Internet Gaming Disorder: The interplay between physical activity and user-avatar relationship

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ABSTRACT

Understanding both the risk and protective factors associated with Internet Gaming Disorder (IGD) has been viewed by many in the gaming studies field as an area of research priority. The present study focused on the potential risk and protective effects of user-avatar (game figure) relationship and physical activity (PA) respectively. To address these aims, a cross-sectional and a longitudinal mixed-methods design were combined (comprising both psychological and physiological assessments). A sample of 121 emerging adult gamers (18-29 years) residing in Australia, who played massively multiplayer online games, were assessed in relation to their IGD behaviors using the nine-item Internet Gaming Disorder Scale-Short Form. Additionally, the Proto-Self-Presence scale was used to evaluate the extent to which gamers identified with the body of their avatar. Finally, a PA monitor (*Fit-Bit Flex*) measured levels of energy consumed during real world daily activities (active minutes). A number of linear regressions and moderation analyses were conducted. Findings confirmed that Proto-Self-Presence functioned as an IGD risk factor and that PA acted protectively, weakening the association between Proto-Self-Presence and IGD behaviors. Implications of these findings are discussed in relation to IGD treatment and gaming development aspects.

Keywords: Internet Gaming Disorder; Proto-Self-Presence; Physical Activity; Emerging Adulthood; Massively Multiplayer Online games.

1. Introduction

Internet use has grown exponentially, constituting an inherent part of contemporary life (Anderson, Steen & Stavropoulos, 2016). In that context, the user-internet interplay (within the broader human computer interaction filed) has attracted the attention of researchers from a diverse range of scientific disciplines including psychology, information technology, computer science, and sociology (Lazar, Feng, & Hochheiser, 2017). One particularly popular and continuously expanding online application/activity that has gravitated research focus is Internet gaming (Andreassen et al., 2016). More specifically, the potentially positive (e.g., mental health improvements, cultural openness, a sense of meaning and accomplishment, collaboration and emotive stimulation; Smahel, Blinka, & Brown, 2012; Kaplan & Haenlein, 2010; Armitage, Claypool, & Branch, 2006; Billieux et al., 2015; Hsu, Wen, & Wu, 2009; Snodgrass, Lacy, Dengah, & Fagan, 2011) and negative effects (e.g., negative impact on identity formation, physical health and interpersonal relationships; Billieux et al., 2015; Hyun et al., 2015; Kuss, 2013; Hsu et al, 2009; Freeman, 2008) of Internet gaming, depending on the intensity of gaming involvement, have been demonstrated (Anderson et al., 2016). Additionally, the significance of the gamer-avatar (i.e., game character) association has been repeatedly highlighted, and associations with Internet Gaming Disorder (IGD) have been reported (Bessière, Seay & Kiesler, 2007; Caplan, Williams & Yee, 2009; Bainbridge, 2009; Williams, Yee, & Caplan, 2008. Corneliussen & Rettberg 2008; Constantiou, Legarth & Olsen, 2012). Despite these findings, further research has been recommended in regard to the effects of the interplay of user-avatar characteristics on the development of IGD behaviors (Stavropoulos et al., 2017a).

Driven by these recommendations, the present study explored the gamers' level of physical-body identification with their avatars (Proto-Self-Presence [PSP]; Ratan & Dawson, 2015) and their physiological activity (PA) as risk and protective factors of IGD behaviors respectively. Addressing these questions appears important, given the dearth of relevant studies and the significant potential implications for more effective IGD prevention and intervention initiatives (e.g., informing more targeted and efficient policies and programs).

1.1.1. Internet Gaming Disorder (IGD)

IGD was included in the latest (fifth) edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as an emerging disorder requiring further clinical and research investigation by the American Psychiatric Association (APA, 2013). IGD is described as a form of persistent and recurrent involvement with online gaming, often leading to the decline of daily and work activities (i.e., neglecting daily routine activities such as showering or eating; APA, 2013; Hawkins, Catalano, & Miller, 1992; Kuss & Griffiths, 2012; Sanchis-Segura, & Spanagel, 2006; Pawlikowski & Brand, 2011). Accordingly, its prevalence and psychosocial impact have prompted much research interest (e.g., Spekman, Knijn, Roelofsma, & Griffiths, 2013). However, despite the increasing number of cross-sectional studies, there is a dearth of longitudinal studies examining risk and protective factors (especially related to the virtual-gaming context) of IGD behaviors (Kuss, 2013; Pontes & Griffiths, 2015). To help prioritize practical knowledge concerning vulnerable IGD populations, the present study focuses on emerging adulthood (as an age period; Spekman et al., 2013;

Stavropoulos et al., 2017a; Winkler et al, 2013) and Massively Multiplayer Online (MMO) games (as the game genre; Billieux et al., 2015; Kuss, 2013; Stavropoulos et al., 2017a; Young, 2009) because these features are believed to be risk factors in developing IGD among the gamer population (Anderson et al., 2016).

1.1.2. Emergent Adulthood as the Age Range of focus

Emergent adulthood includes people aged between 18 and 29 years (Arnett, Žukauskienė, & Sugimura, 2014) and has been identified as a risk period for addictions more generally (including technological addictions; Arnett, 2000) and IGD in particular (APA, 2013; Blinka, 2008; Freeman, 2008; Douglas et al, 2008; Substance Abuse and Mental Health Services Administration, 2015). In Australia, 78% of online gamers are emergent adults or adults, who predominantly play online videogames to positively moderate their feelings and relieve boredom (Brand & Todhunter, 2015). However, to date, there has been a dearth of longitudinal studies investigating IGD risk during this particular developmental time (Spekman et al., 2013; Stavropoulos et al., 2017a; Winkler et al, 2013).

1.1.3. Game Genres

Within the broader range of Internet gaming genres (Kuss, 2013; Thipse, 2016), the present study focuses on Massively Multiplayer Online games (MMOs), as they have consistently been associated with higher IGD risk (Billieux et al., 2015; Elliott et al., 2012; Kuss, 2013; Lee et al., 2007; Stavropoulos et al., 2017a; Young, 2009). MMOs are defined as games that are co-played online with others (on a massively multi-player basis) and involve competitive and cooperative goals that are both challenging and immersive (Steinkuehler & Williams, 2006; Lee, Cheung, & Chan, 2015). It should also be noted that MMO games are often used interchangeably with that of Massively Multiplayer Online Role Playing Games (MMORPGs; Caplan, Williams, Yee, 2009) although some MMO games may not involve role-playing. Various factors have been suggested to explain the higher IGD risk in MMO games, such as escapism motives, low achievement, and poor self-esteem in real life (Billieux et al., 2015). Additionally, the higher IGD risk in MMO games has also been attributed to the emotional attachment formed between the players and their avatars (Badrinarayanan et al., 2014; Billieux et al., 2013; 2015; Hsu et al., 2009). More specifically, players may find themselves becoming more immersed with their virtual character, increasing their excessive gaming time (Badrinarayanan et al., 2014; Stavropoulos et al., 2017a; Yee, 2006).

1.2. Theoretical Background

1.2.1. Risk and Resilience Framework (RRF)

To expand the knowledge considering the effect of the gamer-character association on IGD behaviors, the present study adopts the risk and resilience framework (RRF; Stanley, 2009). Resilience is defined as the combination of aspects and experience (i.e., protective factors-resources) that allow a person to be unaffected by something problematic (Masten, 2014). In contrast, risk is defined as involving aspects and experiences of the individual that make him/her susceptible to problematic conditions (Masten, 2014). In this context, the RRF suggests that the intensity of psychopathological behaviors dynamically (and constantly) varies on a continuum (minimum to maximum) based on the interplay between individual characteristics (e.g., age, gender, personality traits, etc.) and contextual factors (e.g., family, culture, etc.) (Masten, 2014; Bronfenbrenner, 2006; Cicchetti & Toth, 2009; Hussain et al., 2015). Given the importance of the gaming context in the development of IGD behaviors, the

RRF is enriched here by the inclusion of gaming factors (i.e., user-avatar relationship; Andreassen et al., 2016). Within this broader framework, and to contribute to the field, the present study emphasizes the effect of proto-self-presence as an IGD risk factor (e.g., the level of physical-body identification between the gamers and their avatars; Ratan & Dawson, 2015) and physical activity as an IGD resilience factor.

-*Figure 1*. Risk and Resilience IGD Framework-

1.2.2. Proto-Self-Presence (PSP)

The avatar is a complex multi-leveled tool enabling social and virtual interaction, affecting the user emotionally, cognitively, and behaviorally (Ratan & Dawson, 2015). The avatar may often merge with aspects of the user's identity (i.e., body, behavior, and emotion) creating an overlap between reality and the virtual environment (Blinka, 2008). The concept of the 'Proteus effect' has been introduced to best describe how the user's perception, knowledge, and experience merge with the avatar (Yee et al, 2009). The 'Proteus effect' assumes that players are influenced by their avatars, changing how they interact with others in real life (Yee, & Bailenson, 2007). One study found the characteristics of the avatar to influence how the player perceived themselves (use of tall avatars influenced taller self perception) and behaved (attractive avatars influenced confident behavior during social interactions; Chandler et al., 2009). Subsequently, virtual sensations (psychological or body-related) may often be mixed with those that are physical and real (Billieux et al., 2015; Chandler et al., 2009). Additionally, it has also been found that players who use avatars that are physically competent are also inclined to perceive themselves as such, even if they lack such a competency in reality. The latter has been described as a "de-individuation" (from someone's real self) aspect involved with the 'Proteus effect' (Yee, & Bailenson, 2007).

In this context, the extent to which gamers identify with the body of their avatars is conceptualized as PSP (Ratan & Dawson, 2015; Riva et al., 2004). Higher PSP levels induce an 'extension of the body' experience in the world of the game (Luppicini, 2013; Ratan & Hasler, 2010; Riva et al., 2004). How the avatar's influence poses a potential IGD risk factor can be highlighted via the compensatory internet use model (Kardefelt-Winther, 2014). This signifies behaviors of escaping and/or using the online world to displace and/or address real life problems (Kardefelt-Winther, 2014) and appears consistent with a significant body of literature (Bessière et al., 2007; Caplan et al., 2009; Constantiou et al., 2012; Corneliussen & Rettberg 2008). Players may be projecting their physical insecurities onto their in-game character to compensate for what they may physically lack in the real world (Blinka, 2008; Hopp, Barker, & Weiss, 2015; Smahel et al., 2008). This can reach levels of deindividuation when the idealized self of the player (projected onto the avatar) provides players with the perceptive experiences of their ideal attributes (Yee, & Bailenson, 2007). Therefore, gamers are likely to endorse their avatars with physical characteristics desired in real life, becoming emotionally attached, as a means to attain an idealized self. This process may reinforce excessive gaming involvement precipitating and perpetuating IGD symptoms. Similarly, people who spend longer periods of time on-screen tend to experience a more disadvantaged sense of self in reality (i.e., poorer outcomes in body composition, fitness, self-esteem, self-worth, pro-social behavior, and academic achievement; Tremblay et al., 2011). Thus, a cyclical interaction can be reinforced, understood through the Selection Optimization and Compensation (SOC) model (Lerner, Freund, Stefanis & Habermas, 2001). This portrays individuals directing their psychological and physical efforts towards a goal or behavior that provides them with the greatest benefit (in this case their avatar; Lerner, Freund, Stefanis & Habermas, 2001). Consequently, the present study hypothesizes that higher PSP levels will accommodate a fusion between the player's real (physical) self and virtual self (Yee et al., 2009) potentially inducing IGD behaviors (Billieux et al., 2013; 2015; Hsu et al., 2009).

1.2.3. Moderation effect: Physical activity

Given that PSP, as an IGD risk factor, could be understood via compensating for physical disadvantages in the real world (Blinka, 2008; Lerner et al., 2001; Smahel et al., 2008), one could assume that improving physical activity (PA) could reduce the propensity for IGD behavior among players with higher PSP (Young, 2009). PA can be defined as any form of motion throughout the body that indicates significant movement, impacting or changing the individuals overall physical status or wellbeing (e.g., walking, bike riding, gardening, etc.; Fitbit, 2016; Kendzor et al., 2008; Kremer, Malkin, & Benshoff, 1995). Indeed, increasing PA in an individual's daily-life schedule by implementing an exercise routine has been found to reduce the severity of other addictive behaviors (Weinstock, Barry, & Petry, 2008), such as smoking (Kurti & Dallery, 2014), and alcohol consumption (Murphy et al., 1986; Read et al., 2001). Therefore, there are reasons to expect that PA may act as a moderator (buffer) between PSP and IGD (Bronfenbrenner, 2006; Cicchetti & Toth, 2009; Griffiths, 2005). This expectation is reinforced by consistent findings that have identified PA as a significant buffer in the associations between a range of maladaptive behaviors and physiological difficulties (McDonnall, 2011; Richardson et al., 2005; Schmidt, Beck, Rivkin, & Diestel, 2016; Sliter, Sinclari, Cheung, & McFadden, 2014; Sliter & Yuan, 2015; Torsheim et al., 2010).

The potential buffering effect of PA on IGD symptoms of players with higher PSP levels can be supported on the basis of three theoretical hypotheses. First, *the distraction hypothesis* suggests that diversions that draw attention from negative stimuli could enable the maintenance, or the improvement of one's psychological status (Festinger & Maccoby, 1964). Therefore, PA may facilitate competitive and pleasurable emotions, redirecting interest from excessive Internet gaming involvement (Read et al., 2001; Weinstock et al., 2008). Second, *the mastery hypothesis* emphasizes the potential reduction of negative mood affects (that may precipitate and perpetuate IGD), when an individual experiences a sense of accomplishment through PA-related activities (Greist et al., 1979). A high level of PA performance, or reaching milestones, has been associated with positive mood states (Feltz, 2007; Lerner, Freund, Stefanis & Habermas, 2001), higher self-confidence, and personal judgements of worthiness (Feltz, 2007; Taylor, 1987; Woodman & Hardy, 2003). These positive mood states may later encourage further PA participation, thus acting as a buffer for IGD (Calzo et al., 2014; Feltz, 2007). Finally, *the social interaction hypothesis* suggests that socialization due to PA involvement can induce positive feelings (Bengston, Gans, Putney & Silverstein, 2009). Studies contend that various forms of social exercise can encourage positive group outcomes and maintenance of personal relationships, a benefactor for the individual's overall mental wellbeing (Bengston at al., 2009; Duncan & McAuley, 1993; McIntrye, Watson & Cunningham, 1990), that can influence further participation and substitute gaming socialization. Therefore, it is hypothesized that potentially beneficial outcomes of PA will compete with those attainable in Internet Gaming. In this context, PA will anchor the player's presence to the physical world, decreasing the effect of PSP in relation to IGD behaviors.

1.3. The Present Study

The present study[1] adopted a risk and resilience theoretical perspective that dimensionally conceptualizes IGD behaviors on a continuum from minimum to maximum, to explore the gamers' level of physical-body identification with their avatars (PSP) and PA, as risks and resilience factors of IGD behaviors respectively. To address these aims, the present study combined a cross-sectional and a longitudinal (three measurements over a period of three months, one month apart each) mixed methods design (involving both psychological and physiological assessments). More specifically, it examined a sample of Australian, emergent adults (18-29 years), MMO players, collected online and face-to-face. Based on the literature reviewed, the following hypotheses were formulated:

H1: A higher level of physical-body identification between gamers and their avatars (PSP) will increase the risk IGD. Compensatory internet use behaviors may explain the association between higher PSP and IGD behaviors (Arnett, 2000; Blinka, 2008; Kardefelt-Winther, 2014; Smahel et al., 2008). These behaviors can potentially generate a psychological attachment to the avatar as a means to experience an idealized self, increasing gaming exposure and IGD behaviors (Yee, & Bailenson, 2007).

H2: A higher PA will reduce (i.e., positively moderate) the IGD behaviors of gamers more physically-body identified with their avatars. PA has been repeatedly highlighted as an effective strategy of reducing addictive behaviors (Kurti & Dallery, 2014; Murphy et al., 1986), and a significant potential buffer of psychopathological symptoms in general (Richardson et al., 2005; Torsheim et al., 2010). PA combines a range of beneficial outcomes (i.e., sense of accomplishment, improved sense of body image, etc.) that may compete with reasons for excessive MMO game engagement (Bengston et al., 2009; Duncan & McAuley, 1993; Festinger & Maccoby, 1964).

2. Materials and Methods

2.1. Sample

The sample comprised 125 participants (64 online and 61 face-to-face) who were emerging adults, aged between 18-29 years old, Australian residents, and played MMO games (i.e., *World of Warcraft,* etc.; Arnett, Žukauskienė, & Sugimura, 2014)[1]. Participants in the online component of the study comprised 49 males and 15 females aged from 18-29 years old (*M*=23.34 years, *SD*=3.29). Participants in the face-to-face component of the study (three measurements over a period of three months, one month apart each) comprised 45 males and 16 females aged 18-29 years old (*M*=22.53 years, *SD*=3.04; see Figure 1). The combined use of online and offline data has been applied in past studies (Orgad, 2005; Wilson, & Atkinson, 2005) and has been further advocated by findings indicating equivalence between online and face to face collection methods (Pettit, 2002; Weigold, Weigold, & Russel, 2013). In the present study, to ensure there were no significant differences between the online and face-to-face samples in relation to their demographic and internet use characteristics, independent sample t-tests and chi-square analyses were additionally conducted. No significant differences were detected concerning gender (X^2 =.21, DF = 1, p=.89), age, ($t_{(120)}$ = -.54, p = .59), years of internet use ($t_{(122)}$ = 2.35, p =.06), PSP ($t_{(119)}$=1.09, p=.28) and IGD scores ($t_{(111)}$=-.14, p=.89). PA measurements were not collected for the online sample and therefore relevant comparisons could not be calculated. Based on these, the present study combined the face-to-face sample at Time Point 1 (TP1; n=61), with the online sample (n=64) to address cross-sectional related questions (see Table 1 for sample details)[2].

The longitudinal (face-to-face/ offline) design was further assessed for attrition. Time point 1 (TP1) comprised 61 participants, Time Point 2 (TP2) 56 participants (8.20% attrition), and Time Point 3 (TP3) 43 participants (29.51% attrition from TP1). The estimated maximum sampling errors with a size of 125 (cross-sectional sample) and a size of 61 (longitudinal sample) are 8.77% and 12.55% (Z = 1.96, confidence level 95%) respectively.

-Table 1. *Sociodemographic Characteristics of the Participants in the Study-*

-*Figure 2.* Visual Representation of the Present Study-

2.2. Instruments

2.2.1. Internet Gaming Disorder Scale – Short Form 9 (IGDS-SF9). To dimensionally examine IGD behaviors and reinforce assessment consistency among researchers, the present study used the IGDS-SF9 (Pontes & Griffiths, 2015). The IGDS-SF9 is based on the nine criteria in the DSM-5 for IGD (APA, 2013). It comprises nine items that elicit information in relation to IGD behaviors (e.g., "Do you feel more irritability, anxiety or even sadness when you try to either reduce or stop your gaming activity?") rated on a 5-point Likert scale (1 "Never" to 5 "Very Often"). To calculate the final IGD score, each item score is added together resulting in a total ranging from 9 to 45 with higher scores being indicative of IGD behaviors. Internal reliability in the present study was high, with a Cronbach's alpha of .88.

2.2.2. Proto-Self-Presence Subscale (PSP) of the Self-Presence Questionnaire (SPQ). To assess the level of user-avatar physical-body identification, the PSP subscale of the SPQ was used (Ratan & Dawson 2015). The SPQ is a 13-item self-report instrument that assesses different aspects of the user-avatar relationship. Only the PSP subscale was used in the present study. PSP describes the extent to which the mediated self-representation in the game (i.e., avatar) is integrated into body schema of the user and consists of five items (e.g., "When playing the game, how much do you feel like your avatar is an extension of your body within the game?"). Participants respond to each item on a 5-point Likert: 0 ("Not at all"), 1 ("Somewhat"), 2 ("Moderately"), 3 ("Very much"), and 4 ("Absolutely"). Scores of the five items are added to provide the total PSP score ranging between 0 and 20, with higher scores indicating a higher experienced level of PSP. Internal reliability of the PSP subscale in the present study was high with a Cronbach's alpha of .90.

2.2.3. Physical activity: Active minutes. To assess PA, the current study utilized an activity monitor (i.e., a *Fitbit Flex*; FBF). Face-to-face participants were required to consistently carry/wear the FBF for a period of three days for each of the three time points assessed. The FBF constitutes an actuarial measurement that records the number of steps, distance achieved, calories consumed, and accumulated 'active minutes' per period of time chosen (Fitbit, 2016). More specifically, the number of 'active minutes' was selected as the PA indicator in the present study. Active minutes calculation relies on recording the levels of energy-consumed-per-minute in offline physiological activities. One active minute, as a unit of measure, is calculated using metabolic equivalents that keep track of the level of energy expenditure (Fitbit, 2016). Therefore, *Fitbit* active minute measurements rely on metabolic equivalents that record activities' intensity. By measuring the intensity of the individual's activities as opposed to keeping track of distance covered or calories burned, active minutes become comparable against users of different weights (Fitbit, 2016). The FBF validity and reliability were found to be high with an error estimation of 17-18% (Alharbi, Bauman, Neubeck, & Gallagher, 2016; Bai et al., 2015; Diaz et al., 2015) and their use has been recommended in medical practice to monitor treatment plans involving PA (Alharbi et al., 2016; Diaz et al., 2015).

Studies have found that the FBF has an increased accuracy for longer periods of time, compared to that of other activity tracking devices, partially due to its convenient use (e.g., wrist-wear; Diaz et al., 2016). To increase the measurements' validity and reliability, the present study adopted previous research recommendations to aggregate measurements (i.e., produce mean scores) over longer periods of time (Diaz et al., 2016). Therefore, the present study aggregated PA scores over the course of three days per-time-point (to produce the mean of active minutes).

2.3. Procedure

This project was approved by the Human Research Ethics Committee of Federation University Australia (HREC-A16-044, 2016). Participants were recruited in the general community using traditional (i.e., information flyers) and electronic (i.e., email, social media) advertising methods[3]. The face-to-face, longitudinal component of the study was conducted over three months, with the three time-point assessments completed between June 2016 and September 2016. The process of data collection was identical between the three time points and participants' measurements were matched via the use of a re-identifiable code. A specially trained research team of five undergraduate students and two postgraduate students collected the face-to-face data.

Considering the online collection (conducted between June 2016 and July 2016), and based on the ethical approval received, eligible individuals interested in participating and unable or unwilling to attend face-to-face testing sessions were invited to register with the study via a *Survey-Monkey* link available on MMO gaming websites and forums (i.e., http://www.ausmmo.com.au). The link directed individuals to the plain language information statement. Individuals who chose to participate online had to digitally provide informed consent (i.e., click a button). Physical measurements were not included in the online collection.

2.4. Analyses and statistical testing

To assess both cross-sectionally and longitudinally the association between PSP levels and IGD behaviors (*H_1*), offline and online questionnaire data were combined (after controlling for significant differences) using the merge data command of SPSS 21 (see Figure 1). This method could only be applied to the questionnaire variables as PA (i.e., active minutes) was only measured in the offline group. Two hierarchical linear regression models were conducted on the cross-sectional and the longitudinal data respectively. In relation to the cross-sectional analysis, and to control for the possible confounding effects of gender and age on IGD behaviors (Andreassen et al., 2016), both gender and age were inserted separately as IGD predictors during the first step. PSP was then inserted as an IGD predictor at the second step of the model. In relation to the longitudinal analysis, the same two-step hierarchical linear regression model was calculated with the differences of (i) IGD behaviors assessed at TP3 being used as the outcome variable, and (ii) PSP levels assessed at TP1 being used as the IGD predictor variable at the second step. Potential confounding effects of age and gender were (similarly to the cross-sectional analysis) controlled at the first step of the model (see Table 2 for descriptive data of the sample).

To assess the potentially buffering (protective) effect of PA on the IGD behavior of gamers, who are more physically-body identified with their avatars (present with higher PSP levels) (*H_2*), a moderation analysis was conducted using only the longitudinal data through the Process macro (Hayes, 2013) on SPSS 21. The use of the longitudinal data only was based on recommendations supporting that causal associations should be best addressed longitudinally (Winer et al., 2016). More specifically, PSP at TP1 was used as the independent variable, PA (active minutes) at TP2 were used as the moderator, and IGD behaviors at TP3 were used as the outcome variable. Finally, the Johnson Neyman (J–N) technique was applied to derive regions of significance (i.e., points of transition) of the moderation effect of PA on the association between PSP and IGD behaviors (Preacher, Rucker, & Hayes, 2007).

3. Results

In the H_1 cross-sectional analysis, the slope of the two-step (step$_1$ gender and age, step$_2$ PSP) hierarchical regression model calculated was significant ($F_{(3,118)} = 13.10$, $p < .001$) and accounted for 25% of the IGD behaviors' variance ($R^2 = .25$). The addition of PSP to the model accounted for 20% of the IGD behaviors' variance ($F_{change(1,118)} = 31.55$, $p < .001$, $R^2_{change} = .20$). More specifically, for each point of PSP increase, IGD behaviors increased by .81 ($b = .81$, $p < .001$; see Table 2).

-Table 2. *PSP predicting IGD (Cross-section)*-

To complement and reinforce the direction of causality of the association between PSP and IGD, the model was repeated using the longitudinal data (Winer et al., 2016). In the H_1 longitudinal analysis, the slope of the two-step (step$_1$ gender and age, step$_2$ PSP) hierarchical regression model was (similarly to the cross-sectional model) significant ($F_{(3,54)} = 10.36$, $p < .001$). The full model accounted for 37% of the variance in the IGD ($R^2 = .37$). The addition of PSP to the model accounted for 36% of variance ($F_{change(1,54)} = 30.55$, $p < .001$, $R^2_{change} = .36$). More specifically, for each point of increase of PSP, IGD behaviors increased by .76 ($b = .76$, $p < .001$).

-Table 3. *PSP predicting IGD (Longitudinal)*-

The longitudinal data were chosen to address H_2 for two reasons. First, to reinforce the inferences of causality assessed in the moderation analysis (Winer et al., 2016) and second because PA measurements were not collected for the online cross-sectional data. In the H_2 moderation analysis, the model aimed to estimate the risk effect of PSP (IV) levels on IGD behaviors (DV) and how much, if at all, this effect was buffered by higher levels of PA (Moderator) as measured by FBF active minutes. Thus, PSP as the focal predictor (F), PA as the proposed moderator (M) and their interaction (F x M) were included as predictors in an OLS regression predicting IGD behaviors. Gender and age were also included as covariates in the model to control for their effects. The equation estimated was the following:

$$IGD= a+b_1(PSP) + b_2(PA) +b_3(PSP1x\ PA)+b_4(Gender)+b_5(Age)$$

Findings indicated that the full model accounted for 41% of the variance of IGD behaviors. The slope of the regression line for the overall model was significant ($F_{(5,52)}$ =7.35, p<.001). An inspection of the moderation coefficient indicated that PSP and PA significantly interacted (buffering effect) in predicting IGD behaviors, (b_3=-0.10, $t_{(52)}$ =-2.05, p= .046, LLCI= -0.01, ULCI=-0.0005). This finding indicates that when gamers present concurrently at a higher point (than the intercept) on PSP and at a higher point on PA then their IGD scores reduce (i.e. the IGD behavior of those higher on PSP decreases when they present with higher PA scores). The Johnson Neyman (J–N) technique was then applied to examine how the effect of PSP on IGD differed according to PA variations (Preacher, Rucker, & Hayes, 2007). Findings demonstrated that the buffering effect of PA on the PSP-IGD association had a ceiling level at 144.92 active minutes. This means that while for PA values less than 144.92 active minutes, the IGD behavior of gamers higher on PSP significantly decreased, the IGD behavior related to higher levels of PSP did not further decrease after that point of active minutes' (i.e., had reached a maximum level at 144.92 active minutes; see Figure 2).

-*Figure 2*. Moderation summary of PA (Active Minutes) on the relationship between Proto-self and IGD-

4. Discussion

The interplay of user-avatar characteristics has been identified as an area of research priority in relation to the development of IGD behaviors (Stavropoulos et al., 2017a; Stavropoulos et al., 2017b). Consequently, the present study investigated Massively-Multiplayer Online (MMO) gamers' level of physical-body identification with their avatars (Proto-Self-Presence [PSP]; Ratan & Dawson, 2015) and their physical activity (PA) levels as risk and protective factors of IGD behaviors respectively. The study findings and their practical implications in planning IGD prevention and intervention initiatives, as well as relevant future gaming developments are discussed below.

4.1. PSP and IGD

In relation to H_1, it was shown that higher PSP was associated with higher IGD behaviors. Results additionally indicated that the association between PSP and IGD behaviors remained significant over the period of time examined (i.e., three months). These findings are in consensus with previous cross-sectional studies that have reported associations between higher levels of user-avatar identification and excessive gaming (Billieux et al., 2013; Blinka, 2008). As players establish a stronger presence in the virtual world (via higher levels of body-identification with their avatars), they tend to increase the amount of time spent gaming. Avatar control tasks and addressing gaming challenges, that have been associated with higher PSP, could induce achievement and gaming socialization experiences that may increase the players' gaming engagement (Hsu et al., 2009; Luppicini, 2013; Yee, 2006). This notion could be further reinforced by the players' tendency to compensate for (perceived) real life body disadvantages through their game character, as supported by the compensatory internet use model (Kardefelt-Winther, 2014). Therefore – and based on the SOC model – it was expected that players would concentrate their attention and efforts towards their virtual self, if this was perceived as being more emotionally beneficial (Lerner et al., 2001). This concurs with studies showing that an individuals' longer internet use associates with poorer perception of their self in real life (Tremblay et al., 2011) and is encouraged through more positive emotional gaming experiences (Banks & Bowman, 2016). Such processes may exacerbate IGD behaviors by encouraging longer game play sessions that could escalate the level that gamers emotionally rely on their in-game persona (Blinka, 2008; Hopp, Barker, & Weiss, 2015; Smahel et al., 2008).

4.2. PA as a buffer of the risk effect of PSP on IGD

In relation to $H_{2,}$ higher PA was shown to weaken the risk effect of PSP on IGD behaviors. This finding concurs with past studies showing that PA significantly moderates the associations between several psychopathological symptoms and behavior (McDonnall, 2011; Richardson et al., 2005; Schmidt, Beck, Rivkin, & Diestel, 2016; Sliter, Sinclari, Cheung, & McFadden, 2014; Sliter & Yuan, 2015; Torsheim et al., 2010) and re-emphasizes the potential benefit of incorporating PA into medical and psychological treatment programs (Kurti & Dallery, 2014). In line with this, the severity of various forms of addictive behaviors has been found to decline via increased PA

(Kurti & Dallery, 2014; Murphy et al., 1986; Read et al., 2001; Weinstock, Barry, & Petry, 2008).

PA's buffering effect (on the higher IGD behavior of players experiencing higher PSP) could be explained on the basis of redirecting the player's attention via attaining positive PA outcomes and fulfilling goals by facilitating competitive and pleasurable physical activities (i.e., *the distraction hypothesis*; Festinger & Maccoby, 1964; Greist et al., 1979). These may increase players' sense of confidence in their real-world-self, thus competing with their gaming involvement (i.e., *the mastery hypothesis*; Greist et al., 1979). Furthermore, increased PA could involve group activities that initiate and strengthen personal relationships (i.e., *the social interaction hypothesis*) that reinforce players' real world identity, reducing their experienced PSP (Bengston at al., 2009; Duncan & McAuley, 1993; McIntrye, Watson & Cunningham, 1990). Subsequently, PA may put players (who are more physically identified with their avatars) in a positive real-world mood state that could later encourage further participation, thus acting as an IGD buffer (Calzo et al., 2014; Feltz, 2007). Furthermore, PA may reinforce real world physiological features and performance (Young, 2009), buffering the negative associations attributed to higher levels of PSP and reducing IGD vulnerability. Overall, it could be assumed that PA competes with attractive MMO features that involve improving personal, social, and game-related achievements and development (Andreassen et al., 2016; Bengston at al., 2009; Calzo et al., 2014; Feltz, 2007; Festinger & Maccoby, 1964). Consequently, PA appears to potentially counterbalance characteristics of MMO gaming in a way that could strengthen the players' physical identity and deter them from being more physically identified with their avatars (i.e., experience higher PSP).

Despite the significant moderation effect detected, findings demonstrated that IGD behaviors of more physically/bodily identified with their avatars gamers did not further decrease, after PA had reached significantly high levels. Therefore, PA appears to have a maximum potential for reducing the PSP risk effect on IGD behaviors. This could be interpreted as the result of user-avatar body identification (and the associated IGD risk with it) not being exclusively associated to real world PA attractiveness (Andreassen et al., 2016). Caplan's (2009) study was replicated indicating game-related features (i.e., avatar graphs, gaming structure, etc.) contributed to the gamer's immersion with their virtual character, increasing the amount of time within the virtual environment (Andreassen et al., 2016). These gaming-related factors constitute attractive features of the game context that may impose some level of IGD behavior, independent of how PA may increase attraction to the real world.

4.3. Strengths and limitations

The present study contained several strengths: (a) a concurrent examination of online and face-to-face participants; (b) a combination of cross-sectional and longitudinal analyses; (c) an emphasis on an under-researched high risk population for IGD (emergent adults, MMO gamers); (d) a focus on both individual and gaming related factors, as well as their interplay in relation to IGD; and (e) the use of a mixed-methods design that comprised both physical and psychological measurements.

However, there are several limitations that need to be considered. The most notable limitation during data collection was the introduction of new expansions for major online games (e.g., *Legion for World of Warcraft*) and the development of mobile games (e.g., *Pokémon Go*). A previous study that surveyed *World of Warcraft* players, found that the introduction of new gaming content increased player's exposure and financial involvement (Constantiou, & Legarth, 2012). These motivations may have affected data in a way that was outside the control of the current study. Another limitation identified was that the assessment of IGD focused on a specific online gaming genre (i.e., MMO games). There are many different online gaming genres, and therefore characteristics of those who play them may vary accordingly. Furthermore, the sample size being relatively small (N=125), suggesting that limitations may exist when extrapolating and generalizing the results. The longitudinal design applied was over a relatively short time frame (i.e., three months). In terms of the tools used, the FBF was not a precise measure, like other physical activity trackers, the FBF simply provides relatively accurate estimations (Alharbi et al., 2016; Bai et al, 2015; Diaz et al, 2015). Additionally, the present study used self-report measures which may affect reliability as participant responses can be influenced by mood and situational factors at the time when the measurement was taken (Smith & Handler, 2007). Finally, different directions of the causal relationships between the variables involved in the study could be examined (i.e., PA moderated by PSP on IGD risk).

4.4. Implications

Considering IGD prevention, the findings suggest that individuals who experience stronger PSP (i.e., are more bodily identified with their avatars) need to be prioritized, especially when they exhibit lower levels of PA. Concerning treatment directions, cognitive-behavior therapy may be useful to promote awareness in regard to the use of IGD as a potential maladaptive emotional compensation strategy, emphasizing the significance of the identification of gamers with their avatars. Interpersonal therapy may prove beneficial when exploring the role of PSP on IGD behavior. Finally, it is recommended that PA components should be included in the IGD treatment of players who present with higher PSP levels.

Conceptually, these implications resemble the foundations that comprise Tisseron's (2009) method of psychological IGD treatment. More specifically, Tisseron attempts to understand what facets of the player's characteristics are being compensated or are more appreciated within the virtual identity, and attempts to find ways to fulfill such gaps within the gamer's real identity (Tisseron, 2009).

Gaming implications can also be derived from the findings. Firstly, there is the notion of promoting healthy behaviors through games by combining virtual elements (e.g., goal orientation and avatar progression) with PA. This concept has already been highlighted through the mobile game *Pokémon Go* which encourages its player base to increase their PA to progress. In line with this development, gaming platforms like the virtual reality headsets (e.g., *Occulus Rift* and *Playstation VR*), *Nintendo Wii,* and *Microsoft Kinetic*, are some of the many examples of gaming organizations implementing PA components into their products. Additionally, the findings reiterate the reason for the increasing popularity for MMOs. Visual progression (i.e., experience bar, upgrading gear, expanding guild member count etc), character customization, and large communities are all attractive and rewarding experiences. Understanding the effects of these components may indicate why some games are more popular than others which can direct future gaming development and product choice.

4.5. Future research

Future research should further investigate the longitudinal interplay between individual (i.e., age, gender, societal, cultural background) and gaming-related factors (i.e., game genre, game structure, character development, etc.). Furthermore, increasing the length of the longitudinal period studied could greatly benefit knowledge considering time-related variations in the association between PSP and IGD, as well as the PSP-PA interaction. Investigating other potential protective factors that might reduce the association between PSP and IGD may also add to the extant knowledge. Such findings can help inform the guidelines for more effective IGD treatment programs. Given that IGD has been classified as a potentially significant public health risk (APA, 2013), it is imperative to develop and expand our understanding of IGD to better address it.

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6. Footnotes

Note 1: The present study is part of a wider project of Federation University Australia that addresses the interplay between individual, Internet and proximal context factors in the development of Internet Gaming Disorder symptoms among emerging adults. Instruments used in the data include the: (1) Internet Gaming Disorder 9- Short Form (Pontes & Griffiths, 2015); (2) Beck Depression Inventory – 2nd edition (21 items) (Beck, Steer, & Brown, 1996); (3) Beck Anxiety Inventory (21 items) (Beck & Steer, 1990); (4) Hikikomori-Social Withdrawal Scale (5 items) (Teo et al., 2015); (5) Attention Deficit Hyperactivity Self-Report Scale (18 items) (Kessler et al., 2005); (6); Ten Item Personality Inventory (Gosling, Rentfrow, & Swann, 2003); (7) The Balanced Family Cohesion Scale (7 items) (Olson, 2000); (8) Presence Questionnaire (10 items) (Faiola, Newlon, Pfaff, & Smyslova, 2013); (9); Online Flow Questionnaire (5 items) (Chen, Wigand, & Nilan, 2000) (10) Self-Presence Questionnaire (Ratan & Hasler, 2010); (11) The Gaming-Contingent Self-Worth Scale (12 items) (Beard, & Wickham, 2016) and; (12) Demographic and Internet Use Questions. The battery of questionnaires was utilized for both online and face-to-face data collection. The use of the fitness tracker (Fitbit flex) was used only for face-to-face data collection. It is noted that different parts of the present data has been used in two more published studies to address different research questions/hypotheses (Burleigh, Stavropoulos, Liew, Adams & Griffiths, 2017; Adams, Stavropoulos, Burleigh, Liew, Beard & Griffiths, 2018). *Note 2:* Statistical power was computed separately for the cross-sectional and the longitudinal sample. A probability error of .05, power (1- β error probability) of .95 and effect size of .15. was used for the cross-sectional sample (N=125) resulting to an observed statistical power of Powerα-β =.99 ($F_{(122)}$=3.92, λ=18.75). A probability error of .05, power (1- β error probability) of .95 and effect size of .25 was used for the longitudinal sample (N = 61) resulting to an observed statistical power of Powerα-β =.73 ($\alpha_{\text{error probability}}$= .27, $\beta_{\text{error probability}}$=.27, $F_{(2,61)}$= 1.34, *Pilai V*= .06, λ=3.81).

Note 3: In line with the approval received by the ethics committee of Federation University, the flyers: a) indicated that participants were required to participate on three separate measurement occasions approximately one month apart; b) included an email address to contact the investigators; and c) clearly described the process and stages of the data collection (face-to-face and online). MMO players, aged between 18-29 years old, interested in the study received the Plain Language Information Statement (PLIS). The PLIS clearly indicated that participation was voluntary and that participants could independently decide to withdraw from the study at any point. Individuals who choose to participate were required to provide informed consent.

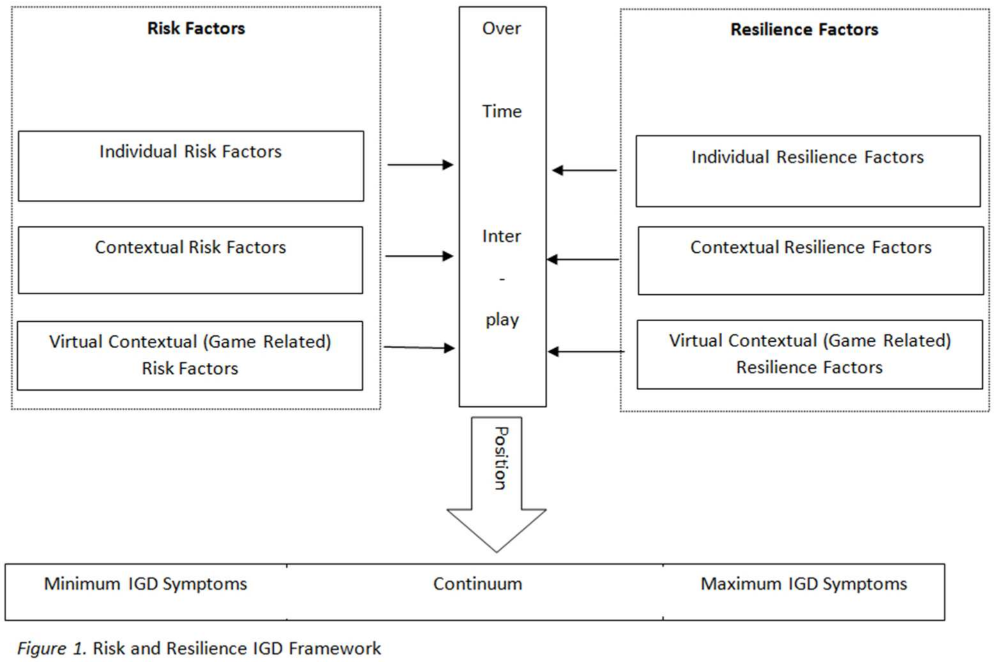

Figure 1. Risk and Resilience IGD Framework

190x128mm (120 x 120 DPI)

Table 1. Sociodemographic Characteristics of the Participants in the Study

Sociodemographic Variables		Face-to-Face (n = 61)	Online (n = 64)	Total (n = 125)
Gender	Male	45 (36.0%)	49 (39.2%)	94 (75.2%)
	Female	16 (12.8%)	15 (12.0%)	31 (24.8%)
Game Genre	MMOs	38 (30.4%)	43 (34.4%)	81 (64.8%)
	MMORPGs	23 (18.4%)	21 (16.8%)	44 (35.2%)
Highest level of Education	Year 7-10	4 (3.2%)	2 (1.6%)	6 (4.8%)
	Year 12	25 (20.0%)	21 (16.8%)	46 (36.8%)
	Tertiary Diploma	15 (12.3%)	17 (13.9%)	32 (26.2%)
	Undergraduate Degree	12 (9.8%)	15 (12.3%)	27 (22.1%)
	Postgraduate Degree	5 (4.0%)	9 (7.2%)	14 (11.2%)
Employment Status	Unemployed	1 (0.8%)	11 (8.8%)	12 (9.6%)
	Temporary Leave	2 (1.6%)	2 (1.6%)	4 (3.2%)
	Student	14 (11.2%)	10 (8.0%)	24 (19.2%)
	Casual Employment	15 (12.0%)	8 (6.4%)	23 (18.4%)
	Part-Time Employment	9 (7.2%)	8 (6.4%)	17 (13.6%
	Full-Time Employment	20 (16.0%)	25 (20.0%)	45 (36.0%)
Residing with	Family of origin (two parents and siblings if any)	11 (9.1%)	23 (19.0%)	34 (28.1%)
	Mother and siblings if any (parents divorced/separated)	2 (1.7%)	5 (4.1%)	7 (5.8%)
	Mother and siblings if any (father passed away)	2 (1.6%)	1 (0.8%)	3 (2.4%)
	Father and siblings if any (parents divorced/separated)	0 (0.0%)	1 (0.8%)	1 (0.8%)
	With partner	18 (14.9%)	16 (13.2%)	34 (28.1%)
	With partner and siblings	1(0.8%)	1 (0.8%)	2 (1.7%)
	Alone	1 (0.8%)	3 (2.5%)	4 (3.3%)
	With friends	13 (10.4%)	6 (4.8%)	19 (15.2%)
	Shared accommodation	13 (10.4%)	8 (6.4%)	21 (16.8%)

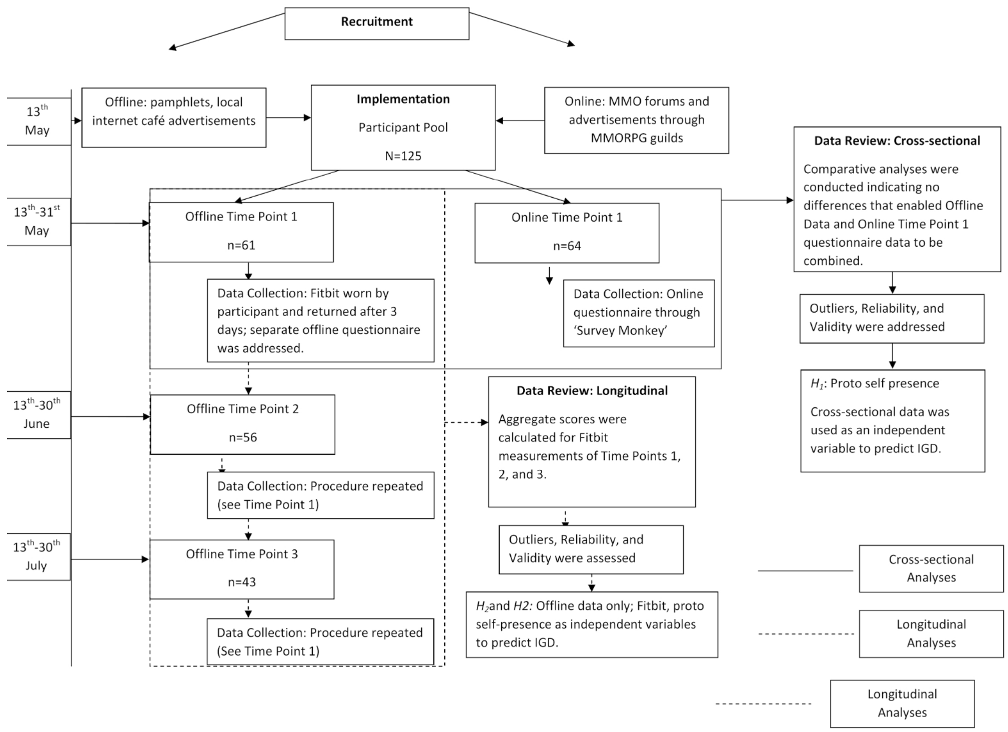

Figure 2. Visual Representation of the Present Study

776x599mm (72 x 72 DPI)

Appendix A1. Descriptive statistics and reliability coefficients per item and questionnaire/ measurement used

Time point (TP)	Data collection type		Minimum	Maximum	Mean	SD	*Cronbach's α if Item removed*
TP1	Face-to-Face	IGD1	1.00	5.00	3.18	1.09	.88
		IGD2	1.00	5.00	2.20	1.13	.86
		IGD3	1.00	5.00	2.07	1.04	.86
		IGD4	1.00	5.00	1.83	1.07	.86
		IGD5	1.00	5.00	1.97	1.07	.88
		IGD6	1.00	5.00	1.95	1.19	.87
		IGD7	1.00	5.00	1.75	1.13	.85
		IGD8	1.00	5.00	3.02	1.23	.88
		IGD9	1.00	4.00	1.52	.98	.98
	TP1 *N* = 61; TP1 Cronbach's α =.88; TP1 Cronbach's α Based on Standardized Items = .88						
TP2	Face-to-Face	IGD1	1.00	5.00	2.92	1.11	.87
		IGD2	1.00	5.00	2.12	1.12	.86
		IGD3	1.00	5.00	2.02	.97	.85
		IGD4	1.00	4.00	1.84	.89	.87
		IGD5	1.00	5.00	1.95	1.14	.88
		IGD6	1.00	5.00	1.97	1.22	.86

		IGD7	1.00	5.00	1.59	1.01	.86
		IGD8	1.00	5.00	2.86	1.25	.87
		IGD9	1.00	4.00	1.52	.88	.88
TP2 *N* =56; TP2 Cronbach's α= .88; TP2 Cronbach's α Based on Standardized items= .88							
TP3	Face-to-Face	IGD1	1.00	5.00	2.92	1.08	.83
		IGD2	1.00	5.00	2.03	1.11	.82
		IGD3	1.00	4.00	2.11	1.04	.81
		IGD4	1.00	5.00	1.74	.91	.82
		IGD5	1.00	5.00	2.01	.94	.83
		IGD6	1.00	5.00	1.87	1.05	.82
		IGD7	1.00	4.00	1.44	.74	.84
		IGD8	1.00	5.00	2.93	1.32	.81
		IGD9	1.00	4.00	1.39	.75	.84
TP3 *N* = 43; TP3 Cronbach's α = .84; TP3 Cronbach's α Based on Standardized items= .84							
TP1	Face-to-Face	PSP1	.00	4.00	1.13	1.32	.88
		PSP2	.00	4.00	.72	.99	.87
		PSP3	.00	3.00	.92	1.09	.89
		PSP4	.00	4.00	.52	.99	.88

		PSP5	.00	4.00	.52	.89	.89
TP1 *N* = 61; TP1 Cronbach's α= .90; TP1 Cronbach's α= Based on Standardized items= .91							
TP2	Face-to-Face	PSP1	.00	4.00	.83	1.16	.91
		PSP2	.00	4.00	.72	1.11	.89
		PSP3	.00	3.00	.87	1.08	.92
		PSP4	.00	4.00	.50	1.01	.91
		PSP5	.00	4.00	.58	1.00	.91
TP2 *N* = 56; TP2 Cronbach's α =.93; TP2 Cronbach's α Based on Standardized items= .93							
TP3	Face-to-Face	PSP1	.00	4.00	.86	1.16	.88
		PSP2	.00	4.00	.72	1.10	.89
		PSP3	.00	4.00	.81	1.06	.90
		PSP4	.00	4.00	.57	1.01	.88
		PSP5	.00	4.00	.74	1.03	.90
TP3 *N* = 43; TP3 Cronbach's α =.91; TP3 Cronbach's α Based on Standardized items= .91							
TP1		Active minutes	.00	263.00	71.03	71.03	
TP2		Active minutes	.00	258.33	80.21	80.21	
TP3		Active minutes	.00	259.00	75.98	56.66	

TP1	Online	IGD1	1.00	5.00	3.16	1.10	.94
		IGD2	1.00	5.00	2.15	1.19	.92
		IGD3	1.00	4.00	2.18	1.22	.92
		IGD4	1.00	5.00	2.00	1.18	.92
		IGD5	1.00	5.00	2.16	1.12	.93
		IGD6	1.00	5.00	2.17	1.42	.92
		IGD7	1.00	4.00	1.64	1.21	.92
		IGD8	1.00	5.00	2.84	1.49	.94
		IGD9	1.00	4.00	1.60	1.12	.92

TP1 Online *N* = 64; TP1 Online Cronbach's α = .93; TP1 Online Cronbach's α Based on Standardized items= .94

T1	Online	PSP1	.00	4.00	1.10	1.30	.91
		PSP2	.00	4.00	.56	1.01	.88
		PSP3	.00	4.00	.87	1.26	.89
		PSP4	.00	4.00	.37	.93	.88
		PSP5	.00	4.00	.32	.89	.91

T1 *N* = 64; T1 Cronbach's α .91; T1 Cronbach's α Based on Standardized items=.92

Table 2.PSP predicting IGD (Cross-section)

Variable	R^2	*b*	*SE*	*p*
Step 1	.05			
Age		-0.49*	0.23	-.190
Gender[a]		-2.18	1.72	-.110
Step 2	.20			
PSP		.81	.14	.001***
R^2	.25***			

Note, [a]0 = females, 1=males

*$p < .05$. **$p < .01$. ***$p<.001$

Table 3.PSP predicting IGD (Longitudinal)

Variable	R^2	*b*	*SE*	*p*
Step 1	.006			
Age		-0.10	0.26	-0.050
Gender[a]		-0.78	1.83	-0.060
Step 2	.36			
PSP		0.76	0.14	.001***
R^2	.37**			

Note, [a]0 = females, 1=males

*$p < .05$. **$p < .01$. ***$p<.001$

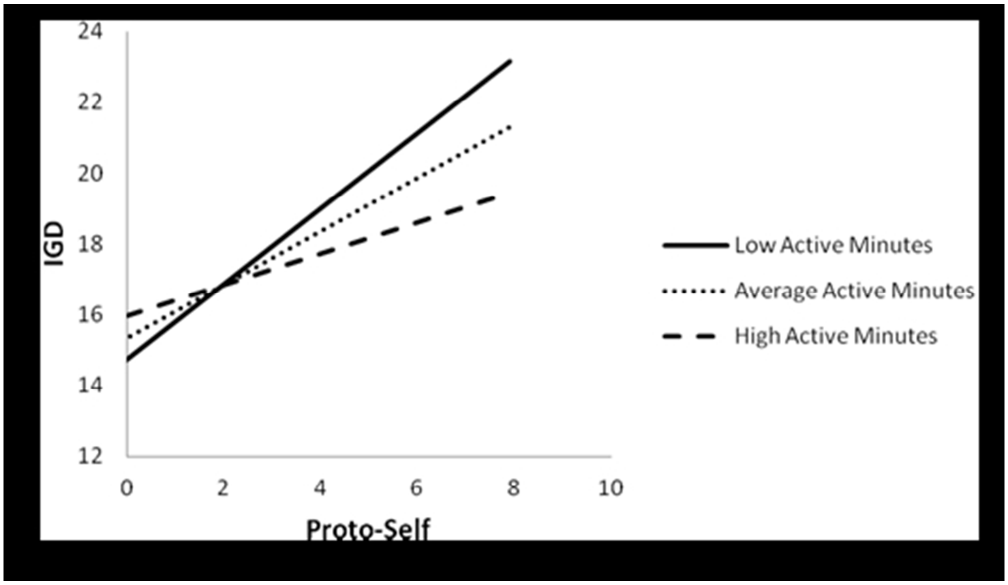

Figure 3. Moderation summary of PA (Active Minutes) on the relationship between Proto-self and IGD

141x81mm (96 x 96 DPI)

Appendix A2. Descriptive statistics of the aggregate study variables for offline and online data sets

Time point (TP)	Data collection type		Minimum	Maximum	Mean	SD
TP1	Face-to-Face	IGDT1	10.00	43.00	19.44	7.07
	TP1 *N* = 61					
TP2		IGDT2	9.00	38.00	18.80	6.91
	TP2 *N* =56					
TP3		IGDT3	9.00	33.00	17.95	5.93
	TP3 *N* = 43					
TP1	Face-to-Face	PSPT1	.00	19.00	3.75	4.52
	TP1 *N* = 61					
TP2		PSPT2	.00	18.00	3.20	4.55
	TP2 *N* =56					
TP3		PSPT3	.00	20.00	3.27	4.69
	TP3 *N* = 43					
TP1	Face-to-Face	ActiveMinT1	.00	263.00	71.03	66.77
	TP1 *N* = 61					
TP2		ActiveMinT2	.00	258.33	80.21	69.73
	TP2 *N* =56					

TP3		ActiveMinT3	.00	259.00	75.98	56.66
	TP3 $N = 43$					
TP1	Online	IGDT1	9.00	45.00	19.70	8.91
	T1 $N = 64$					
TP1	Online	PSPT1	.00	20.00	3.26	4.72
	T1 $N = 64$					