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Playing location-based games is associated with psychological well-being: an empirical study of Pokémon GO players

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ABSTRACT

Location-based games (LBGs) augment urban environments with virtual content turning them into a playground. The importance of understanding how different modes of play impact LBG players' psychological well-being is emphasized by the enormous and constantly rising popularity of the genre. In this work, we use the two-factor theory of psychological well-being to investigate the associations between five constructs related to game mechanics and personality traits, and psychological well-being and fatigue. We test our proposed structural model with Finnish Pokémon GO players ($N = 855$). The results show deficient self-regulation and fear of missing out to be positively associated with gaming fatigue. Engagement with cooperative and individual game mechanics had a positive relationship with well-being. Competitive game mechanics were found to have a positive relationship with both well-being and fatigue. Finally, the overall playing intensity had a strong relationship with well-being, but no association with fatigue.

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Location-based games; pervasive games; Pokémon GO; well-being; fatigue; fear of missing out

1. Introduction

Satellite navigation and the ubiquitous access to smartphones have given birth to location-based games (LBGs) which make use of the players' real-world location as a way to interact with the gameworld (Papangelis et al. 2020). As such, LBGs turn the real world into a playing field. The games have recently become massively popular, being downloaded cumulatively to over a billion devices and the most popular game Pokémon GO alone generating over four billion USD in lifetime revenue (Chapple 2020).

The behavioural consequences of LBGs as well as their implications on urban life are manifold. LBGs have been studied in the fields of philosophy (Liberati 2019), human–computer interaction (Papangelis et al. 2020), health (Althoff et al. 2016), psychology (Kaczmarek, Behnke, and Dżon 2019), education (Rauti, Laato, and Pietarinen 2020) and cartography (Colley et al. 2017) among others. While the extant literature on video games in general has taken into account broadly both positive and negative consequences of playing (McLean and Griffiths 2013), the negative side of LBGs deserves further attention (Kaczmarek, Behnke, and Dżon 2019). Previous work on the negative effects of LBGs has focused predominantly on analysis of the games as distractions to drivers and pedestrians (Ayers et al. 2016), players' trespassing behaviour (Papangelis et al. 2017), addiction and back pain (Kaczmarek, Behnke, and Dżon 2019) and the adoption of unwanted real world behaviour (Alomar, Alsaleh, and Alarifi 2019). The effects of playing LBGs on psychological well-being have been explored to some extent (e.g. Bonus et al. 2018; Yang and Liu 2017), but understanding how specific game mechanics and personality traits relate to psychological well-being and fatigue of players still needs to be addressed. Understanding the relationships between well-being and fatigue and LBG playing habits and player personality traits helps decision makers and game designers to make more accurate evidence-based decisions with regards to, for example, health game interventions.

The current study aims to fill this research gap by focusing on the relationship between playing LBGs and psychological well-being. The two-factor theory (TFT) and related studies (Herzberg, Mausner, and Synderman 1959; Stallings et al. 1997) suggest that well-being should be studied independently of negative affect, as the two are driven by different sets of factors, and both positive and negative affect can co-exist simultaneously (Diener et al. 1999; Yang and Liu 2017). In this study we use the TFT to study the associations of playing LBGs on psychological well-being (positive) and fatigue (negative).

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With this research approach we expand the understanding of LBG players' psychological well-being and illuminate the societal change that results from gaming moving outdoors. As empirical work we build a theoretical model by employing (1) psychological well-being; and (2) fatigue as our dependent variables and observing the relationships of game mechanics, playing intensity, fear of missing out (FoMo) and deficient self-regulation (DS-R) with the dependent variables. To test the model we collected cross-sectional data from Finnish Pokémon GO players ($N = 855$). Pokémon GO was chosen for the following reasons: (1) it is currently the most popular LBG; (2) a vast body of academic literature has focused on Pokémon GO making our findings comparable to the prior studies; and (3) previous studies have suggested that findings from Pokémon GO may be generalised to cover other LBGs (Hamari et al. 2019; Laato et al. 2020c). The findings of our structural model highlight the importance of avoiding game-related FoMo and DS-R to facilitate psychological well-being and showcase that the overall playing intensity has a significant positive relationship with psychological well-being but no relationship with fatigue.

2. Background

2.1. Games and psychological well-being

As video games are a broad category and each game is unique, it is no surprise that a multitude of both positive and negative consequences of playing them have been identified (Jones et al. 2014; McLean and Griffiths 2013). Among the positive outcomes is psychological well-being. Johnson et al. (2013) surveyed 200 studies connected to video games and well-being, and concluded that video games can facilitate emotional, social and psychological well-being of young players, including positive emotional state, self-esteem, optimism, vitality, resilience, engagement, relationships, sense of competence, self-acceptance, and social connections and functioning. A more recent literature review (Halbrook, O'Donnell, and Msetfi 2019) investigated the positive effects of video games on well-being including both psychological and physical perspectives. The findings showed engagement with social components of games to have clear positive effects on psychological well-being. The study further suggests that playing cooperative games may result in higher levels of enjoyment whilst lowering the levels of aggression among players, but this only happens when the amount of playing is moderate and is primarily motivated by social interaction. Halbrook, O'Donnell, and Msetfi (2019) further concludes that games with prosocial features correlate with players' ability to cooperate, and scaffold the ability to maintain positive relationships also outside games. The strong relationship between prosocial gameplay and prosocial behaviour was also identified by McLean and Griffiths (2013) in their systematic literature review on positive and negative effects of video games. They further found several other positive psychological effects of video games, including affective, arousal and cognitive effects; increase in perceptual, visual attention and spatial skills; and development of visuospatial cognition. McLean and Griffiths (2013) and Eichenberg and Schott (2017) both presented evidence of video games having been successfully used as tools for psychotherapy, thereby facilitating the psychological well-being of patients. Finally, Joronen, Aikasalo, and Suvitie (2017) investigated the nonphysical effects of exercise games (exergames) on child and adolescent well-being by surveying 10 intervention studies. The results suggested that some of the studies found positive effects, among others, on psychological well-being, self-efficacy enjoyment and motivation, but the effects of individual game mechanics were not observed.

In order for a game-based psychological well-being intervention to reach the desired positive effect, its game mechanics must be carefully planned and aligned with the goals of the intervention. This process implies the understanding of a variety of game motivators and design principles that contribute to intrinsically motivated engagement (Laine and Lindberg 2020), which in turn can translate to increased adherence to the intervention. Yet research has shown that many interventions fail to do this, thus raising a question on how regularly are game designers involved in intervention development processes. For example, Brown et al. (2016) analysed the results of 61 randomised controlled trials where gamification was applied to web-based mental health interventions, with the main focus on whether gamification helped increase adherence to the intervention. The authors found no statistically significant evidence that gamification elements – the most popular being story, progress, goal setting, and rewards – would increase adherence. Moreover, most of the interventions used only one or two gamification elements, thus suggesting that these interventions may not have been designed as games, but these elements were added on top of an existing health intervention. Complementing this result, Cheng et al. (2019) reviewed 70 studies that applied gamification on mental health and well-being interventions, discovering that researchers often treat gamification as a black box without considering the underlying mechanics.

The negative effects of video games have been discussed in particular related to games with violent content. This has been a vibrant topic among game researchers for decades. There has even been reported publication bias and flawed methodologies in several previous studies on the effects of violent video games (McLean and Griffiths 2013). A recent study by Kuhn et al. (2019) investigating the effects of violent video games on aggression found no evidence to support video games causing violence after a two-month control group study. Beyond the debate whether video games induce violence, previous studies have linked playing games to (1) having negative influence on academic performance when the amount of playing time is substantial (McLean and Griffiths 2013; Liu and Peng 2009); (2) fatigue (Liu and Peng 2009); and (3) problems in personal life (Liu and Peng 2009). The negative effects have been shown to be correlated to psychological dependency on the game (i.e. addiction) (Liu and Peng 2009) as well as DS-R (Lee and LaRose 2007).

In addition to the extant literature identifying both positive and negative influence of playing on well-being, there is also some evidence of games having dual outcomes. A recent study on online video games showed playing to decrease well-being (Goh, Jones, and Copello 2019) while an earlier work demonstrated playing games to increase well-being (Johnson et al. 2013). Lobel et al. (2017) found no connection between playing cooperative games and prosocial behaviour while Halbrook, O'Donnell, and Msetfi (2019) showed the exact opposite. While the argument can be made that the genre and type of the game heavily influences these outcomes, Von Der Heiden et al. (2019) found no significant correlation between players of different game genres and psychological functioning. Whether games lead to positive or negative outcomes also relates to the players themselves. Vallerand et al. (2003) demonstrate that individuals may develop either a harmonious or obsessive passion with regards to an activity, where harmonious passion is self-regulated and produces psychological well-being and obsessive passion is linked to addiction and negative affect. In summary, video games in general can have a wide range of positive and negative effects, with some evidence also pointing that they may have a dual effect simultaneously increasing well-being (Johnson et al. 2013) and fatigue (Liu and Peng 2009).

2.2. Location-based games and the positive and negative outcomes of playing them

Previous studies on psychological well-being have shown surprising life events to be better predictors of psychological well-being than expected events (Stallings et al. 1997). By taking playing outside, LBGs turn the chaotic unpredictability of urban life into a playing field, adding an ever-changing element to the game: real life. At no point players are completely able to predict what will happen next, as players might run into people they know or encounter a particularly beautiful sunset. In addition, several LBGs are creating in-game random events for players. For example, in Pokémon GO players might be surprised with a shiny pokémon (a very rare form of a pokémon) or hatch a pokémon that they did not have before or the hatching of a rare pokémon from an egg (Yu and Fu 2019). As an example, Koskinen et al. (2019) and Bonus et al. (2018) demonstrate that Pokémon GO can facilitate positive and memorable experiences. A recent work by Alavesa and Xu (2020) also showed that several players are eager to share their experiences online in the form of images and screenshots taken while playing.

Previous studies on LBGs have divided game mechanics into three categories: (1) individualistic; (2) cooperative; and (3) competitive (Morschheuser et al. 2017; Riar et al. 2020). Here cooperative game mechanics have been shown to lead to altruism and increased we-intentions (Riar et al. 2020), and engagement with cooperative game mechanics has been shown to be a better predictor of positive emotions than individualistic game mechanics (Morschheuser et al. 2017). Papangelis et al. (2017) note that in LBGs the real world environment impacts players' perceptions of the game, and that the playing location is therefore an important component in the outcomes of playing LBGs. This also connects to territorial expression in the LBG world, which has further been linked to social structures among players (Papangelis et al. 2020).

The behavioural consequences of LBGs have been studied by, for example, Alomar, Alsaleh, and Alarifi 2019; Colley et al. 2017; and Oleksy and Wnuk 2017. However, studies looking at the relationships between playing LBGs and psychological well-being are scarce. Among the few studies are that of Watanabe et al. (2017) who showed playing Pokémon GO to be correlated with mild improvement on psychological distress. Another related study showed relationship initiation in LBGs to have effects on both positive and negative aspects of well-being (Yang and Liu 2017). The most recent study (Williams and Slak-Valek 2019) found a correlation between playing LBGs and increased sense of happiness.

The positive and negative effects of playing LBGs identified by previous studies are summarised in Table 1. Note that some potential negative impacts such as trespassing and reckless driving (Ayers et al.

Table 1. The positive and negative outcomes of playing LBGs derived from previous studies.

Positive impacts of LBGs	Negative impacts of LBGs
(1) Exercise (Althoff et al. 2016; Laato et al. 2020c; Laato, Inaba, and Paloheimo 2020b)	(1) Physical problems, pains, problems with vision (Kaczmarek, Behnke, and Dżon 2019)
(2) Social Connectedness (Bhattacharya et al. 2019; Vella et al. 2019)	(2) Smartphone addiction (Kaczmarek, Behnke, and Dżon 2019; Sobel et al. 2017)
(3) Positive life experiences (Bonus et al. 2018; Koskinen et al. 2019; Oleksy and Wnuk 2017)	(3) Problems with self-regulation, internet addiction (Yu and Fu 2019)
(4) Improvement on psychological distress or well-being (Watanabe et al. 2017: Williams and Slak-Valek 2019; Yang and Liu 2017)	(4) Reckless behaviour in traffic (Ayers et al. 2016; Faccio and McConnell 2020; Wagner-Greene et al. 2017)
(5) Navigation and cartographic skills (Carbonell Carrera, Saorín, and Hess Medler 2018; Colley et al. 2017)	

2016; Wagner-Greene et al. 2017) were excluded from this list. Even though these might be issues for a small proportion of players, a recent study found the claims that LBGs cause adoption of such behaviour to be unjustified (Alomar, Alsaleh, and Alarifi 2019).

Comparing this summary to our review of the effects of video games in general, it is evident that several major research gaps exist. First, the possible negative aspects of LBGs are only touched by a few studies (e.g. Kaczmarek, Behnke, and Dżon 2019; Yang and Liu 2017). Second, the studies seem to focus on aspects that are specific to LBGs, while likely some of the findings on video games in general (e.g. Johnson et al. 2013) also apply to LBGs. To address these gaps, we explore the associations between fatigue (negative) and psychological well-being (positive) and playing Pokémon GO. In doing so we not only include the impact of engagement with game mechanics, but also the impact of DS-R and FoMo which are related to the marketing strategies (e.g. Niantic 2020) that LBG developers may use to motivate players to make in-app purchases, nudge players to advertise the game on social media (Alavesa and Xu 2020) and engage players to play more (Laato, Laine, and Islam 2020).

2.3. Theoretical foundation

2.3.1. The two factor theory and Kano's satisfaction model

The two-factor theory (TFT) was originally developed to understand job satisfaction, but has since been also used in other research areas. At its core, the theory divides job satisfaction to be the outcome of two types of factors: (1) Motivators; and (2) Hygiene factors (Herzberg, Mausner, and Synderman 1959). In the context of a workplace, motivators are factors related to the work itself such as how challenging and rewarding the work is and does it facilitate a sense of importance. Motivators are predictors of job satisfaction, but according to TFT, their absence does not cause dissatisfaction. In fact, dissatisfaction is predicted only by hygiene factors, which are conceptualised to be things such as salary, relationships with co-workers and working conditions. The hygiene factors do not increase job satisfaction, but their absence will increase job dissatisfaction. In summary, TFT postulates that satisfaction and dissatisfaction should be separated instead of seeing them as the polar ends of the same phenomenon. Furthermore, TFT states that factors influencing satisfaction are called motivators, which are distinct from the hygiene factors that predict dissatisfaction. (Herzberg, Mausner, and Synderman 1959)

Previous studies have found this theory to be problematic because while satisfaction and dissatisfaction can be regarded to be separate phenomena, it does not mean one factor could not have an impact on both (Islam 2014). An alternative view on satisfaction and dissatisfaction is the Kano's satisfaction model (Kano 1984) which conceptualises satisfaction and dissatisfaction to be the result of (1) basic factors; (2) excitement factors; and (3) performance factors. The theory shares similarities with TFT by postulating that basic factors do not cause satisfaction, but their absence can increase dissatisfaction. Excitement factors are the opposite, also aligning with TFT by saying their presence can cause satisfaction but their absence does not cause dissatisfaction. Kano's satisfaction model departs from TFT in the third group of factors, the performance factors, by stating these are factors that can impact both, satisfaction and dissatisfaction (Islam 2014; Kano 1984).

Adopting TFT to the context of human psychological well-being, Bradburn (1969) proposed that in fact well-being should not be viewed as a spectrum either with sadness and depression on the other end. Instead, the two should be considered independently of one another (Bradburn 1969). Since then, this conception has been empirically verified by several studies (Stallings et al. 1997; Watson and Tellegen 1985; Diener et al. 1999). When probing into what factors increase well-being or positive affect, studies have found (1) sociability, (2) extraversion; and (3) the frequency of pleasant events to be one of the strongest predictors (Stallings et al. 1997). On the other hand, sadness or negative affect seems to be predicted by a different set of factors, in

particular, neuroticism, health complaints, frequency of unpleasant events and stress levels (Stallings et al. 1997).

An important implication of Kano's model compared to TFT is that the same factor can have a positive impact on both satisfaction and dissatisfaction (Kano 1984) or well-being and sadness (Stallings et al. 1997). This apparent causal asymmetry is the result of conceptualising the existence of performance factors (Kano 1984). The dual outcomes of the same activity has been demonstrated recently, for example, in relation to self-promotion, which was found to lead to both addiction (negative) and vitality (positive) (Islam, Mäntymäki, and Benbasat 2019). Currently it remains unexplored whether similar duality can be seen in LBGs. However, recent findings regarding the multiplayer elements of LBGs suggest that cooperative mechanics may lead to increased we-intentions (Morschheuser et al. 2017) but also give birth to negative attitudes towards opposing players (Laato, Inaba, and Paloheimo 2020b).

Thus, we propose that when studying the relationship of playing LBGs and psychological well-being, the negative effects should be represented in the theorised model as another dependent variable. For the negative dependent variable we chose gaming fatigue, which has been shown to be linked with psychological and health problems especially with regards to gaming addiction (Männikkö, Billieux, and Kääriäinen 2015). To summarise, using TFT conceptualisation of well-being (Diener et al. 1999), we employ two dependent variables: (1) psychological well-being; and (2) gaming fatigue.

2.3.2. The self-determination theory

In addition to game mechanics, a major part of LBGs' influence on players is connected to the marketing strategies by which the games advertise themselves to the players, trying to engage them to play and get them to make in-app purchases (Laato et al. 2020c). From the wide variety of psychological tricks that LBGs can utilise, two seem particularly relevant: (1) fear of missing out (FoMo); and (2) deficient self-regulation (DS-R). In order to understand DS-R and FoMo we refer to the self-determination theory (SDT) which especially concerns humans' intrinsic motivation (Deci and Ryan 1985). The theory decomposes intrinsic motivation into three components: (1) competence; (2) autonomy; and (3) relatedness. Competence describes the human willingness to be useful and have the ability to impact their surroundings in a meaningful way; autonomy describes the human need to seek to control their immediate surroundings and be an autonomous actor, not having to rely on external actors for survival; and relatedness describes the need to interact with other humans, building social connections and self-evaluating through comparison to others. (Deci and Ryan 1985)

Self-regulation is an integral part of human thought processes and refers to the individual's ability to regulate their behaviour (Deci et al. 1994). SDT posits that self-regulation is the result of being able to act autonomously, that is, acting based on one's interests and values (Reeve et al. 2008). If the autonomous acting is disrupted, this can lead to DS-R. Other reasons for DS-R or self-regulation failures have been found to be cognitive dissonances, false assumptions and impulsive action (Baumeister and Heatherton 1996). In the context of video games, DS-R is linked to video game addiction (Lee and LaRose 2007), and in addition to autonomy, also competence and relatedness have been shown to negatively associate with video game addiction (Wu, Lei, and Ku 2013). Related to DS-R is dysfunctional impulsivity, which refers to making quick decisions based on affect and intuition in cases where such decisions are non-optimal (Puerta-Cortés et al. 2017). This has been shown to be a predictor of playing massive multiplayer open online games (Puerta-Cortés et al. 2017), and, for example, the most popular LBG Pokémon GO can be seen to be such a game. The mechanism via which games increase DS-R is typically attributed to game mechanics offering instant gratification (Svelch 2017).

FoMo describes the feeling of being left out on something and is typically discussed especially with regards to social relationships (Przybylski et al. 2013). Building off SDT, FoMo has been suggested to occur when the relatedness need is not fulfilled, and is characterised by constantly seeking to know what people and groups socially connected to the individual are doing (Al-Menayes 2016; Przybylski et al. 2013). FoMo has been shown to increase social media use and engage people (Beyens, Frison, and Eggermont 2016), and LBG companies trying to engage players are therefore trying to invoke the feeling in people. As an example, Pokémon GO constantly features events that are only available for a limited time, and in the developer's communication of these events, they encourage players to play now and share photos of them catching rare pokémon and having fun on social media (Niantic 2020).

3. Research model and hypotheses

In this section we theorise the relationships of DS-R, FoMo and engagement with game mechanics with two dependent variables: (1) psychological well-being; and (2) gaming fatigue. Building off SDT, we adopted the concept of subjective vitality to represent psychological well-being and define it as the feeling of being alive, alert

and full of energy (Bostic, Rubio, and Hood 2000; Islam, Mäntymäki, and Benbasat 2019). There are two types of subjective vitality measurements. One measures the ongoing characteristics of individuals while the other is temporal and measures the state of well-being at a particular moment (Ryan and Frederick 1997). We adopted the latter, as it allows us to measure well-being while playing LBGs and link it to the game mechanics and personal attributes. Lewis and Wessely (1992) define fatigue as an exhaustion of mental and physical strength resulting from bodily labour or mental exertion. As we focus on gaming in our study, we focus only on the mental exhaustion aspect (Lewis and Wessely 1992). Therefore, we define fatigue as the exhaustion of mental strength resulting from playing. Next, we hypothesise key relationships to these dependent variables based on the selected theories.

3.1. Deficient self-regulation

As DS-R is associated with the loss of control (Tokunaga 2015), it has been connected to increased playing intensity and even video game addiction in previous studies (Lee and LaRose 2007). Players with DS-R are particularly susceptible to incentives that games provide to spend real money and make microtransactions (Soroush, Hancock, and Bonns 2014). For this reason, video game developers are interested in coming up with ways to boost DS-R to increase in-game sales. Controversially, this also applies to games that are advertised as health games, such as several LBGs. A hedonistic lifestyle filled with continuous seeking of instant gratification, which certain gameplay promotes, gives heightened temporary enjoyment, and therefore can develop addiction, which reduces self-regulation (Eisingerich et al. 2019; Svelch 2017; Turel and Serenko 2012).

The problematic nature of DS-R materialises in that players lose control of their playing which can backfire by taking time away from other more meaningful or necessary activities. The dismissal of important activities in favor of playing can cause cognitive load (Sweller 2011) which will cause additional strain on players. Via this mechanism, DS-R can increase players' negative affect and consequently gaming fatigue. Seeing that DS-R has been connected to increased playing, more impulsive behaviour (Lee and LaRose 2007; Tokunaga 2015) and lack of fulfillment on the needs depicted by SDT (Wu, Lei, and Ku 2013), it seems feasible that it could also negatively associate with well-being. Low self-regulation abilities can relate to long term negative affect, such as fatigue (Reeve et al. 2008). For these reasons, we propose the following two hypotheses.

H1: Deficient self-regulation is positively associated with gaming fatigue.

H2: Deficient self-regulation is negatively associated with well-being.

3.2. Fear of missing out

LBGs can invoke FoMo in two ways. First, the games are often highly social including both cooperative and competitive game mechanics. Players are offered rewards from interacting with one another and are provided challenges which require the help of others to conquer. Social gatherings not only happen in the online world, as LBGs can bring players together in the real world (Bhattacharya et al. 2019). Subsequently, LBGs can incentivise players to play via FoMo, by communicating to players that unless they play they could miss out on some of the social events and related social gratification. The second way LBGs draw out FoMo is by constantly introducing events and limited time opportunities for obtaining unique rewards. Players share these rewards and their in-game achievements to others on social media and chat channels which can further escalate the sense of FoMo on players seeing these posts. As gaming companies can be relentless in the frequency of events and calls to play now, this can cause a strain on players who are experiencing FoMo. Furthermore, previous studies on social media users have found FoMo to be linked with fatigue (Bright and Logan 2018; Dhir et al. 2018). Accordingly, we hypothesise the following:

H3: FoMo is positively associated with gaming fatigue.

FoMo has been found to also strongly correlate with smartphone addiction (Elhai et al. 2016; Wolniewicz et al. 2018). Addiction on the other hand, decreases well-being (Cardak 2013). In addition, it is associated with lower mood and life satisfaction (Przybylski et al. 2013). While studies have shown that a different set of factors influence well-being and negative affect (Stallings et al. 1997), Kano's model of satisfaction suggests the existence of factors that can have an impact on both (Kano 1984). FoMo may be such a factor because it has been conceptualised to be the consequence of deeper deficiency at the level of core intrinsic motivation (Wu, Lei, and Ku 2013). According to SDT, FoMo occurs when the relatedness need is unfulfilled (Al-Menayes 2016), suggesting a negative relationship between FoMo and well-being. For these reasons, we hypothesise the following.

H4: FoMo is negatively associated with psychological well-being.

3.3. Engaging with LBG game mechanics

While LBGs at their core consists of gameplay that is tied to the player's real world location, the games can in theory be as complex as any game. In fact, recently released LBGs such as Minecraft Earth and Orna are differentiating themselves from other games from the genre by adding all kinds of unique new features. While the games motivate players to go out and walk, the increasing complexity of the games can actually do more harm than good. Complex games and multiple game mechanics force players to look more of the smartphone screen and less at the environment they are walking in. Referring to the cognitive load theory (Sweller 2011), the more game mechanics players need to engage with, the more likely they are to get overloaded. Following previous studies on LBG game mechanics (Riar et al. 2020), we decompose the game mechanics into three groups: (1) individual; (2) cooperative; and (3) competitive; game mechanics. Next, we hypothesise their relationships to well-being and fatigue.

3.3.1. Individual mechanics

While characterised as outdoor social games (Laato et al. 2020c), a major proportion of the standard gameplay in almost all LBGs is individualistic. Still, the individualistic mechanics can offer incentives to exercise (Althoff et al. 2016; Laato et al. 2020a), visit new places (Oleksy and Wnuk 2017), facilitate memorable life experiences (Bonus et al. 2018; Koskinen et al. 2019) and give gratifications from progression (Alha et al. 2019). On the other hand, individual playing can have negative effects as well (Yang and Liu 2017), because too intense playing may lead to neglecting more meaningful and important activities (Beach et al. 2019). Neglect of real life activities can increase cognitive load (Sweller 2011) which can in turn lead to fatigue. In addition to cognitive overload, eventually the game mechanics might become stale and uninspiring, leading to a lack of enthusiasm and consequently, fatigue. Accordingly, we propose the following two hypotheses.

H5: Engagement with individualistic game mechanics has a positive association with gaming fatigue.

H6: Engagement with individualistic game mechanics has a positive association with psychological well-being.

3.3.2. Cooperative mechanics

Introverted people experience greater cognitive load from social encounters. Too many social encounters, especially with unfamiliar people, can lead to cognitive overload, which in turn births anxiety and wishes to retrieve away from the social situation (Kirschner et al. 2018). A recent study characterised engaged LBG players as introverted (Caci et al. 2019), meaning the players are at greater risk to get overloaded by social encounters and get fatigued. Yang and Liu (2017) found relationship initiation to have dual outcomes, both increasing and decreasing psychological well-being. These findings would suggest that LBG players engaging in social encounters could indeed experience fatigue. Accordingly we hypothesise the following.

H7: Engagement with cooperative game mechanics has a positive association with gaming fatigue.

On the other side of the study by Yang and Liu (2017) was that relationship initiation increases well-being. Psychological well-being has been further decomposed into joviality, self-assurance and serenity, of which especially self-assurance has been shown to be linked with positive social outcomes in face-to-face computer-assisted environments (Pietarinen et al. 2019). Moreover, social activities in video games, particularly those of cooperative nature, have been found to positively affect psychological well-being and player enjoyment (Halbrook, O'Donnell, and Msetfi 2019). LBGs can facilitate face-to-face group interaction with several game mechanics, of which an example is raids in Pokémon GO, whereby a group of players come physically to the same place to join their forces to beat a powerful boss (Bhattacharya et al. 2019). The collaboration in raids can be characterised as a group work where participants work together towards a common goal. Building off the work of Pietarinen et al. (2019), Halbrook, O'Donnell, and Msetfi (2019), and previous studies on the outcomes of cooperation in LBGs (Morschheuser et al. 2017; Riar et al. 2020; Yang and Liu 2017), we theorise that the face-to-face cooperation that LBGs facilitate can have a positive relationship with psychological well-being. Accordingly we formulate the following hypothesis.

H8: Engagement with cooperative game mechanics has a positive association with psychological well-being.

3.3.3. Competitive mechanics

Competition and exploration of self through playing has an important role in the psychological development of humans (Pellegrini and Smith 2005). Climbing trees and playful fighting can be seen as re-enactment of our evolutionary past, something programmed into our being to prepare us for skills that would have been useful in the hunter-gatherer way of living (Pellegrini and Smith 2005). In a similar way, humans are seen to have a tendency to engage in competitive playing

and sports. Competition has been shown to play a crucial role in the enjoyment of video games, with it bringing perceived meaning to the activity via human opponents, and also providing gratifications when overcoming human opponents (Vorderer, Hartmann, and Klimmt 2003). While competition can certainly have positive impacts on well-being through gratifying primal needs and even increasing serotonin and dopamine levels in the case of winning (Boureau and Dayan 2011), it can also lead to several negative things such as taking away time to such an extent, that it hurts with other life activities. Furthermore, competition can increase stress levels, technology overload and consequently lead to fatigue (Karr-Wisniewski and Lu 2010). Accordingly, engaging with competitive mechanics may positively be associated with both well-being and fatigue. Thus, we propose the two hypotheses.

H9: Engagement with competitive game mechanics has a positive relationship with gaming fatigue.

H10: Engagement with competitive game mechanics has a positive relationship with psychological well-being.

3.4. Playing intensity

Playing intensity is understood to be the combination of the daily number of hours spent playing and the habit of playing (Puerta-Cortés et al. 2017; Whelan, Islam, and Brooks 2020). As such, high playing intensity can cause fatigue (Liu and Peng 2009; Whelan, Islam, and Brooks 2020), but it can also predict psychological well-being due to the various positive outcomes of playing (e.g. Bonus et al. 2018; Koskinen et al. 2019; Riar et al. 2020; Vella et al. 2019; Yang and Liu 2017). There could furthermore be diminishing returns in the effects of playing intensity; in other words, once playing intensity is above a certain threshold, which might vary from player to another, more time spent playing no longer increases psychological well-being. Furthermore, if the playing starts to hurt other more important life activities, then that should be seen in DS-R, which was in turn predicted to have a strong negative influence on well-being. Accordingly, we use playing intensity as a control variable, proposing that it is associated with both fatigue and psychological well-being.

Our final research model connecting the proposed hypotheses is shown in Figure 1. On the right side of the model we have the three types of game mechanics: (1) cooperative; (2) competitive; and (3) individual, which were hypothesised to have significant relationships with both gaming fatigue and well-being. On the right side we have DS-R and FoMo which were predicted to have a negative association with well-being and a positive association with gaming fatigue.

4. Methodology

4.1. Survey design

We searched the prior literature for validated scales for the eight constructs in our structural model: (1) DS-R; (2) FoMo; (3) psychological well-being; (4) Fatigue; (5) Playing intensity; and (6) Engagement with individual, (7) cooperative, and (8) competitive game mechanics. We found validated scales for the first five from prior literature, and adopted them to the context of the case LBG, Pokémon GO. For looking at the engagement with game mechanics, we adopted the approach used by Morschheuser et al. (2017) and Riar et al. (2020) where the game mechanics are measured as formative constructs. To this end, we played and studied the case game Pokémon GO to identify relevant game mechanics, and based on this analysis, we created a multiple choice question where players were asked to select all game mechanics which were important to them. These items were classified into (1) cooperative; (2) competitive; and (3) individualistic; game mechanics. Some of the survey items taken from prior literature had to be adopted and changed to fit the current study context of LBGs, but the changes were kept as minor as possible and reviewed by two authors before being included in the final survey. The full list of used constructs, related survey items and the sources for the scales can be found in Appendix.

As the survey was going to be deployed for Finnish speaking players, we translated and validated the survey in the Finnish context. To this end, an author who was also a native Finn first translated the items into Finnish. Another native Finn then translated the items back to English. The original English items and the re-translated items were then compared. At this point some issues were identified, mainly grammatical, however a few inaccurate translations were also detected. The two translators discussed the items, the translations and their meaning, making sure that for those items where the translation was different, a common understanding was found on what was the best wording.

To ensure the understandability of the survey, it was sent to 12 Pokémon GO players in a closed WhatsApp chat for proofreading and review. The participants gave a few suggestions on the grammar, which were then fixed by the authors. In addition to the survey items (available in Appendix), a title page was included in the survey where the goal of the study and handling of

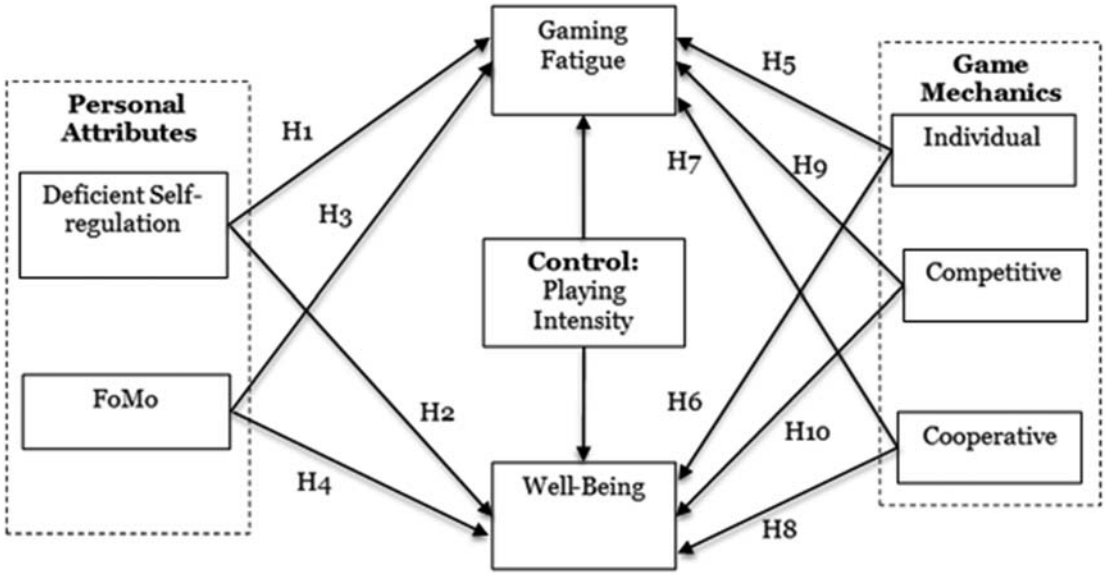

Figure 1. Proposed structural model to explore the two-factor relationships of well-being and fatigue in playing LBGs.

the data were explained. The authors also included their contact information to this page as well as a notification that by proceeding to fill the voluntary survey, the respondents would give their permission to use the data anonymously for research.

4.2. Data collection

The survey was implemented using the Webropol survey tool and all questions were marked mandatory to avoid the situation where some answers would be incomplete. The Webropol tool takes technical measures preventing the same IP-addresses from answering the survey twice. The survey was distributed on April 8th, 2020 to Finnish Pokémon GO players via two Facebook groups and eight local chat groups. One of the Facebook groups was nation-wide. The survey was available for one week, and was closed on April 14th. The final number of responses was 855 and there were no cases of missing data. The participants' demographic data can be seen in Table 2. We look at gender, age and the participants' level in Pokémon GO. For reference, reaching level 30 takes approximately 40 hours of playing and reaching level 40 ten times that, which equals to 400 hours of playing.

Table 2. Demographic information of the participants.

Gender		Age		Level in Pokémon GO	
Female	70.7%	Under 25	21.6%	1–20	0.1%
Male	27.3%	26–40	52.0%	21–30	4.0%
Other/undisclosed	2%	41–60	25.7%	31–35	14.1%
		Over 60	0.7%	36–39	25.6%
				40	56.2%

However, this is highly dependent on the playstyle and even playing location and therefore this is just an estimation. Still, the majority of respondents seemed to be highly active high performing players with over half of them having reached level 40. Please note that in late 2020 new levels were added to the game, increasing the level gap to 50. However, at the time of the empirical study, the max level was 40. Also a surprisingly large proportion of respondents were women, which is unusual for a video game survey but not unusual for Pokémon GO (see e.g. Alha et al. 2019; Laato et al. 2020c).

4.3. Validity and reliability

We verified the validity and reliability of the collected data. In particular, we looked at convergent and discriminant validity. To this end, we used the SmartPLS software version 3.3.2. All constructs were modeled as reflective constructs, except the game mechanics constructs, which were modeled as formative constructs.

For the reflective constructs, we tested the convergent validity, which concerns that all items in a scale need to measure the same construct. Originally proposed by Fornell and Larcker (1981), it is currently widely accepted that the loading values of scale items need to be at least at 0.7 and the composite reliabilities at 0.8. Furthermore, the average extracted variance needs to be 0.5 at minimum (Fornell and Larcker 1981). We carried out this analysis using SmartPLS and the results can be seen in Appendix. A few survey items were removed during the analysis for not filling these criteria, and they are also marked in Appendix. We also found the weights

Table 3. The correlation matrix with square roots of the average variance extracted values presented diagonally.

	Conflict	Cooperative	DS-R	Fatigue	FoMo	Playing intensity	Individual	Well-being
Conflict	1.00							
Cooperative	0.32	1.00						
DS-R	0.21	0.15	0.82					
Fatigue	0.25	0.18	0.63	0.78				
FoMo	0.23	0.21	0.55	0.66	0.79			
Playing Intensity	0.26	0.28	0.53	0.41	0.43	0.75		
Individual	0.16	0.23	0.10	0.13	0.15	0.19	1.00	
Well-being	0.26	0.28	0.17	0.13	0.19	0.44	0.25	0.79

of the items in formative constructs, ranging from 0.10 to 0.72 (see Appendix).

Next, we measured the discriminant validity of the data. This means ensuring that the survey items of a particular construct do not measure other constructs. The correlation matrix with square roots of the average variance extracted values are displayed in Table 3. As can be seen from the table, the square root of the average variance extracted values displayed diagonally are in all cases greater than the correlation values. As also the discriminant validity of the data could be verified, we conclude that the data set has sufficient validity and reliability to provide results for the proposed structural model.

Next for our data, we wanted to check the model fit. Following the guidelines of Henseler et al. (2014) we utilised the goodness-of-fit (GoF) and standardised root mean square residual (SRMR) statistics for evaluating our model fit. First, we used SmartPLS to calculate the SRMR, for which the outcome value should be below 0.08. For our data, the SRMR was 0.06. Next, we used the Wetzels, Odekerken-Schröder, and Van Oppen (2009) equation for GoF. According to Wetzels, thresholds for this value regarding the model fit are small (0.1), medium (0.25) and large (0.36). Here our calculation yielded the value 0.50. Overall, the GoF and SRMR statistics indicate a good model fit. Hence, we could move on to obtain the structural model results.

4.4. Structural model results

The structural model results are displayed in Figure 2. We found DS-R to have a strong positive association with fatigue ($\beta = 0.37$, $p < 0.001$) and a negative association with well-being ($\beta = -0.10$, $p < 0.05$), thus confirming H1 and H2. This finding highlights the importance of self-regulation ability in maintaining psychological well-being and avoiding fatigue. FoMo was positively associated with gaming fatigue ($\beta = 0.45$, $p < 0.001$), but had no relationship with psychological well-being ($p > 0.05$). Thus, H3 was confirmed but H4 rejected.

We also looked at the relationships between three types of game mechanics and well-being and fatigue. Here we found that engagement with individualistic game mechanics had no association with gaming fatigue ($p > 0.05$), but a positive association with well-being ($\beta = 0.14$, $p < 0.01$), confirming H5 but rejecting H6. Similarly, we found that engagement with cooperative game mechanics had no association with gaming fatigue ($p > 0.05$), but a positive association with well-being ($\beta = 0.11$, $p < 0.01$). Thus, H7 was rejected but H8 was confirmed. The only deviation in the types of game mechanics found in this study was with the competitive game mechanics. With regards to H9, we found engagement with competitive game mechanics to have a relationship with fatigue ($\beta = 0.07$, $p < 0.05$) and with regards to H10 found engagement with competitive game mechanics to associate with well-being ($\beta = 0.12$, $p < 0.01$), thus confirming both hypotheses. The relatively small differences between the three constructs of game mechanics may be explained by the fact that most of these mechanics are intertwined in playing.

Overall, seven of the hypothesised relationships were supported. The control variable of playing intensity shows a clear overall positive association with psychological well-being ($\beta = 0.42$, $p < 0.001$) but no relationship with fatigue. The model explained 55% of the variance of fatigue and 27% of the variance of well-being.

5. Discussion

5.1. Key findings

Confirming our hypotheses, DS-R and FoMo were associated with fatigue ($p < 0.001$). DS-R also had a negative relationship with psychological well-being, however this impact was small. By contrast, FoMo had no association with psychological well-being, implying that it could be a factor only associated with negative affect such as fatigue (Stallings et al. 1997).

With regards to the three types of game mechanics, engaging with competitive game mechanics was associated with both increased psychological well-being and

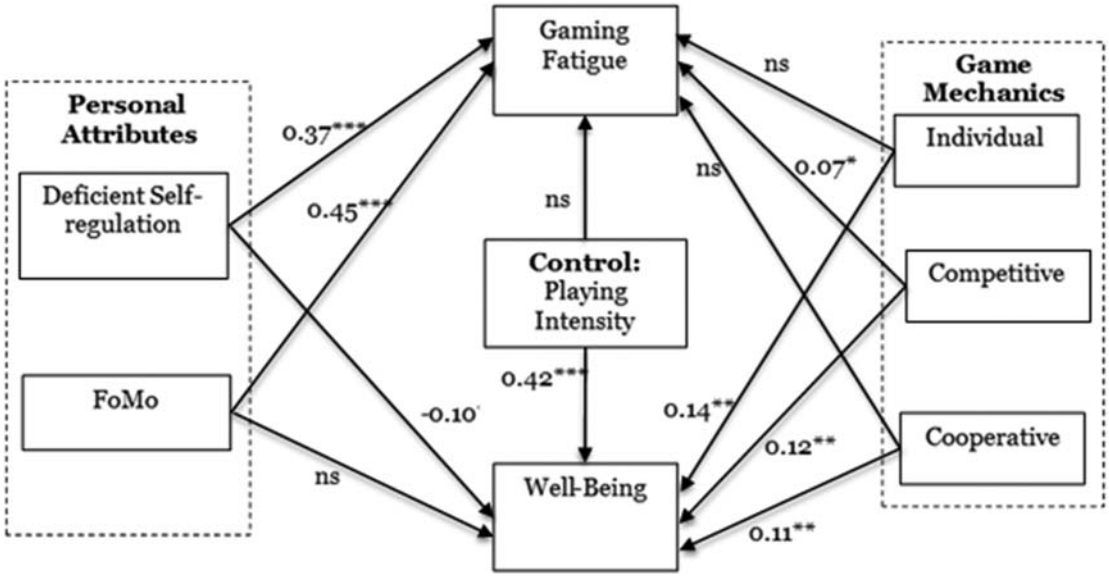

Figure 2. PLS analysis results (***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; ns: non-significant).

increased fatigue. This may be related to how overcoming human opponents releases the neurotransmitter serotonin and increases well-being, while losing has the opposite effect (Boureau and Dayan 2011; Vorderer, Hartmann, and Klimmt 2003). Engagement with individualistic and cooperative mechanics were associated only with psychological well-being.

Interestingly, DS-R and FoMo were much more strongly associated with fatigue than the observed game mechanics. This implies that while playing LBGs in general is a positive activity, losing control over playing (DS-R) and being compelled to play by social anxiety (FoMo) should be avoided. What makes this problematic is that several game companies are specifically leveraging FoMo to engage players. For example, the observed LBG Pokémon GO constantly pushes notifications of events with exclusive rewards (Niantic 2020). This takes control away from the player and instead of sovereign decisions on when to play, the game creator is attempting to tell players when to play. In light of our findings, this kind of marketing can be devastating to players with poor self-regulation abilities. However, further research on the topic is needed.

Finally, playing intensity had a strong positive relationship with psychological well-being, but a non-significant relationship with fatigue. This indicates that while LBGs may give birth to negative side effects such as fatigue through DS-R and FoMo, overall playing LBGs has a positive association with psychological well-being. Longitudinal studies are needed to confirm to what extent players with high psychological well-being gravitate towards playing LBGs more intensively, and to what extent a high intensity of playing leads to psychological well-being.

5.2. Implications to theory

Our study has three theoretical implications. First, LBG playing intensity was found to be positively associated with psychological well-being. Previous work suggests that LBGs in general may help reduce social anxiety and increase social well-being (e.g. Laato et al. 2020c; Tateno et al. 2016; Vella et al. 2019; Yang and Liu 2017). Here we contribute by showing that engagement with cooperative game mechanics is in general associated with psychological well-being. This supports other studies focusing on cooperative game mechanics in LBGs specifically (Morschheuser et al. 2017; Riar et al. 2020; Vella et al. 2019). We also identified DS-R and FoMo to be positively associated with fatigue and DS-R to also have a negative relationship with well-being. Therefore, our findings contribute to the previous studies on positive outcomes of playing LBGs, which are increased exercise and outdoor activity (Althoff et al. 2016; Laato, Inaba, and Paloheimo 2020b), positive (and surprising) life experiences (Bonus et al. 2018; Koskinen et al. 2019), learning about local surroundings (Oleksy and Wnuk 2017), practise of cartographic and navigation skills (Carbonell Carrera, Saorín, and Hess Medler 2018), increased sense of happiness (Williams and Slak-Valek 2019), improvement on psychological distress (Watanabe et al. 2017) and increased social connectedness (Vella et al. 2019).

Second, we contribute to literature on the dual outcomes of hedonic systems (Islam, Mäntymäki, and

Benbasat 2019; Yang, Wang, and Lu 2016) by showing that playing Pokémon GO was associated with both positive and negative consequences. While the overall playing intensity was significantly associated with only well-being, experiencing DS-R in the context of Pokémon GO was connected to reduced well-being and increased fatigue. FoMo in the context of playing was also linked to increased fatigue. Therefore, our findings are in line with TFT, which suggests that the drivers of positive and negative outcomes are different. These findings also relate to the perspective of obsessive and harmonious passion (e.g. Fuster et al. 2014; Vallerand et al. 2003; Wang and Chu 2007), which implies that depending on individual characteristics, players may develop either a harmonious or an obsessive passion towards the game. Here our findings highlight DS-R and FoMo as potential factors associated with obsessive passion. Thus, future work could investigate these two factors in further detail to see whether they lead to obsessive passion. Taken together, our paper contributes to the prior works that have been conducted using TFT, especially in the context of psychological well-being (Diener et al. 1999; Islam 2014; Stallings et al. 1997; Watson and Tellegen 1985)

Third, we contribute to the overall research on understanding video games as a hobby and how playing games relates to well-being (e.g. Eichenberg and Schott 2017; Halbrook, O'Donnell, and Msetfi 2019; Johnson et al. 2013; McLean and Griffiths 2013) by showing that FoMo may be linked to negative affect (fatigue) but not psychological well-being. This has implications to SDT where FoMo has been linked to the relatedness need (Al-Menayes 2016; Przybylski et al. 2013) and supplements previous studies, where FoMo has been associated with problematic smartphone use (Elhai et al. 2016; Wolniewicz et al. 2018). Overall this study contributes to the literature of the psychological impact of LBGs and helps situate the LBG genre among the rest of video games.

5.3. Implications to practice

One cause for the negative associations related to DS-R and FoMo may be explained by the advertisement approach adopted by the LBGs. In the case of Pokémon GO, the game not only markets in-app purchases that make personal progression in the game faster, but for example, leverages social pressure in the form of asking money to participate in social raids (Bhattacharya et al. 2019) and selling clothing and character poses for players to allow them to better express themselves (Niantic 2020). These approaches may be beneficial from the LBG developer's vantage point. However, they also need to consider the possible side effects of such measures. In fact, prior literature has pointed that fatigue may lead users to discontinue or take a temporary break from using a service (Maier et al. 2015). Therefore, the presence of FoMo and DS-R may lead to players' yielding playing altogether. Competitiveness can be engaging, but it too can lead to fatigue and consequently to the decrease in overall player retention (Song et al. 2013).

Our findings also have implications for LBG players. To increase personal psychological well-being, players need to be mindful of what aspects of the games give birth to negative affect. FoMo and DS-R seem to be invoked via constant bombardment of in-game events and news (Niantic 2020) and hence, players should not let this have an impact on their self-regulation nor reinforce FoMo. As DS-R was negatively associated with well-being and positively with fatigue, measures should be taken to counter it. There is evidence that while relationship initiation in LBGs can lead to fatigue and decreased well-being (Yang and Liu 2017), it can lead to lasting friendships that overall have a significant positive impact on the player (Bhattacharya et al. 2019; Riar et al. 2020; Vella et al. 2019). As LBGs can also be regarded as the gamification of outdoor movement (Colley et al. 2017; Hamari et al. 2019), this study has implications on how game mechanics could be used to facilitate human well-being during commuting and other necessary travel.

6. Limitations and future research

Research conducted on LBGs and Pokémon GO specifically have already quite exhaustively looked at reasons why people play these games (Alha et al. 2019; Hamari et al. 2019; Rasche, Schlomann, and Mertens 2017; Vaterlaus, Frantz, and Robecker 2019) as well as peeked into the behavioural consequences of playing (Alomar, Alsaleh, and Alarifi 2019; Colley et al. 2017; Kaczmarek, Behnke, and Dżon 2019; Vella et al. 2019). Our study departs from the extant work by using TFT to conceptualise a model with psychological well-being and fatigue as dependent variables. While our approach gave new insight and suggestions into how LBGs could facilitate well-being, the complexity of the research problem forced us to simplify our model and not include the many aspects which have already been addressed by previous work. Therefore, future research may build a more comprehensive research model to investigate the phenomena.

The participants ($N = 855$) of the current study were from a geographically and culturally limited area, Finland. Furthermore, data were collected in the beginning

of April 2020, when people were advised to avoid social meetings during the COVID-19 pandemic (Hellewell et al. 2020; Farooq, Laato, and Islam 2020). These two factors may have introduced some biases to the data. As a cross-sectional study, our work did not account for any possible changes in the model constructs and their relationships that may have occurred over time, for example, because of the COVID-19 pandemic. We measured psychological well-being and fatigue in the context of Pokémon GO, however, future work may measure psychological well-being more broadly. For this end, comparison studies or longitudinal studies are needed.

One of the theoretical limitations of our work is choosing fatigue as an example of the negative outcomes of playing LBGs. While fatigue certainly is a negative outcome, there are other negative outcomes such as sadness and depression (Stallings et al. 1997). Fatigue was chosen for this study because of its connection with gaming addiction (Männikkö, Billieux, and Kääriäinen 2015) and its established relationship with DS-R and FoMo (Dhir et al. 2018). However, future research may include sadness and depression as negative outcomes. DS-R and FoMo, on the other hand, were chosen as they were identified to be potential consequences of the aggressive marketing strategies identified in the case LBG. Future research could also look into how our findings may differ with regards to the big five personality factors (extroversion, agreeableness, openness, conscientiousness, and neuroticism) (Caci et al. 2019; Tabacchi et al. 2017). Finally, while we primarily looked at how playing increases well-being, it is also possible that people are playing more intensively as a result of the game increasing their well-being.

One of the important future research agendas is the confirmation of the causality of the observed relationship via longitudinal analysis. Future studies could also investigate whether similar phenomena can be seen in other video game genres besides LBGs. It is also worth considering the tradeoff between playing LBGs and doing something else. For example, with regard to exercise, LBGs have been found to be an ineffective choice (Beach et al. 2019). Finally, as LBGs are dependent on the playing location, time of day and time of year, future work could explore whether the real world environmental occurrences have impact on the findings.

7. Conclusions

Our results revealed a strong relationship between playing intensity and psychological well-being. This is an important finding as it suggests that those playing LBGs are generally happier. By contrast, the aggressive marketing of in-app purchases and events in LBGs may mitigate the positive effects it can increase DS-R and FoMo which were associated with the negative outcome, fatigue. Overall our findings encourage future research into the outcomes of playing LBGs and how they differ from other genres of video game. As LBG developers are constantly improving existing technology and coming up with increasingly innovative ways to tie gameplay to the real world, scholars need to work towards understanding the impact of these technologies on players and related phenomena.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix. The survey items, loadings, composite reliabilities, and average variance extracted values

Construct name	Items	Loading/ weights
Individual game mechanics (adopted to Pokémon GO from Riar et al. 2020)	Catching pokémon	0.19 ns
	Solo raids	0.32***
Formative construct	Hatching eggs	0.10 ns
	Collecting medals and XP	0.17 ns
	Collecting golden gym badges	0.22**
	(secondary, cooperative and competitive)	0.38***
	AR content	0.72***
	Playing with multiple accounts	0.15 ns
	Community days (secondary: cooperative)	
Cooperative game mechanics (adopted to Pokémon GO from Riar et al. 2020)	Opening and sending gifts	0.32***
	Trades	0.47***
Formative construct	Creating new stops and gyms	0.50***
	Social raids	0.41***
Competitive game mechanics (adopted to Pokémon GO from Riar et al. 2020)	Gym battles (secondary, cooperative)	0.49***
	PvP battles or GO Battle League	0.37***
Formative construct		
Psychological well-being (Islam, Mäntymäki, and Benbasat 2019)	When I play Pokémon GO, I feel alive.	0.82
	When I play Pokémon GO, sometimes I feel so alive I just want to burst.	0.70
CR: 0.87	When I play Pokémon GO, I have energy and spirit.	0.83
AVE: 0.63	When I play Pokémon GO, I feel I am fully living.	0.84
	When I play Pokémon GO, I do not feel very energetic.	Removed
Deficient self-regulation (Assunção and Matos 2017)	I have a hard time keeping my Pokémon GO playing under control.	0.90
CR: 0.86	I have tried unsuccessfully to cut down on the amount of time I spend playing Pokémon GO.	Removed
AVE: 0.67		0.72
	I sometimes try to conceal how much time I spend playing Pokémon GO from my family or friends.	0.83
	I feel my Pokémon GO playing is out of control.	
Fear of missing out (adapted from Przybylski et al. 2013)	I fear others will get more shinies or legendary pokémon than me if I don't play.	0.79
CR: 0.84		0.81
AVE: 0.63	I get worried when I find out my friends are raiding or playing an event without me.	0.78
		Removed
	I get anxious when someone takes down a gym from me.	
	I am not worried that my gyms are captured or I don't get coins I don't play for a few days.	
Gaming fatigue (Whelan, Islam, and Brooks 2020)	I find it difficult to relax after continually playing Pokémon GO.	0.75
CR: 0.86	After a good playing session of Pokémon GO, I feel mentally exhausted.	0.75
AVE: 0.61	After playing Pokémon GO, it takes effort to concentrate in my spare time	0.82
	While playing Pokémon GO, I often feel too fatigued to perform other tasks well	0.81
Playing intensity (Whelan, Islam, and Brooks 2020)	Playing Pokémon GO is part of my everyday activity.	0.72
CR: 0.84	I feel out of touch when I haven't played Pokémon GO for a while.	0.80
AVE: 0.56	I would be frustrated if I could not play Pokémon GO.	0.83
	How many minutes per day do you spend playing Pokémon GO?	0.70