions of physical presence (feeling one is actually in the world of the game), emotional presence (feeling that game events have real emotional weight), and narrative presence (the extent to which one has a personal investment and engagement with the story) (Ryan et al., 2006). Varying the level of immersion across these dimensions has been shown to affect memory of the experience (Mania & Chalmers, 2001), enjoyment of an experience (Ryan et al., 2006), and the carryover effects of content into real-world outcomes (Weinstein, Przybylski, & Ryan, 2009).

The studies on which the MMVGE was based also uncover a curious finding: many popular games are designed to satisfy psychological needs, with substantial differences in enjoyment, immersion, and pre-to–postplay shifts in well-being (Ryan et al., 2006). This is an important finding for the field of serious games—especially games for health—because the clients and grant–funding bodies that are the primary funders of these interventions often are most concerned with the intervention components and are unfamiliar with effective game design or the aspects of games that engage or immerse players (Djaouti, Alvarez, Jessel, & Rampnoux, 2011). This situation can lead to games designed for health interventions lacking features that satisfy psychological needs.

Granted, this was not the case twenty years ago, when a number of serious games like *Captain Novolin* (Sculptured Software, 1992), a Super Nintendo game in which players controlled a diabetic superhero and were tasked with managing his blood glucose levels by collecting food powerups to help him fight off aliens, enjoyed a degree of commercial success, being sold in stores alongside entertainment-focused game titles like *Indiana Jones and the Fate of Atlantis* (LucasArts, 1992). These games were no less clinically successful than those being made today, with *Captain Novolin* and similar diabetes games effectively reducing a diabetic child's likelihood of hospitalization from a hyperglycemic crisis by 77 percent (Brown et al., 1997), as well as decreasing social stigma around diabetes and helping children speak with their friends about their condition (Satava, Morgan, Sieburg, Mattheus, & Christensen, 1995). Unfortunately, due to market pressures and downward pricing by retailers in the following decade, the edutainment industry went into a steep decline (Shuler, 2012). Today, most serious games are no longer distributed commercially, with many of their developers preferring to fund their titles in a manner that does not leave them at the mercy of the retail marketplace (e.g., grants, clients) (Djaouti et al., 2011). What few remain in this space tend to either call themselves exergames, or refrain from calling themselves serious games at all.

Two examples of exergames are *Wii Sports* (Nintendo EAD, 2006), which carries the distinction of being the bestselling single-platform game of all time, and *Zombies, Run!* (Six to Start, 2012), an immersive running game which became the highest-grossing Health & Fitness app on the Apple App Store within two weeks of release despite its high price point (Chatfield, 2012). Both of these games appear to have been designed with player need-satisfaction in mind, with several elements implemented that seem to lower the cognitive burden of the activities they promote and lower the cognitive burden of simply playing the game.

In *Wii Sports* (Nintendo EAD, 2006), players interact with the game by using the Wii Remote to mimic the actions of real-life sports. The game requires no hardware beyond what is provided by the Wii system and the motions are intuitive thanks to the Wii Remote's built-in motion sensors. This gives it a substantial advantage over games which require expensive extra hardware, especially those with a steep learning curve (and thus, a higher barrier to mastery of controls) like the Xbox Kinect. Similarly, with *Zombies, Run!* (Six to Start, 2012), the primary interaction a player has with the game is listening to the narrative while running, with the built-in accelerometer of the smartphone tracking the player's movements. No additional hardware is required, nor does a player have to do much when running, save for following instructions to speed up, slow down, or turn to escape the undead hordes.

Considering the settings in which the games tend to be played and how settings shape the resulting play experience is important. While *Wii Sports*

(Nintendo EAD, 2006) does have a robust single-player practice mode, it is far better known for its multiplayer functionality. Indeed, outside of the therapeutic context, the title is most commonly played in local multiplayer mode at parties and other social gatherings. As such, the design of the game draws upon a sense of social connectedness and playfulness to encourage people to participate and allows players to create their own narratives around competition (Li et al., 2016).

Zombies, Run!, by contrast, is a much more solitary experience: an interactive audio-book paired with a survival game, in which players are given the role of a survivor of a helicopter crash, Runner 5, through whose perspective the story of the game unfolds (Schrier, 2011). The design is highly immersive, with the protagonist's narrative synchronizing with the player's actions such as collecting resources while running, and providing meaningful choices regarding what to do with those resources that influence the course of the story. *Zombies, Run*! fosters a sense of personal investment into the events of the story, tapping into what Adrian Hon, the game's producer, calls a fantasy that many people have: that they can be the hero of their own action movie (Schrier, 2011). This is not dissimilar to the core conceit of many conventional role-playing games and the deep individual immersion they create, even if these games are interacted with via a keyboard or controller. However, such an immersive experience often requires a significant investment in time, effort, and mental energy. The burden of deeply-immersive narrative-driven games like *Zombies, Run!* tends to be balanced by the knowledge that these investments are finite—at some point, the story will come to an end.

The luxury of a finite investment is not available to health consumers diagnosed with chronic conditions, such as heart disease or diabetes, that cannot be completely cured no matter the investment they may painstakingly put into self-management. What are the tactics and techniques that may be necessary when the goal of the game—and the treatment—is to create a non-finite play experience? What are the design features that support a continuous behavior modification, keeping players motivated and returning to the game—and treatment—time and time again? Immersion, via narrative or otherwise, only works for finite periods of time. A game can release large amounts of content, but digital content in and of itself does not necessarily generate interest. As popular games like *Wii Sports* (Nintendo EAD, 2006) suggest, fostering a sense of relatedness and creating a space which supports the growth of communities, whether formalized or not, is a strategy that motivates players to return.

Fostering this kind of community-building space usually involves incorporating multi-player elements into a game. In some of the largest multiplayer digital games, this takes the form of gameplay modes where players either find themselves pitted against one another or in group content where players cooperate to overcome a challenge insurmountable by any single one of them. Given hardware and practical limitations, these scenarios are less common in mobile applications. Many mobile games implement some sort of unit loan system—a sort of asynchronous play where one borrows a character from a friend to support them though difficult content. In either case, in-game mechanics are supplemented by online communities that exist outside the game on platforms such as forums and social media. In these virtual spaces, players can share information, show off their achievements (Ryan et al., 2006), and find general support—players can see that they are not alone—and consequently feel they are part of something bigger than themselves, even if the interactions between them and the community may be limited. Occasionally, portions of these virtual communities will be brought together at offline meetings, during conventions, expos, or more informal gatherings (Sessions, 2009). At such meetups, representatives of the developers often solicit feedback, lead attendees through bonding activities, and otherwise work to promote solidarity and connection among community members, which research has shown to increase activity in a given community (Koh, Kim, Butler, & Bock, 2007).

For players, participating in any of these multi-player mechanisms offers a way to address their relatedness needs, which are as much a key to long-term retention as autonomy or competence (Przybylski et al., 2010). The social meetings also reinforce the players' sense of emotional presence, reinforcing the meaning of continued participation in the game and affecting their activity level and length of retention in a given community, as well as their own perceived well-being (Siedlecki, Salthouse, Oishi, & Jeswani, 2014; Williams, 2006). Within the context of a game, relatedness and connection can cushion individual players against frustrations during play, technical challenges, or boredom from repetitive tasks, while giving them opportunities to contribute to the game (such as offering support to other players) and making players feel more positive.

Notably, while multi-player options and player communities are common in successful commercial titles, they are not usually seen in titles explicitly marketed as exergames. Indeed, aside from the local multiplayer mode central to *Wii Sports,* the majority of exergames features only social media integrations that allow players to compare their fitness achievements with others or share how far they ran on a given day. While these methods are a start, they are not sufficient to foster a sense of community founded in something besides physical activity goals, meaning that the only people who seek out the exergame—if it is labelled as such—tend to be those already interested in exercise. Or, in the case of *Wii Sports* (Nintendo EAD, 2006), people who already own a Wii and want something they can play with other people.

The intent of exergames was never to make exercise more rewarding for those already doing it however, it was to reach those not currently getting enough exercise. To truly take advantage of the various mechanisms of motivation and engagement—including relatedness—perhaps there is a need for a title which fulfils the core features of an exergame but does not advertise itself as such. Or perhaps one already exists in the form of *Pokémon GO*, the augmented reality game by Niantic designed "to encourage healthy outdoor exploration and social interaction" (Niantic, 2016b).

THE CURIOUS CASE OF *POKÉMON GO*

A game grounded in the basic principles of augmented reality, *Pokémon GO* offers a relatively simple and largely single-player experience. It tasks players with acquiring virtual creatures called "Pokémon," either by capturing them when they appear on the map, or by hatching them from eggs which happens when they walk between two to ten kilometers with the egg in their possession, with exact distance depending on the type of egg. Eggs can be obtained only from interacting with "Pokéstops" (prominent landmarks), which require players walking to them; the game uses the phone's accelerometer to prevent people from simply driving, locking players out if they were moving too fast.

Within one week of its launch in July 2016, *Pokémon GO* quickly became the most popular game in the United States (Carlon, 2016). Despite server instability and a lack of social features, the title became a social phenomenon, with over 100 million downloads during the first month (Moon, 2016), and nearly 45 million people playing every day (Anthony, 2017). In its first month, a number of articles were written citing the potential of *Pokémon GO* as a health intervention, promoting physical activity, social interaction, and more (e.g., Althoff et al., 2016; Clark & Clark, 2016; Tateno, Skokauskas, Kato, Teo, & Guerrero, 2016). Most of these were commentaries, although Althoff et al. (2016) found that users of the Microsoft Band who played *Pokémon GO* walked approximately 25% more steps on average.

In the months following its release, much of the scientific community lost interest and a number of news outlets began to report that the game started to lose significant portions of its player base (e.g., "Why Pokémon Go may have passed its peak," 2016). Many began to dismiss the game as a fad despite the game's weekly player retention rate of 75%, on par with that of other top-rated games such a *Candy Crush Saga* (King, 2012; Sonders, 2016). The high player retention rate was particularly outstanding for *Pokémon GO* given it lacked the mechanisms other games had developed over the years to raise retention rate, and the developer's lackluster response to many early technical issues (Niantic, 2016b).

In fact, *Pokémon GO* at launch was nearly devoid of design aspects that evoke social elements, either in the form of a friend system or the trading and battle systems of previous Pokémon titles. There was a primitive multi-player system in which players could have their virtual creatures defend or assault landmarks to gain "Poké Coins" (the game's premium currency) as a member of a color-coordinated team. Aside from this basic interaction, there was very little to promote a sense of community. Unlike other games that drew in new users via advertisements, *Pokémon GO*'s virality was primarily driven by word of mouth and by people posting pictures on social media about the odd places they found Pokémon (Hernandez, 2016). The app lacked social media integration upon release, meaning that players could not simply share pictures from within the game but had to open social media applications manually. Even so, *Pokémon GO* pictures flooded Facebook and Twitter, drawing more and more people to the game, including those who may not consider themselves gaming enthusiasts or inclined to physical activity.

There are several dynamic factors that contribute to the need for physical activity and that support community development. First, the likelihood of encountering each species of Pokémon depends on location, time of day, terrain, and other environmental conditions, making it difficult to know what is likely to be found at any given location. Rare Pokémon can be lured to Pokéstops if players place a lure module, making the process of catching the creatures far less tedious. Lure modules are rare to find and expensive to buy, but there are certain locations—usually parks, shopping malls or other large public spaces—where Pokéstops may overlap each other. Due to high volume of traffic, there is a higher chance a player will have placed a lure module at these places. These areas become real-life locations where *Pokémon GO* players congregate—*de facto* community hubs where people come with their phones (and chargers) to talk about Pokémon, catch Pokémon, and to spend time in general. After all, since the virtual creatures do not permanently exist in the landscape and there is no indication of what Pokémon will spawn, players who wanted to "catch 'em all" had to spend time walking, waiting, and inquiring about where certain creatures may be from others.

The very lack of social features within the game necessitated players to communicate via social networks, consult online databases and unofficial online maps, and attend local player gatherings. In a major public relations gaffe, Niantic shut down the unofficial maps, declaring that they violated the terms of service and were not how the game was intended to be played. As time went by with no official replacement for the maps and no word on when something would be implemented to fill the niche, many previously avid users eventually stopped playing.

By the start of 2017, the number of daily active users shrank from 45 million to 5 to 8 million (Anthony, 2017; Windels, 2017), where it stabilized. While this is a steep reduction from the original number of *Pokémon GO* players, it is still comparable to the figures of other major mobile games such as *Clash of Clans* (Supercell, 2012; Sonders, 2016). To put things in perspective, *Clash of Clans* (Supercell, 2012) is not only one of the most popular mobile games in the world, it was also the first to reach $2 billion USD in global revenue (Blacker, 2018). Saying that these games *merely* have 5 to 8 million daily active users is itself misleading. At the same time, the rate of monetization was higher for *Pokémon GO* compared to *Clash of Clans*. *Pokémon GO* set records for the mobile game industry by reaching $500 million in global revenue in 2 months and reaching the milestone of $2 billion USD in approximately the same timeframe as *Clash of Clans*, demonstrating that *Pokémon GO* has become more effective at monetizing from a smaller audience (Blacker, 2018). And, unlike *Clash of Clans* (Supercell, 2012) and its contemporaries, which make players pay to skip long wait timers, buy extra lives, and the like, *Pokémon GO*'s only monetization options are its item shop and its avatar costumes. None of these premium items are necessary for the full play experience—an experience which has only grown richer after the re-implementation of a tracker system, a re-design of the battle system, a friend and gifting system, a buddy system where one "walks" with a chosen Pokémon, and the addition of "raid" content, which can only be completed in cooperation with other players.

Today, there are no more mobs of people wandering the streets playing *Pokémon GO*, and many of the large forums and subreddits lay silent. Yet it would be wrong to say that *Pokémon GO*'s time has passed. In every major city, there are groups of players (each with their own Facebook groups) ready to gather for a raid target, even if they no longer walk for kilometers in search of Pokémon, having already "caught them all." With new exclusive creatures being released, the recent launch of several Nintendo Switch titles that benefit from player actions in the mobile game, and the highest user numbers the game had seen since 2016, perhaps a *Pokémon GO* resurgence is near at hand.

LESSONS LEARNED FROM *POKÉMON GO*

Pokémon GO provides a number of lessons for exergame design. As a game that was never marketed as a health app, it still effectively improved physical activity outcomes and did so to a vast population in a more *consistent manner* than any traditional exergame (Althoff et al, 2016; Meschtscherjakov, Trösterer, Lupp, & Tscheligi, 2017; Wagner-Greene et al, 2017). Notably, social connectedness and perceptions of physical or virtual community—vital for *Pokémon GO*'s dissemination—are also areas that previous health games have not given enough thought. Despite the game's commercial success, it is difficult to measure its impact on a large and holistic scale without proprietary data access, as the only data typically accessible are from those who already use various health apps and related tools to self-track activity. Investigating game data or devoting more efforts into modifying existing methodologies may be the necessary next steps for the field of exergame research to further its credentials and reach. Still, as indicated in Table 1, *Pokémon GO* features a collection of good exergame design features as reviewed earlier in this paper, which combine to form its success.

According to Yang & Liu, the motives for which people play *Pokémon GO* were found to be associated with wellbeing (2017). Those who play *Pokémon GO* for fun benefited the most from the game experience, reporting higher perceived bonding, physical health, and reduced loneliness. Those who play to maintain existing relationships also reported higher satisfaction with life, indicating better mental health. Results in other areas are mixed. While Yang and Liu (2017) report that playing for nostalgia resulted in higher feelings of loneliness, they also report a high correlation between nostalgia and both friendship maintenance and relationship initiation. Another study found that *Pokémon GO* in fact resulted in a higher sense of belonging, with nostalgia fostering a deeper sense of connectedness (Vella et al., 2017). Players playing for escapism, however, reported on lowered life satisfaction (Yang & Liu, 2017)—an indication that despite reaching similar physiological goals, the motivations behind playing exergames matter greatly for players' holistic health outcomes (Clark & Clark, 2016).

Exergame design feature	Implementation in *Pokémon GO*
Lower body exercise instead of upper body exercise	Focusing on using walking to find and hatch Pokémon
Target a younger audience	Pokémon models focus on 'cute' designs
Competence	Simple controls and shallow learning curve
Autonomy	No set exercise goals
Relatedness	Main character is a player insert
Mastery of controls	Simple controls and shallow learning curve
Experience of immersion	Exercise has a purpose and meaning (finding and hatching Pokémon)
Allows for social interactivity	Encourages physical interactions between players due to Pokémon congregating in certain locations
Sense of community	Physical gatherings, existing Pokémon fanbase
Novel and fun features	Augmented reality gameplay

Table 1. Good exergame design features in *Pokémon GO*

It is also important to remember that *Pokémon GO* benefited from a vast and long-running existing multi-media property. Nintendo's *Pokémon* was initially designed to have walking as a meaningful part of the gameplay and gathered a faithful community of players over more than twenty years, a feat that many other exergames cannot claim. The existence of an established player community and incorporation of walking in-universe gameplay helped *Pokémon GO* greatly. Moreover, just like all health interventions, participants need to be aware of negative effects from exergames. Players who play *Pokémon GO* while driving, or walking without paying attention to their surroundings, pose potential dangers to themselves (Wagner-Greene et al., 2017). Approximately 43% of players surveyed by Wagner-Green et al. reported they are likely to play *Pokémon GO* while riding a bike, and 37% reported they are likely to sacrifice sleep to play more of the game (Wagner-Greene et al., 2017). The full extent of effects from exergames thus requires more research, with trials that take these traditionally unexpected adverse effects into account.

TRIAL DESIGN FOR EXERGAME STUDIES

To emulate the natural environment that games are played in, trials for exergames should avoid enforced play at the very least. When exergames are examined in an enforced setting, the group subjected to the intervention is not playing out of their own volition, in a comfortable setting or a timeframe that fits naturally into their daily lives. It is therefore no surprise to see study participants starting to report exergames as boring after a few weeks of enforced play, especially if these participants have unconsciously started to perceive the game as a burden or a chore (Madsen, Yen, Wlasiuk, Newman, & Lustig, 2007). Disliking a game is one of the most significant factors contributing to participant discontinuation of serious games; even if players continue playing, it increases their cognitive burden and voids the positive impact a game may have had (Heeter, Lee, Magerko, & Medler, 2011).

The assumption that games, like drugs, can exert their physiological effect regardless of a participant's inclinations or motivation, is fundamentally flawed. It is therefore heartening to see that exergame researchers have already taken steps to modify and create methodologies to better fit the nature of games. There are more studies that examine the mental benefits of exergames and some studies have also included intervention groups where the participants were merely *provided* with a given game, rather than being forced to play for a set amount of time per day (Garde et al., 2016; Klompstra, Jaarsma, & Strömberg, 2014). In such studies, the only difference between the intervention and the control groups was whether the participants had access to the game software (or in some cases, the hardware the game required), not whether or not they were observed to play, mimicking the realities of community-based behavioral health interventions.

In one study of older adults in Sweden, participants were provided with a Wii console and the *Wii Sports* game, together with an instruction session (Klompstra et al., 2014). Participants also had access to an instructor via telephone if they needed technical assistance during the trial. It is interesting to note that while participants only received a vague suggestion regarding play requirements—that of "playing 20 minutes per day by themselves or with others"—the mean playtime in the trial was 28 minutes per day per person, exceeding that of the recommended daily play time (Klompstra et al., 2014). It is possible, therefore, that trials do not have to rely on enforced participation for participants to gain the benefit of the exergames, unlike in traditional RCTs where strict adherence to the intervention is vital.

Other methods can be used to examine player agency. For example, a study with school children and a mobile-based exergame (Garde et al., 2016) employed a protocol that consisted of within-subject comparison (the participant's exercise baseline data was used for pre and post comparison), a washout period (participants were monitored for a week after losing access from the game), and alternating exposure to the game (the two groups of participants received access to the game during different time periods). In a study such as this, the intervention was not so much 'playing the game', but 'being exposed to the game', retaining the sense of autonomy that is particularly important for the development of intrinsic motivation. The inclusion of a washout period is also important, as it allows observation for any residual effects of game exposure, or if other factors were confounding the amounts of exercise the participant conducted. As the study showed the amount of physical activity performed during the participants' baseline week and washout week were not significantly different, the study showed a relationship between playing the game and participating in more exercise.

The impact of global hits such as *Pokémon GO*, on the other hand, enable participant numbers at a scale not seen before for exergames. In their anonymous trial involving 32,000 Microsoft Band users, Althoff et al. (2016) identified *Pokémon GO* players through the users' search engine history. Microsoft Band users who actively searched for *Pokémon GO* tips online were assumed to be playing the game. The study found there was a significant increase in step counts (~25% increase in step counts compared to prior activity levels, $p < 0.001$) for these participants in the first 30 days after the launch of *Pokémon GO* (Althoff et al., 2016). The authors note that *Pokémon GO* had a beneficial effect for all players irrespective of age, gender, or other factors, and that a higher number of internet searches for *Pokémon GO* tips was correlated with higher increases in step counts (Althoff et al., 2016), indicating that interest (and potential engagement) in the game could be directly related to increased exercise. It is possible that these results are limited to those people who own Microsoft Bands and who may already have a greater interest in health and wellness, yet the study manages to draw data about the intervention—and related activity (e.g. internet searches)—from a number of participants impossible to achieve without the size and proprietary access granted by Microsoft's partnership. These findings were only possible due to the authors' affiliation as Microsoft employees at the time, which also provides a positive example of the exergame research community benefiting from working with similar companies.

In seeking to study the effects of *Pokémon GO*—or other commercialized exergames whose success is tied in part to good mechanics in design—it may prove necessary to pursue collaborations with the companies developing such titles, as the data they possess on player engagement, retention, and activity is by necessity more comprehensive—and analytically accessible—than the proxies used in existing exergame studies. In particular, such collaborations can shed light on the details behind observed social effects and boosts in motivation, and in turn yield valuable insights on optimal design for such games for health.

CONCLUSION AND RECOMMENDATIONS

Exergames, by their interactive nature, are more than simply another prescribed drug. Without patient input and participation, the long-term promise of behavioral modification through exergames cannot be reached in healthcare despite their demonstrable short-term benefits during periods of enforced play. Such controlled consumption of the medium in no way taps into the rich potential of self-motivation that good games are designed to elicit from their players. Exergames are also beneficial to players beyond merely improving their physical fitness in ways that standard interventions struggle with, due to the immersive and participatory nature of the games—e.g., improved cognitive functions, mood-improvement, and an increase in the internal perception of well-being.

To capture the true scope of these benefits, it is therefore necessary for researchers to modify the methods we currently use to assess and validate therapies in the healthcare sphere. Progress has already been made in designing trials that take into account the beneficial effects of voluntary play, while maintaining the rigor of controlled trials. To assess the full scope of advantages that exergames bring to community care, researchers need to have trials that address the 'invisible' benefits of such interventions such as reductions in perceived treatment burden, which is known to affect adherence rates and thus health outcomes. Alternative data sources, such as data from developers, may need to be accessed to analyze such changes on a population scale.

At the same time, exergame design would do well to keep the holistic benefits of gaming in mind. As perhaps the most prolific exergame in history, *Pokémon GO* has many lessons to offer those designing and researching exergames regarding the factors that led to its success and its ability to retain a large, loyal base of players. Research is necessary on the nature of the real-life connections and communities *Pokémon GO* supports, specifically the factors which give rise to them and sustain them, and whether the social factors which made the game a success can impact player wellbeing. Another research direction involves examining other game-based communities and seeing what lessons they may have for exergames and serious games as a whole. *Pokémon GO* also validated past work regarding player motivation, and highlighted the importance of social factors in play. This aspect of the game is something that exergame developers can certainly learn from.

Good games are more than a collection of tasks and goals. Good exergames should motivate the player to continue participating in the therapeutic intervention, as well as reducing the cognitive burden involved. Ultimately, the goal for exergames isn't to have the player constantly engaged with the game, it is to allow players to change their lifestyle by way of playing the game. The study of serious games, rooted in human psychology, has found that factors such as social relatedness, a sense of belonging, autonomy, and feelings of competence are essential qualities of a good game—more so than flashy graphics or the use of sophisticated technologies such as augmented reality. In the end, while games can achieve more than a list of tasks can ever manage, they can only do so if one is designing them with the player in mind, treating the game not as a simple prescription for a patient who needs treatment but as an option for a person with limited time and energy, who has the ability to make choices about their life and wellness.

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