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How gaming motives affect the reciprocal relationships between video game use and quality of life: A prospective study using objective playtime indicators

Maxime Larrieu[a,*], Yoann Fombouchet[a], Joël Billieux[b,c], Greg Decamps[a]

[a] LabPsy UR4139, University of Bordeaux, France
[b] Institute of Psychology, University of Lausanne, Lausanne, Switzerland
[c] Centre for Excessive Gambling, Addiction Medicine, Lausanne University Hospitals (CHUV), Lausanne, Switzerland

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ABSTRACT

Previous studies have investigated the relationship between quality of life (QoL) and video game use. However, it remains to clarify the nature of these relationships. This longitudinal study investigated the links between two gaming-related variables – objective playtime indicators and self-reported gaming disorder (GD) symptoms – and QoL, while accounting for gamers' motivational background.

We longitudinally surveyed intensive gamers (final sample: $N_{T1} = 4772$, $N_{T2} = 2021$, $N_{T3} = 1128$), assessing gaming motives, GD symptoms, psychological correlates (impulsivity, personality, self-esteem), and health-related information (quality of life, anxiety and depression), while collecting objective behavioral data. Cluster analyses and random intercept cross-lagged panel models were performed to identify subgroups and investigate gaming-related variables-QoL relationships.

Cluster analysis identified two non-problematic (competitive and recreational) and one vulnerable (escapers) gamer subtypes. Random intercept cross-lagged panel models only showed between-person effects regarding the GD symptoms-QoL relationship. No effects were found concerning the objective playtime-QoL relationship. Results did not differ across motivational profiles.

In line with previous research, our data support the common causes hypothesis, which posits that GD symptoms-impaired QoL association results from shared risk factors, such as specific personality traits and impulsivity. Clinical assessment and prevention efforts should focus on these common causes and on gamers' motivational background. Intensive involvement may not be in itself problematic.

1. Introduction

Playing video games has become a widespread leisure activity around the world (Newzoo, 2021) and constitutes a hobby that provides many cognitive, emotional, and social benefits (Granic et al., 2014; Halbrook et al., 2019). However, a substantial part of the scientific literature has focused on the potential negative effects of video games in an effort to address the growing concerns raised by families, clinicians, and governments.

The American Psychiatric Association (APA) for the first time introduced internet gaming disorder (IGD) as "a condition for further study" in section 3 of the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; APA, 2013). IGD was defined as a "persistent and recurrent use of the Internet to engage in games, often with other players, leading to clinically significant impairment or distress." In 2019, gaming disorder (GD) was introduced as a disorder due to addictive behavior in the *International Statistical Classification of Diseases and Related Health Problems* (11th ed.; *ICD-11*; World Health Organization, 2019). This decision was notably fostered by evidence showing that problematic gaming patterns can be functionally impairing and that treatment demand was increasing worldwide (Billieux et al., 2021; Reed et al., 2022).

Although the decision to include GD in the *ICD*-11 has been welcomed from a public health perspective (Rumpf et al., 2018; Saunders et al., 2017), there is ongoing debate about the recognition of GD as a legitimate disorder. Indeed, a group of scholars has systematically

* Corresponding author. 3 ter Place de la Victoire Bâtiment A 33076 Bordeaux CEDEX
E-mail address: m.larrieu.phd@gmail.com (M. Larrieu).

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questioned the theoretical validity of GD and its supporting evidence, pointing to the risks of moral panics and pathologization of healthy gaming (Aarseth et al., 2017; Van Rooij et al., 2018). Given the ubiquity of gaming, and the fact that intensive gaming is not necessarily problematic (Charlton & Danforth, 2007; Kiraly et al., 2017), negative consequences and functional impairment are an essential feature of GD (Billieux et al., 2017, 2019).

In consideration of this perspective, several studies have explored the relationships between GD symptoms and quality of life (QoL) and obtained mixed results. QoL is defined by the World Health Organization Quality of Life (WHOQOL) WHOQOL Group (1998) as "individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns." Several cross-sectional and longitudinal studies reported an association between GD symptoms and deterioration of various QoL indicators (for reviews, see González-Bueso et al., 2018; Saunders et al., 2017). In contrast, other studies have shown that GD symptoms were not necessarily associated with a deterioration of QoL (Przybylski et al., 2017; Weinstein et al., 2017) and that the inclusion of functional impact in the assessment of GD resulted in a considerable decrease in its estimated prevalence (Borges et al., 2021; Przybylski et al., 2017). However, an important caveat of previous research is that it comprises a substantial number of studies that used non-valid criteria or symptoms to define GD, or failed to take into account functional impairment or diminished QoL (for critical accounts, see Billieux et al., 2019; Castro-Calvo et al., 2021), thus promoting the over-pathologization of gaming behavior.

Another point at the heart of the controversies surrounding the recognition of GD as a mental condition pertains to its relationships with comorbid psychopathological states. In particular, the debate has revolved around the potential causal relationships between GD symptoms and other variables such as emotional symptoms (e.g., depression, anxiety) or QoL (Wartberg et al., 2019; Weinstein et al., 2017). From this perspective, it has been argued that GD is not a disorder per se, but rather the consequence of other psychological problems (Van Rooij et al., 2018). Different frameworks and etiologies have been proposed to account for GD symptoms. First, the *compensation hypothesis* (QoL→GD) posits that problematic gaming results from the motivation to relieve negative emotional states or avoid life problems through video game overinvolvement (Bányai, Griffiths, Demetrovics, & Király, 2019; Biolcati et al., 2020). Poor QoL is supposed to precede GD symptoms, implying that GD might be conceptualized as a dysfunctional coping strategy (Kardefelt-Winther, 2017; Laconi et al., 2017). Second, the *common cause hypothesis* (QoL←X→GD) posits that GD symptoms and compromised QoL result from shared risk factors (Hygen, Skalická, et al., 2020). Candidate risk factors include psychological needs fulfilment (Weinstein et al., 2017) or specific personality traits (Kotov et al., 2010; Müller et al., 2014). Third, the *bidirectionality hypothesis* (QoL↔GD) proposes that GD and comorbid psychopathological states reinforce each other through a vicious cycle (Krossbakken et al., 2018; Lemmens et al., 2011). Fourth, the *displacement hypothesis* (GD→QoL) considers the heavy use of video games as the primary cause leading to functional impairment (at the educational, social, or physical level) and poor QoL (Baggio et al., 2016). The displacement hypothesis aligns with the *DSM-5* and *ICD-11* conceptualizations of GD, in which the gaming behavior is viewed as causing functional impairment. Yet, an important difference between the displacement hypothesis and the *DSM-5* and *ICD-11* conceptualizations is that heavy usage per se is not an essential feature of GD according to *ICD-11* and *DSM-5*, even though these manuals report that affected individuals typically spend a lot of time (e.g., up to 8–10 h per day) playing video games.

Several studies reported a negative association between self-reported playing time and psychological health (Messias et al., 2011; Wenzel et al., 2009), physical health (for a review, see Huard Pelletier et al., 2020), and social competence (Hygen, Belsky, et al., 2020). Yet, previous research overly relied on cross-sectional designs, and recent results obtained via prospective designs suggest that higher use of screens (in general, not specifically for gaming) by children and adolescents might reflect psychological distress rather than causing it (Bado et al., 2020). The attempt to identify a simple "dose-response" relationship between playtime and functional impairment has been heavily criticized in previous years (Orben, 2022; Orben et al., 2020). In fact, several studies showed that intensive use of video games is not necessarily problematic at all and that intensive – but healthy – involvement has to be distinguished from intensive but problematic involvement (Billieux et al., 2013; Charlton & Danforth, 2007; Demetrovics & Király, 2016; Király et al., 2017). This distinction is also relevant in relation to e-sport and the professionalization of gaming (Bányai, Griffiths, Demetrovics, & Király, 2019; Brevers et al., 2020).

Against this background, and in line with what has been suggested in the context of problem gambling research (Clark, 2015; Korn & Shaffer, 1999), it can be assumed that GD symptoms would result from the interaction between the structural characteristics (or design features) of video games and individual vulnerabilities. Several studies have shown that, among these individual factors, the motivations underlying gaming behaviors play a central role in the development of healthy versus pathological gaming patterns. Indeed, previous research has shown that the impact of time spent playing on QoL is dependent on gaming motives (Halbrook et al., 2019; Hellström et al., 2012, Hellström, Nilsson, Leppert, & Åslund, 2015; Shen & Williams, 2011), with risks being greater in playing behaviors motivated by escapism, status gains, or the demands from others, and less important for those who play mainly for fun or social motives.

The study of gaming motives therefore appears to be central to a better understanding of the complex and dynamic relationships of playing time, QoL, and GD. Although some authors have documented the prospective links between GD and QoL (Hygen, Skalická, et al., 2020; Lemmens et al., 2011; Richard et al., 2020; Wartberg et al., 2019) or between playtime and QoL (Brunborg et al., 2014; Mikuška & Vazsonyi, 2018), only a few longitudinal studies have examined the extent to which the motivational background of players is involved in these relationships (for a longitudinal study anchored in the self-determination theory, see Weinstein et al., 2017).

An important limitation of the available literature on problem gaming is that it mainly relies on self-reports, and studies that have capitalized on objective playtime indicators are scarce (Caplan et al., 2009; Johannes et al., 2021; Shen & Williams, 2011; Vuorre, Johannes, Magnusson, & Przybylski, 2022). Indeed, it has been shown that self-reported behaviors related to the use of technology are a poor indication of actual behaviors (Johannes et al., 2021; Parry et al., 2021). This finding brought some authors to support the necessary collaboration with the video game industry to (1) obtain objective behavioral indicators (Griffiths & Pontes, 2020) and (2) improve access to specific populations such as highly engaged players (Billieux et al., 2021). Despite recent efforts, this type of collaboration remains especially rare (Johannes et al., 2021; Shen & Williams, 2011; Vuorre et al., 2022).

1.1. The present research

In this study, we aimed to investigate the links between gaming patterns and QoL from a longitudinal perspective, while taking into account the motivational background of gamers. To this end, and following an approach used in our previous research (Larrieu et al., 2022), we first profiled engaged gamers on the basis of their motivations and analyzed whether these profiles can be differentiated in terms of problematic gaming patterns and QoL. We sought to establish the validity of the clusters identified by comparing them with known risk factors for problematic video gaming involvement (i.e., Big Five personality traits, self-esteem, anxiety, depression, and trait impulsivity; for the selection of these candidate risk factors, see reviews by King & Delfabbro, 2018; King et al., 2019). We then prospectively tested the relationships between gaming patterns (both GD symptoms and objective playtime indicators) and QoL in terms of the motivational profiles identified. Our goal was to use this longitudinal analysis to address various hypotheses: compensation, common cause, bidirectionality, and displacement. In accordance with recent calls regarding the need for industry support of research on problematic gaming (Billieux et al., 2021; Griffiths et al., 2016) and the suggestion that self-reported measures of time spent playing tend to be flawed (Johannes et al., 2021; Parry et al., 2021), in the current study, we capitalized on objective playtime indicators obtained in the context of a specific video game.

1.2. Transparency and openness

The present study was not preregistered. Due to the industrial property of the data, sharing is not legally permissible. We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. In view of the legislation in force in the country in which the study was conducted, no accreditation by ethics committees was required due to the anonymous and non-interventional nature of the study.

2. Method

2.1. Participants and procedure

This study was conducted in collaboration with Ubisoft in order to build a database that combined objective playtime indicators with participants' responses to psychometric questionnaires. To specifically address questions related to the effects of competitive multiplayer online games, we decided to survey players of Rainbow Six Siege, an online competitive first-person shooter (FPS) game. Beyond the previously discussed scientific interest in studying a competitive multiplayer FPS, we studied a particular game because incorporating different player populations risks mixing gamers with very different psychological characteristics and motivational backgrounds, which can lead to inconsistent results (King et al., 2019). Furthermore, we selected the most engaged adult players (18 years old or more) from the Ubisoft database, based on their overall playing time, the month prior to the start of the study. This allowed us first, to ensure the inclusion of engaged gamers and second, to limit the risks of attrition. To achieve this, we systematically compensated participation in each measurement period of the study in the form of in-game cosmetic items ("skins"), following the same approach as that used by Caplan et al. (2009) or more recently by Schimmenti et al. (2017).

Although the effects of video game use are generally considered to occur in the short term (<3 months; King & Delfabbro, 2018), a substantial portion of previous prospective studies on problematic gaming relied on a period of 6 months to 1 year (for a review, see Richard et al., 2020). Thus, we initially opted for a 5-point measurement design with a 5-week interval between measurements, taking place between January and June 2020. In the end, because of the amount of missing data in waves four and five, we decided to capitalize only on the first three measurement points, which is the minimum required to guarantee the feasibility of our statistical approach (random intercept cross lagged panel models [RICLPMs]; see data analytic section). In particular, objective playtime indicators tended to become "zero-inflated" at T4 and T5, leading to model convergence problems.

The COVID-19 pandemic and related lockdowns complicated the data collection process, making it impossible to maintain strict equivalence between measurement intervals (T1-T2 = 43 days, T2-T3 = 38 days, T3-T4 = 31 days, T4-T5 = 31 days). Nonetheless, all assessments were conducted at the same times for all participants (Collins & Graham, 2002) and over a long enough period of time to enable us to detect potential change (Ployhart & Ward, 2011).

Of 76,920 invitations sent, 7202 individuals participated in the study at T1 (corresponding to a response rate of 9.36%), 2480 at T2, and 1311 at T3. We excluded identifiers that were found more than once and prevented pairing with objective playtime indicators ($n_{T1} = 474$, $n_{T2} = 160$, $n_{T3} = 44$). We decided to remove participants whose responses were flagged as spam ($n_{T1} = 1262$, $n_{T2} = 124$, $n_{T3} = 28$), and whose completion time for the questionnaire was below the 5th percentile, as suggested by Carver (1992) ($n_{T1} = 154$, $n_{T2} = 95$, $n_{T3} = 61$). Participants who did not complete at least the questionnaires related to gaming motives and QoL questionnaires were also excluded, given the importance of these measures in the study ($n_{T1} = 540$, $n_{T2} = 80$, $n_{T3} = 50$). Because of the trait-like nature of impulsivity and personality and because we were interested in motivations to play at T1 only to extract motivational clusters, all questionnaires were included at T1, and only the questionnaires assessing QoL (WHOQOL), anxiety and depression (Hospital Anxiety and Depression Scale [HADS]), self-esteem (Rosenberg Self-Esteem Scale [RSES]), and GD symptoms (IGD Scale) were included at T2 and T3.

The final sample included 4772 participants at T1, 2021 at T2, and 1128 at T3. However, the sample size varied across analyses conducted because of missing data. Participants had an average age of 21.38 years (minimum = 18 years, maximum = 69 years, $SD = 5.37$) and 94.7% were male, 4.4% female, and 0.9% other genders, which matches the characteristics of other samples of engaged gamers (Bányai, Griffiths, Demetrovics, & Király, 2019; Larrieu et al., 2022).

2.2. Measures

2.2.1. Gaming motives

The Motives for Online Gaming Questionnaire (MOGQ; Demetrovics et al., 2011; French version: Laconi et al., 2017) is composed of 27 items rated on a 5-point scale ranging from 1 (*almost never/never*) to 5 (*almost always/always*). It measures different types of gaming motives, including seven dimensions: social (e.g., "I play online games because I can get to know new people"), escape (e.g., "I play online games because it makes me forget real life"), competition (e.g., "I play online games because I enjoy competing with others"), coping (e.g., "I play online games because it helps me get rid of stress"), skill development (e.g., "I play online games because it improves my skills"), fantasy (e.g., "I play online games to be somebody else for a while"), and recreation (e.g., "I play online games for recreation"). A higher score indicates that the motive concerned is stronger for the gamer. The omegas obtained from the scores in our study were satisfactory (all $\omega > 0.70$).

2.2.2. Quality of life

The WHOQOL short version (WHOQOL-BREF; WHOQOL Group, 1998; French version: Baumann et al., 2010) is a 26-item questionnaire rated from 1 to 5 (response modalities vary depending on the domains explored) that explores physical health (seven items, e.g., "How much do you need any medical treatment to function in your daily life?"), psychological health (six items, e.g., "How much do you enjoy life?"), social relationships (three items, e.g., "How satisfied are you with your personal relationships?"), environmental QoL (eight items, e.g., "How safe do you feel in your daily life?"), and two overall QoL items (e.g., "How would you rate your quality of life?"). A higher score indicates a higher QoL. The omegas obtained from the scores in our study were satisfactory for all measurement times ($\omega > 0.70$), except for the social relations dimension ($\omega_{T1} = 0.66$, $\omega_{T2} = 0.67$, $\omega_{T3} = 0.69$). Moreover, we decided to remove Item 21 concerning sexual satisfaction because the General Data Protection Regulation (GDPR; European Commission, 2021) requires informing participants that they will be asked questions on this subject when collecting their consent (sensitive data), which would have in our view compromised the recruitment process by discouraging participation.

2.2.3. GD symptoms

The IGD Scale assesses GD symptoms on the basis of *DSM-5* criteria (APA, 2013) and comprises nine items that assess the corresponding

DSM-5 criteria. A high score indicates more GD symptoms. To measure GD within the conceptual framework of the *ICD-11* and given the absence of a validated tool in English and French at the time of the study, we decided to use the four *DSM-5* criteria that overlap with the *ICD-11* clinical guidelines for GD (as done previously by, e.g., Jo et al., 2019; Ko et al., 20120. The items retained were as follows: Item 4 (loss of control), Item 5 (loss of interest in other activities), Item 6 (continuation despite knowledge of negative consequences), and Item 9 (loss of a relationship or job because of the activity). This choice is also in line with recent work showing the sound diagnostic validity, clinical relevance, and prognostic value of these criteria, and the fact that other *DSM-5* criteria (e.g., tolerance) are not valid indicators of problematic gaming (Castro-Calvo et al., 2021). To identify individuals with GD, we applied a monothetic and conservative approach, as suggested by the WHO (for the rationale, see Billieux et al., 2019, 2021) to ensure that we were not pathologizing intensive but healthy gaming patterns (Borges et al., 2021; Mentzoni et al., 2011).

2.2.4. *Personality traits*

The Big Five Inventory (John et al., 1991) is a 44-item questionnaire that contains an additional item in the French version (Plaisant et al., 2010). It provides scores rated on a 5-point Likert scale from 1 (*disagree strongly*) to 5 (*agree strongly*) for each of the five personality dimensions according to Costa and McCrae's (1992) five-factor model: Openness (e.g., "I am someone who has an active imagination"), Conscientiousness (e.g., "I am someone who is a reliable worker"), Extraversion (e.g., "I am someone who is talkative"), Agreeableness (e.g., "I am someone who has a forgiving nature"), and Neuroticism (e.g., "I am someone who is depressed, blue"). The omegas obtained from the scores in our study were satisfactory ($\omega > 0.70$), except for the recreation dimension ($\omega = 0.53$). Because of the presence of only three items in the dimension, it was not possible to exclude items to improve reliability.

2.2.5. *Impulsivity traits*

The Barratt Impulsiveness Questionnaire is one of the most widely used questionnaires for assessing impulsivity. Here we used the brief version provided by Spinella (2007; French version: Rousselle & Vigneau, 2016), which includes 15 items rated on a 4-point Likert scale ranging from 1 (*rarely/never*) to 4 (*almost always/always*), providing a score for each. This scale measures three subdimensions: motor impulsivity (e.g., "I act on impulse"), attentional impulsivity (e.g., "I concentrate easily"), and non-planning impulsivity (e.g., "I plan tasks carefully"). The French version supports the use of a single impulsivity score, but we decided to keep the three original subscales to allow comparability with previous research conducted with the original version. Higher scores indicate greater impulsivity. The omegas obtained from the scores of our study were satisfactory ($\omega > .70$) except for the attentional impulsivity dimension ($\omega = 0.67$).

2.2.6. *Self-esteem*

The RSES (Rosenberg, 1965; French version: Vallieres & Vallerand, 1990) is a 10-item questionnaire rated on a 4-point Likert scale ranging from 1 (*strongly agree*) to 4 (*strongly disagree*) that measures self-esteem (e.g., "On the whole, I am satisfied with myself"). A higher score indicates greater self-esteem. The omegas obtained from the scores in our study were satisfactory ($\omega > 0.70$).

2.2.7. *Anxiety and depression*

The HADS (Lépine et al., 1985; Zigmond & Snaith, 1983; French version) is a 14-item scale that measures depression (seven items, e.g., "I feel as if I am slowed down") and anxiety (seven items, e.g., "Worrying thoughts go through my mind") rated on a 4-point Likert scale (response modalities vary depending on the items). Total scores range from 0 to 21 for each subscale. A higher score indicates higher depression or anxiety symptoms. The omegas obtained from the scores in our study were satisfactory ($\omega > 0.70$).

2.2.8. *Objective gaming behavior*

Objective playtime indicators were collected, corresponding to players' activity during the month prior to each measurement. In line with the literature (Higuchi et al., 2021; Triberti et al., 2018), we used a granular approach to indicators of playing time: total playing time, weekend/weekday playing time, and maximum playing duration in a single session. The data collected represent playing activity during the 30 days prior to the start of the study (T1) and during each measurement interval (T2 and T3). Because of the different measurement intervals, we transformed the playing time indicators by dividing them by the number of days in each measurement period to obtain the number of hours of play per average day, hours of play per weekday, and hours of play per weekend day. The indicators of maximum duration of the game sessions were not transformed. Only the indicators for player versus player (PvP) mode were used, as the study focused on competitive gaming and because the initial APA conceptualization of GD specifically refers to PvP playing (*DSM-5*; APA, 2013). Self-reported playtime was also obtained, by asking participants to self-report how much time they played on average per week (separetely for Rainbow Six: Siege and for other games).

2.2.9. *Sociodemographic variables*

Self-reported sociodemographic information was obtained by asking questions regarding age, gender (male, female, other), relationship (single, in a relationship, married, divorced, widowed) and occupational status (employed, self-employed, out of work, student, retired), professional gaming status (yes or no), or having plans to become a professional gamer (yes or no).

2.3. *Ethics*

The questionnaires were preceded by an information letter informing the participants of the procedure, the objectives of the study, and all aspects of the research. Informed consent was then obtained from the participants. Participants' informed consent was also related to the sharing and systematic collection of in-game behavioral data. All participants were aged 18 years or older. Participants had the opportunity to not answer items, withdraw from the study at any time, and request deletion of their data.

For each measurement occasion, Ubisoft sent an email to participants to invite them to participate in the study, inform them about the compensation associated with their participation, and send them the survey on an online survey platform (Qualtrics). Each participant was assigned an encrypted ID to allow Ubisoft to provide us with behavioral data by using a matching table. The questionnaire was set up by the principal investigator only, on a dedicated account that was independent and not accessible by Ubisoft. As a result, Ubisoft had no role in the questionnaire design and research objectives, nor in the analysis of the data or the writing of the manuscript. In order to ensure the independence and ethics of the research as well as compliance with the GDPR, the first and last authors collaborated with Ubisoft's technical and legal teams to design the most appropriate data sharing strategy. The other authors had no contact at all with Ubisoft.

2.4. *Statistical analysis*

Following an approach that we used in a previous study conducted on an independent sample (Larrieu et al., 2022), we first aimed to extract motivational profiles by using a hierarchical clustering analysis, which groups participants on the basis of their motivations (MOGQ scores). The analysis was performed with standardized values (*Z*-scores) to give equivalent weight to each of the questionnaire dimensions. The partition was then consolidated through a k-means algorithm by using the method suggested by Husson et al. (2010). Group scores were then compared for all variables measured at T1 with multivariate analyses of variance (MANOVAs). Subsequent univariate analyses were performed by using ANOVAs with a Welch correction. Differences in demographic variables were examined with ANOVAs and chi-square tests. Post hoc tests were performed by using Games-Howell tests.

A substantial number of previous longitudinal studies used cross-lagged panel models (CLPMs) to test reciprocal effects. However, this statistical approach might be biased because of the lack of distinction between intra- and inter-individual effects. Such a limitation can be addressed by instead relying on RICLPMs (Hamaker et al., 2015; Usami et al., 2019). Crucially, such a modeling approach allows optimal testing of the various hypotheses identified in the literature regarding the relationships between GD symptoms and QoL (Hygen, Skalická, et al., 2020). In addition to testing for prospective within-person effects (compensation [QoL→GD], displacement [GD→QoL], and bidirectionality [QoL↔GD] hypotheses), the RICLPMs allow for the investigation of between-person effects, which refers to the common cause hypothesis (QoL←X→GD).

From a theoretical standpoint, we can expect different effects across measurement times. For example, playing a lot during the week does not necessarily affect daily life in the same way during a period of confinement, such as what took place during COVID-19, as it does at other times. Furthermore, data collection began before the COVID-19 pandemic and continued while it occurred, forcing us to not consider the measurement times as “equivalent.” Thus, we did not constrain the coefficients to equality between measurement times.

For all RICLPMs, a model that included the full sample was first tested. In a second step, the moderation effect of motivational clusters was tested by comparing a multigroup model that specified no constraints between groups with a multigroup model in which the regression coefficients were constrained to be equal between groups (Mulder & Hamaker, 2021). A Satorra-Bentler chi-square test was then performed to test whether this constraint could be imposed without reducing the model adjustment. If the test result was nonsignificant, potential group effects were not investigated. This approach allowed us to investigate whether the relationships between GD and QoL differed depending on the motivational profiles.

For all RICLPMs, the maximum likelihood estimator with robust standard errors was used and missing data were handled with full information maximum likelihood.

Outliers on the variables measured were checked and kept because they were not due to coding errors. Regarding the objective playtime indicators, some outliers indicated high but plausible values and were kept, considering that they belonged to our sample of highly involved players. However, as our study was not preregistered and because some outliers indicated much higher playtime, results without those outliers are also reported (Leys et al., 2019).

During the review process, we were asked to comment about the potential effect of common method biases. Several approaches have been used to reduce these biases in our study, including reverse-scored items, different response modalities, randomization of questionnaires order, as well as capitalizing on data obtained from different sources (self-reported and objective data) and using a longitudinal design. Yet, following the comment of a reviewer and to strengthen the robustness of our results, we also computed a post-hoc Harman single factor test for each measurement time which included all items measured by the questionnaires (Jordan & Troth, 2020). The results of the confirmatory factor analyses showed that the % of variance explained by the single factors was less than 50% for the three measurement times (T1 = 15%, T2 = 29%, T3 = 30%), which suggests an absence of common method bias.

All analyses were performed by using R software (v 4.1.0). We used the FactoMineR package to conduct cluster analysis (Lê et al., 2008), Lavaan package (Rosseel, 2012) for RICLPMs, and the tidySEM (Van Lissa, 2019; 2021) package for the models’ graphical representations.

3. Results

3.1. Descriptive analysis

Participants played an average of 12.74 h per week (*SD* = 5.18) of Rainbow Six Siege. In contrast, self-reported game time was 22.66 h (*SD* = 16.03), which translates into over-reporting of overall playtime by an average of 10 h. A weak and positive correlation was observed between self-reported and actual overall playtime ($r_\tau = 0.17$, $p < .001$). The reported time dedicated to other games was 12.51 h per week (*SD* = 14.77). Descriptive statistics for objective playtime indicators are shown in Table 1.

The prevalence of GD by using a monothetic approach (presence of all four *ICD-11* clinical guidelines for GD as assessed by the corresponding *DSM-5* criteria) was estimated to be 4.33% at T1, 4.34% at T2, and 5.47% at T3. For diagnostic purposes, however, it was necessary to consider the temporal stability of the disorder, as it must be present for at least 12 months (World Health Organization, 2019). Seventeen participants who completed all three measures met all four criteria at T1, T2, and T3, representing a prevalence of 1.64% (named “GD group”), consistent with a recent meta-analysis reporting an estimated prevalence of the disorder of 1.96% (Stevens et al., 2021). The characteristics of these participants can be found in Table 2.

3.2. Cluster analysis

A three-cluster solution was found on the basis of inertia gain and theoretical relevance. Escape motivation was the most influential variable in the partitioning ($\eta^2 = 0.51$, $p < .001$). A first cluster (Cluster 1) was characterized by lower motivation scores in all dimensions of the MOGQ (especially for skill development), except for recreation, which was the highest motivation score in this cluster and was thus labeled “recreational” (*N* = 1,422, 33% of the total sample). Cluster 2 was characterized by intermediate scores in all dimensions, which were higher than those of Cluster 1 (except for escape) and lower than those of Cluster 3 (except for recreation). The highest motivation scores in this cluster were competition and skill development; this cluster was thus labeled “competitive” (*N* = 1,586, 36% of the total sample). A third cluster (Cluster 3) was characterized by overall higher scores than in Cluster 1 and Cluster 2 in all MOGQ dimensions (except for recreation). The highest motivation scores in this cluster were escape, skill development, and coping; this cluster was thus named “escapers” (*N* = 1,370, 31% of the total sample).

3.3. Cluster validation on internal variables at T1: MOGQ scores

A one-way MANOVA was performed to assess the observed motivational differences between clusters at T1. It yielded a multivariate significant effect of cluster membership on the investigated motivational scores, Pillai’s trace = 1.09, $F(14, 8740) = 752.21$, $p < .001$. All follow-up univariate analysis yielded statistically significant differences between clusters. The results of these analyses and Games-Howell post hoc tests are presented in Table 3. Graphic representation of the standardized average scores is presented in Fig. 1. All effect sizes were considered large (Cohen, 1988), ranging from $\eta^2_G = 0.16$ for recreation to $\eta^2_G = 0.51$ for escape.

Table 1
Objective playtime indicators at T1, T2, and T3.

Variable	T1	T2	T3
Total playtime, *M* (*SD*) (hrs/day)	1.82 (0.74)	1.57 (0.90)	1.58 (1.03)
Week playtime, *M* (*SD*) (hrs/day)	1.82 (0.79)	1.43 (0.89)	1.53 (1.01)
Weekend playtime, *M* (*SD*) (hrs/day)	1.80 (0.92)	1.97 (1.28)	1.82 (1.28)
Maximum session time, *M* (*SD*) (hrs)	4.45 (1.71)	4.25 (1.80)	3.88 (1.82)

Table 2
Descriptive statistics at T1 for the total sample and GD group.

Variable	Total sample $N = 4772$ *M* (*SD*)	GD group[3] $n = 17$ *M* (*SD*)	
			Norms 25th centile[a]
WHOQOL			
Psychological health	21.25 (4.80)	16.41 (5.04)	17.49
Physical health	27.80 (4.25)	23.06 (3.88)	26.25
Social relationships	7.41 (1.84)	6.12 (1.62)	–
Environment	31.18 (5.21)	29.71 (4.66)	–
GD symptoms	1.20 (1.12)	4.00 (0.00)	
RSES	28.80 (6.07)	24.18 (7.10)	
HADS			HADS cutoff[b]
Anxiety	6.60 (3.91)	10.94 (4.64)	>8 (mild) > 11 (moderate)
Depression	4.96 (3.50)	8.47 (3.95)	>8 (mild) > 11 (moderate)
BFI-Fr			
Openness	3.52 (0.57)	3.36 (0.52)	
Conscientiousness	3.38 (0.65)	2.92 (0.67)	
Extraversion	3.04 (0.82)	2.55 (0.71)	
Agreeableness	3.66 (0.62)	3.40 (0.50)	
Neuroticism	2.76 (0.81)	3.61 (0.83)	
BIS-15			
Attentional impulsivity	9.91 (2.86)	12.71 (4.21)	
Non-planning impulsivity	11.10 (3.00)	13.29 (1.61)	
Motor impulsivity	10.44 (3.08)	11.59 (3.24)	
Total playtime *M* (*SD*) (hrs/day)	1.82 (0.74)	1.64 (0.41)	
Week playtime *M* (*SD*) (hrs/day)	1.82 (0.79)	1.72 (0.40)	
Weekend playtime *M* (*SD*) (hrs/day)	1.80 (0.93)	1.47 (0.60)	
Maximum session time *M* (*SD*) (hrs)	4.45 (1.71)	4.50 (1.42)	

Note. BFI-Fr = French Big Five Inventory, BIS-15: short form of the Barratt Impulsiveness Scale; GD = gaming disorder; HADS = Hospital Anxiety and Depression Scale; RSES = Rosenberg Self-Estimate Scale; WHOQOL = World Health Organization Quality of Life.
[c]GD group = participants endorsing all four GD criteria at T1, T2, and T3 (n = 17).
[a] Baumann et al. (2010); men 18–24 years old.
[b] Stern (2014).

3.4. Cluster validation on external variables at T1

3.4.1. Socio-demographic variables

Regarding socio-demographic variables, significant differences were found for age, $F(2, 2872.6) = 7.98$, $p < .001$, $\eta^2_G = 0.004$: players from the escaper cluster were significantly younger ($p < .05$), but considering the very small effect size, it is not possible to consider this result as meaningful. Significant differences were found for gender, $\chi^2(4, N = 4341) = 16.11$, $p < .01$: The proportions of males in the competitive cluster and females in the escaper cluster were significantly larger ($p < .001$). Significant differences were found for relationship status, $\chi^2(4, N = 4734) = 27.90$, $p < .001$: Players from the competitive cluster were more frequently in a relationship ($p < .001$) and players from the escaper cluster were less frequently married ($p < .05$), in contrast to players from the recreational cluster who were more frequently married ($p < .001$). Finally, significant differences between clusters were found regarding the proportion of professional gamers, $\chi^2(2, N = 4335) = 19.83$, $p < .001$, and participants wishing to become professional gamers, $\chi^2(2, N = 4330) = 150.55$, $p < .001$, who were more frequently found in the escaper cluster ($p < .001$). No significant differences were found regarding occupational status.

3.4.2. External variables

Three one-way MANOVAs were performed to determine the effects of cluster membership on external variables. It yielded a multivariate significant effect for (i) QoL (WHOQOL), GD symptoms (IGD Scale), self-esteem (RSES), and anxiety and depression (HADS), Pillai's trace = 0.13, $F(16, 7866) = 32.\ 26$, $p < .001$; (ii) personality (Big Five Inventory), Pillai's trace = 0.10, $F(12, 7186) = 32.71$, $p < .001$; and (iii) impulsivity (short form of the Barratt Impulsiveness Scale), Pillai's trace = 0.07, $F(6, 8276) = 49.05$, $p < .001$. All follow-up univariate analysis yielded statistically significant differences between clusters ($p < .001$). The highest effect sizes were for anxiety ($\eta^2_G = 0.085$), self-esteem ($\eta^2_G = 0.074$), and neuroticism ($\eta^2_G = 0.071$). The results of these analyses and Games-Howell post hoc tests are presented in Table 4.

Overall, competitive players had the highest scores for self-esteem, psychological and physical health, social relationships, environmental QoL, extraversion, conscientiousness, and agreeableness, as well as the lowest scores for anxiety, depression, non-planning impulsivity, and neuroticism. Escaper players had the lowest scores for self-esteem and psychological and physical health, as well as the highest scores for neuroticism, motor and attentional impulsivity, GD symptoms, anxiety and depression. Finally, the scores for recreational players were intermediate between the other two clusters, except for higher levels of "non-planning" impulsivity and lower levels of openness.

3.4.3. Objective playtime indicators: weekday playtime, weekend day playtime, and maximum session playtime

A one-way MANOVA was performed to determine the effects of cluster membership on objective playtime indicators. It yielded no significant effect, Pillai's trace = 0.00, $F(6, 8022) = 0.57$, $p = .76$.

4. Random intercept cross-lagged panel models

4.1. GD symptoms and QoL RICLPMs

To investigate the prospective within-person effects between GD symptoms and QoL while accounting for time-invariant between-person differences, we specified three RICLPMs, one for each QoL dimension of interest: psychological health, physical health, and social relationships. For illustrative purposes, the model investigating gaming disorder and psychological health is presented in Fig. 2. All models fit our data well: The comparative fit index (CFI) was 1.00 for every model, the Tucker-Lewis index (TLI) ranged from 0.99 to 1.00, the root-mean-square error of approximation (RMSEA) ranged from 0.00 to 0.03, and the standardized root-mean-square residual (SRMR) ranged from 0.00 to 0.01. Given the number of models tested, we only reported and discussed the significant effects.

Regarding prospective within-person effects, there were no significant results except for a small positive association between psychological health at T1 and GD symptoms at T2 ($b = 0.06$, $\beta = 0.21$, $p = .047$). Considering our sample size, a p-value of .047 provides weak support for the alternative hypothesis.

There were significant negative correlated changes at the within-person level only at T3 between GD symptoms and psychological

Table 3
Descriptive statistics, ANOVAs, and post hoc tests for each dimension of the MOGQ at T1.

Variable	Cluster 1 n = 1,422 Recreational M (SD)	Cluster 2 n = 1,586 Competitive M (SD)	Cluster 3 n = 1,370 Escapers M (SD)	F (p)	η^2_G [90% CI]
MOGQ					
Social	9.04 (3.04)[c]	11.99 (3.35)[b]	14.42 (3.42)[a]	980.73 (<.001)	.30 [.28, .32]
Escape	9.01 (3.98)[b]	9.30 (3.47)[b]	16.75 (2.87)[a]	2718.31 (<.001)	.51 [.49, .52]
Coping	9.37 (2.85)[c]	11.78 (2.88)[b]	15.80 (2.65)[a]	1972.66 (<.001)	.46 [.45, .48]
Fantasy	7.30 (3.43)[c]	7.65 (2.77)[b]	14.09 (3.79)[a]	1593.74 (<.001)	.46 [.44, .47]
Skill development	9.53 (3.23)[c]	15.54(3.02)[b]	16.38(3.20)[a]	1943.61 (<.001)	.48 [.43, .49]
Competition	10.31 (3.11)[c]	14.16 (3.35)[b]	14.77 (3.58)[a]	791.75 (<.001)	.25 [.24, .27]
Recreation	12.05 (2.49)[b]	13.80 (1.40)[a]	13.74 (1.45)[a]	292.55 (<.001)	.16 [.14, .18]

Note. ANOVAs = analyses of variance; CI = confidence interval; MOGQ: Motivations for Online Gaming Questionnaire.
[a,b,c] Labels indicating significant mean differences in Games-Howell post hoc analysis with [a] being the highest and [c] being the lowest value.

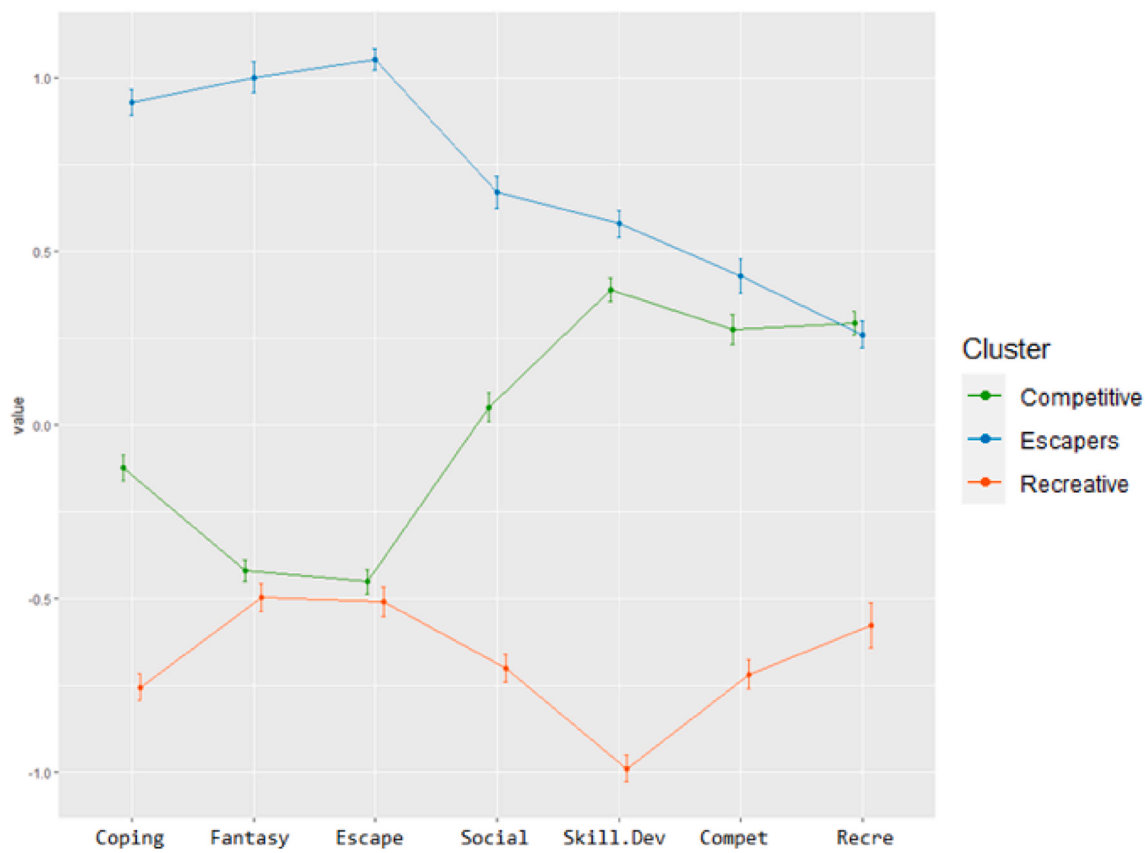

Fig. 1. Graphic representation of the standardized average scores of the three clusters, for each dimension of the MOGQ (error bars indicate ± 1 SD). Notes: Skill. Dev: Skill development, Compet: Competition, Recre: Recreation.

health ($b = -0.36$, $\beta = -0.23$, $p < .001$) and between GD symptoms and physical health ($b = -0.35$, $\beta = -0.22$, $p < .001$). Thus, an increase in an individual's GD symptoms relative to their usual GD symptoms correlated with a decrease in their usual QoL at T3.

At the between-person level, GD symptoms were negatively associated with psychological health ($b = -1.62$, $\beta = -0.41$, $p < .001$), physical health ($b = -1.55$, $\beta = -0.47$, $p < .001$), and social relationships ($b = -0.48$, $\beta = -0.37$, $p < .001$). Therefore, players who had higher GD symptoms than other players also had lower QoL: There were players with both higher levels of GD symptoms and lower levels of QoL and vice versa.

4.2. Objective playtime indicators and QoL RICLPMs

To investigate the prospective within-person effects between objective playtime indicators and QoL while accounting for time-invariant between-person differences, we specified nine RICLPMs. We specified three models for each objective playtime indicator (average playtime on weekdays, average playtime on weekend days, and maximum time of gaming sessions) by associating for each indicator the three QoL dimensions of interest: psychological health, physical health, and social relationships. All models fit our data well: CFI was 1.00 for every model, TLI ranged from 0.99 to 1.00, RMSEA ranged from 0.00 to 0.03, and SRMR ranged from 0.00 to 0.02.

Regarding prospective within-person effects, there were no significant results except for a negative effect of psychological health at T2 on

Table 4
Descriptive statistics, ANOVAs, and post hoc tests for each dimension of the WHOQOL-BREF, RSES, HADS, and GD scale at T1.

Variable	Cluster 1 Recreational $n = 1422$ *M* (*SD*)	Cluster 2 Competitive $n = 1586$ *M* (*SD*)	Cluster 3 Escapers $n = 1370$ *M* (*SD*)	*F* (*p*)	η^2_G [90% CI]
WHOQOL					
Psychological health	21.01 (4.72)[b]	22.61 (4.28)[a]	19.91 (5.05)[c]	123.58, p < .001	.05 [.04, .07]
Physical health	27.53(4.43)[b]	28.86 (3.72)[a]	26.92 (4.34)[c]	89.75, p < .001	.04 [03, .05]
Social relationships	7.23 (1.79)[b]	7.73 (1.74)[a]	7.19 (1.97)[b]	41.98, p < .001	.02 [.01, .03]
Environment	30.78 (5.38)[b]	32.32 (4.72)[a]	30.41 (5.35)[b]	59.69, p < .001	.03 [.02, .03]
IGD Scale (GD symptoms)	1.14 (1.13)[b]	1.04 (1.03)[c]	1.43 (1.15)[a]	47.68, p < .001	.02 [.02, .03]
RSES	28.81 (5.98)[b]	30.69 (5.52)[a]	26.66 (6.07)[c]	169.98, p < .001	.07 [.06, .09]
HADS					
Anxiety	6.20 (3.89)[b]	5.50 (3.38)[c]	8.21 (3.97)[a]	192.62, p < .001	.09 [.07, .10]
Depression	5.07 (3.69)[b]	3.97 (2.95)[c]	5.89 (3.54)[a]	126.21, p < .001	.05 [.04, .06]
BFI-Fr					
Openness	3.43 (0.58)[c]	3.60 (0.57)[a]	3.54 (0.57)[b]	30.78, p < .001	.02 [.01, .02]
Conscientiousness	3.35 (0.66)[b]	3.51 (0.63)[a]	3.28 (0.63)[c]	48.67, p < .001	.02 [.02, .03]
Extraversion	2.96 (0.83)[b]	3.17 (0.82)[a]	2.95 (0.82)[b]	34.54, p < .001	.02 [.01, .02]
Agreeableness	3.64 (0.60)[b]	3.76 (0.61)[a]	3.60 (0.63)[b]	25.93, p < .001	.01 [.01, .02]
Neuroticism	2.73 (0.80)[b]	2.53 (0.77)[c]	3.05 (0.77)[a]	162.14, p < .001	.07 [.06, .08]
BIS-15					
Attentional impulsivity	9.72 (2.72)[b]	9.44 (2.69)[c]	10.65 (3.07)[a]	64.94, p < .001	.03 [.02, .04]
Non-planning impulsivity	11.57 (2.98)[a]	10.72 (2.91)[c]	11.09 (3.03)[b]	29.67, p < .001	.01 [.01, .02]
Motor impulsivity	9.94 (2.91)[b]	10.10 (2.87)[b]	11.26 (3.25)[a]	71.88, p < .001	.04 [.03, .05]

Note. BFI-Fr = French Big Five Inventory, BIS-15 = short form of the Barratt Impulsiveness Scale; CI = confidence interval; HADS = Hospital Anxiety and Depression Scale; IGD Scale = Internet Gaming Disorder Scale; RSES = Rosenberg Self Esteem Scale, WHOQOL = World Health Organization Quality of Life.
[a,b,c]Labels indicating significant mean differences in Games-Howell post hoc analysis with [a] being the highest and [c] being the lowest value.

the maximum session time at T3 ($b = -0.11$, $\beta = -0.15$, $p < .01$). Thus, a decrease in an individual's psychological health at T2 predicted an increase in the maximum duration of their playing sessions at T3. The effect size meant that it would require a decrease of 9.10 points of psychological health to increase the maximum session time by 1 h. Considering that the mean change in psychological health between T2 and T3 was 0.13 (*SD* = 2.63), this result ccannot be considered relevant from a practical point of view.

There were no significant correlated changes at the within-person level. At the between-person level, there were no significant associations.

All presented results were not changed by the exclusion of participants whose playing times were considered outliers.

4.2.1. *Moderation effects by motivational clusters*

No moderation effects were found, as the Satorra-Bentler chi-square tests were nonsignificant for all RICLPMs.

4.3. *Complementary analyses*

To further investigate the between-person associations in the RICLPMs that integrated QoL and GD symptoms, we specified models that we did not plan, with personality and trait impulsivity as time-invariant predictors of QoL and GD symptoms. Indeed, impulsivity (Ryu et al., 2018; Smith et al., 2013) and personality (Kotov et al., 2010; Müller et al., 2014) have been suggested as possible common causes of problematic behaviors and QoL, especially neuroticism, which may account for these between-person associations. All models yielded significant effects for all dimensions of personality and trait impulsivity on both GD symptoms and QoL at T1, T2, and T3. Notably, neuroticism had a large negative effect on psychological health ($b = -3.58$, $\beta =$ [-0.58:-0.60]) and physical health ($b = -2.38$, $\beta =$ [-0.44:-0.45]), as well as a strong positive effect on GD symptoms ($b = 0.34$, $\beta =$ [0.24:0.25]): For each additional point of neuroticism, psychological health scores dropped by 3.58 points and physical health scores by 2.38 points, and an additional GD symptom was present for each 3-point increase in neuroticism.

5. Discussion

The objectives of this study were to investigate the links between gaming patterns and QoL by using a longitudinal design, while accounting for the motivational profile of players.

Our analyses allowed the extraction of three theoretically relevant motivational clusters from the hierarchical classification analysis, which were validated through comparisons with external variables (i.e., established risk factors for problematic gaming). The participants in the first cluster, named "recreational," were characterized by lower overall motivations than the participants in the two other clusters and were mostly motivated by the recreational aspects of the game. These players did not differ in an important way on external variables, their QoL was within the average of our sample, and they displayed only lower openness and higher non-planning impulsivity. We hypothesize that these players display more short-term pleasure-oriented motivations compared with competitors whose motivations are more future oriented (improving skills, reaching goals, etc.) and with escapers, who are more anxious and neurotic (associated with future-oriented cognitions as well).

The players in the second cluster, called "competitive," were mostly motivated by skill development, competition, and the recreational aspects of the games. They presented with higher scores on scales measuring protective factors for problematic gaming (self-esteem, extraversion, conscientiousness, and agreeableness) and lower scores on scales measuring risk factors (impulsivity, neuroticism). They also reported a higher QoL than those in the other two clusters, along with lower anxiety and depression symptoms.

Finally, the players in the third cluster, called "escaper," were mainly distinguished by escapism, skill development, and coping motives. They

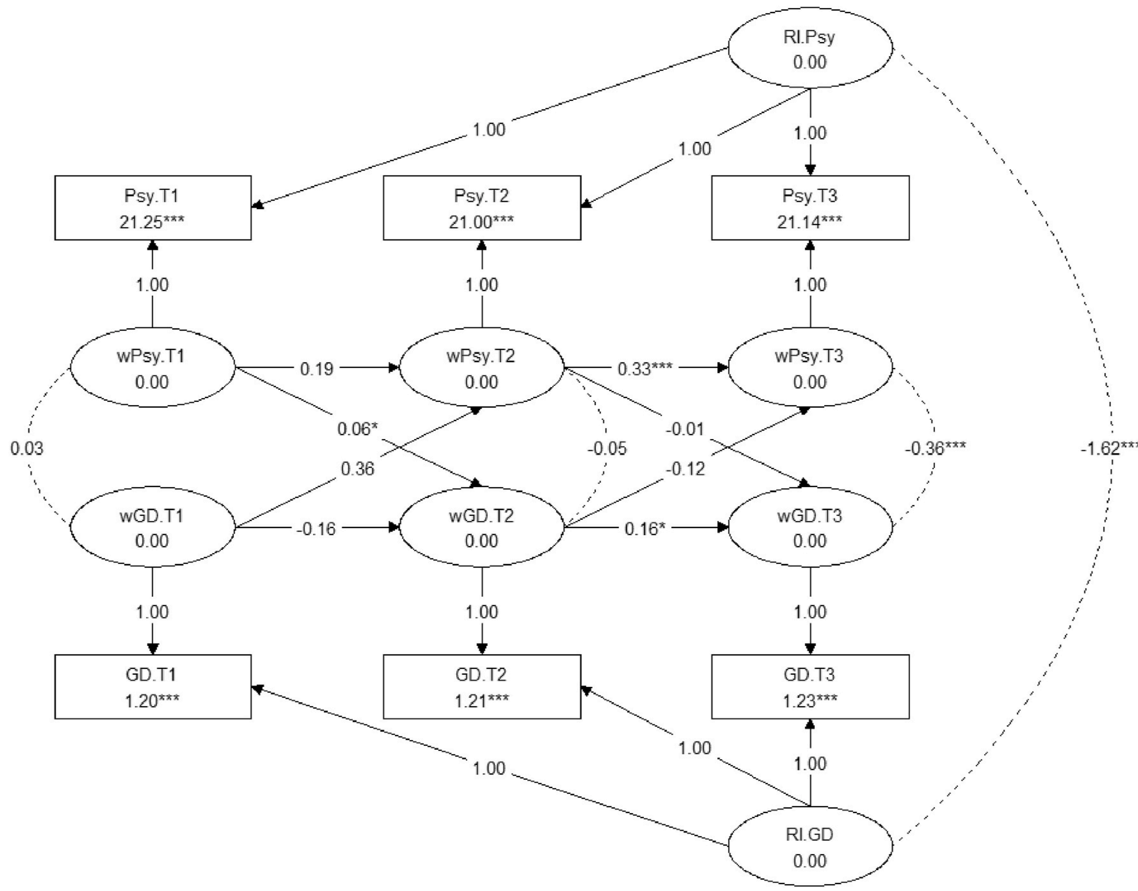

Fig. 2. Graphic representation of the RICLPM investigating the relationship between Psychological health and Gaming Disorder. Notes: *Psy: psychological health; GD: Gaming Disorder; *p < .05, ***p < .001*.
Note. RI=Random Intercept (between person variables), w = within-person variables.

showed lower psychological health and physical health than did those in the other two clusters, while they presented higher scores on risk factors for problematic gaming (neuroticism, motor and attentional impulsivity), lower scores on protective factors (self-esteem, conscientiousness), higher GD symptoms, and higher anxiety and depression symptoms. In addition, participants who met all four GD criteria (according to the *ICD-11* framework) at all three measurement times were more numerous among this cluster than in the other two clusters.

Thus, partitioning our sample on the basis of motivations to play, in particular on differences in escape motivation (which had the greatest influence on the partitioning), allowed the identification of a group of engaged but non-problematic gamers (competitive cluster), a group of problematic gamers (escaper cluster), and an intermediate group (recreational cluster). Taken together, these results confirm the relevance of motivational clusters in identifying at-risk and protected players, reproducing the results obtained by Larrieu et al. (2022) in a sample of online competitive videogame players. However, these clusters did not differ in terms of objective playtime indicators, suggesting equivalent actual involvement in gaming despite very different psychological and functional profiles, further suggesting that time spent gaming is not a good indicator of problematic behavior (Billieux et al., 2013; Demetrovics & Király, 2016; Király et al., 2017). Our data suggest that there is no relationship between risk profile and playing behavior within our highly engaged population of players.

With respect to longitudinal analyses, our results indicated a general lack of prospective within-person effects between GD symptoms and QoL; that is, for a given individual, variations from usual levels of GD symptoms did not lead to changes over time in their QoL and vice versa. This suggests that QoL and GD symptoms do not cause one another. Our data therefore do not support the compensation (QoL→GD), displacement (GD→QoL), or bidirectionality (QoL↔GD) hypotheses. In contrast, the presence of negative between-person effects shows that impaired QoL and elevated GD symptoms (and vice versa) coexist in some individuals, supporting the common causes hypothesis (QoL←X→GD), some factors causing an increase in GD symptoms and a decrease in QoL. These results are consistent with the claims of Hygen, Skalická, et al. (2020) that the negative prospective effects of GD symptoms on QoL found in previous research (Brunborg et al., 2014; Lemmens et al., 2011) could be attributed to the lack of distinction of within- and between-person effects. These results suggest that models allowing for the investigation of inter- and intra-individual effects, such as RICLPM, should be favored in further research aiming to determine the factors involved in problematic gaming patterns.

To identify some of these common causes, we conducted additional analyses. Our results indicated an effect of all dimensions of personality and trait impulsivity on both QoL and GD symptoms, on all measurement occasions. Notably, neuroticism accounted for the largest negative effects on psychological and physical QoL, while increasing GD symptoms. Taken together, these results suggest that personality (especially neuroticism) and impulsivity can be considered as common causes responsible for the association observed between QoL and GD symptoms in the literature. This assumption is further supported by the co-occurrence of lower QoL and higher GD symptoms in escapers and in the GD group (at the descriptive level), associated with higher levels of impulsivity and an at-risk personality profile. This result is consistent with process-based and transdiagnostic approaches to psychopathology that postulate that psychiatric symptoms are driven by specific impairment in key psychological processes (Kinderman, 2005). Here, it could be that psychological processes involved in neuroticism and impulsivity, such as lack of inhibitory control or poor emotion regulation strategies, constitute the potential common cause responsible for the association observed between QoL and GD. Ultimately, such findings call for embracing a process-based rather than a symptom-based approach in the study of addictive online behaviors (Billieux et al., 2015; Perales et al., 2020).

At the diagnostic level, our data indicate that the monothetical and conservative approach of the *ICD-11*, which consists of having a reduced list of mandatory clinical guidelines (rather than a larger list of criteria and a cutoff such as stated in the *DSM-5*), allows for the identification of participants with probable GD whose QoL was even worse than the QoL of the escaper cluster (the GD group; see, e.g., Table 2). Indeed, the psychological and physical QoL of these 17 participants was below the 25th percentile of the general population norms of the same age (norms of the French general population in the absence of US, Canadian, and UK norms, the results being comparable between cultures; Baumann et al., 2010). In addition, these participants showed HADS scores above the cutoff, indicating mild anxiety and depression, even approaching the "moderate" anxiety cutoff. *ICD-11* criteria for GD thus have the ability to detect functional impairment, which is consistent with a recent Delphi study showing that an international panel of GD experts agreed that *ICD-11* criteria (in contrast to *DSM-5* criteria) globally have better clinical validity, clinical utility, and prognostic value (Castro-Calvo et al., 2021). However, it should be kept in mind that the association between functional impairment and GD is not grounded in a cause-and-effect relationship but is rather based on common factors as explained earlier.

Regarding intensity of play, our data suggest that objectively measured playing time does not cause QoL impairment, supporting the results of Vuorre et al. (2022) and contrasting with studies that found a negative effect of self-reported playing time on QoL (e.g., Messias et al., 2011; Wenzel et al., 2009). These results raise the question of the importance of objective measures of playing behaviors, as we have corroborated studies showing that self-reported measurement of playtime is not a reliable indicator of actual usage (Johannes et al., 2021; Parry et al., 2021). Indeed, our participants overestimated their playtime per week by an average of 10 h, although the correlation between reported and measured playtime was relatively low ($r_\tau = 0.17, p < .001$). However, we cannot exclude the possibility that negative effects may only appear as a result of a much more extreme investment in video games, since only a very small minority of players displayed this kind of involvement in our sample. Indeed, the average game time of our participants (1.82 h per day, $SD = 0.74$) seems insufficient to be the cause of impairment. The displacement theory outlines consequences on functioning following an investment of approximately 8–12 h per day, as stated by the APA and some authors (APA, 2013; Baggio et al., 2016; King & Delfabbro, 2018). In this regard, there is a need to further investigate these findings through the study of clinical populations characterized by this type of extreme use. Although certain subgroups of players may represent a risk of evolution toward pathological outcomes (i.e., escapers), samples of players recruited in mainstream online game communities cannot serve as a substitute for clinical populations and could lead to misleading conclusions. In this respect, Vuorre et al. (2022) concluded that "time spent playing video games is unlikely to impact well-being," but excluded gaming sessions exceeding 10 h, thus not allowing for the consideration of gaming patterns that are precisely at the core of concerns about gamers' health.

Overall, our results support the crucial distinction between problematic versus non-problematic intensive engagement in video games (Billieux et al., 2019; Charlton & Danforth, 2007; Deleuze et al., 2017) and underline the necessity to theoretically dissociate practice intensity from functional impairment and problematic use in the context of moderate to intense use (Billieux et al., 2013; Deleuze et al., 2018). The in-depth study of motivations through an individual-centered approach was effective in identifying at-risk players whose degraded QoL was not caused by higher levels of GD symptoms or by their intensive use of video games but, among other unidentified variables, by specific psychological factors related to impulsivity and personality (especially neuroticism).

The current study has important clinical and theoretical implications. First, it is crucial to approach problematic video game use and GD from a perspective that assumes the central role of motivational backgrounds of gamers, rather than solely focusing on the intensity or frequency of play. Such an approach could help clarify why some individuals experience impaired functioning and others do not, given the same amount of playing time. Thus, clinical assessment of at-risk and problematic gamers would benefit from prioritizing the motives underlying playing behaviors, that is, focusing on the function of use in individual dynamics, rather than focusing on the intensity of the practice alone (Granic et al., 2020). Similarly, the clinical assessment of problematic gaming should also target psychological dimensions likely to explain problematic usage patterns, such as impulsivity or neuroticism (see Billieux et al., 2023). Furthermore, our results provide explanatory elements that shed light on the reasons for the ineffectiveness of prevention and public health interventions that are solely focused on reducing playtime (Király et al., 2018; Orben, 2022). We agree with Hygen, Skalická, et al. (2020) that the targets of such actions should be the common causes of both the deterioration of QoL and the increase of GD symptoms, since the absence of prospective within-person links suggests that interventions focused on one cannot influence the other. It is thus necessary to identify more precisely what these common causes are to better identify at-risk individuals (e.g., people with high impulsivity and neuroticism), which would allow tailored prevention and improved treatment strategies. .

5.1. Limitations

First, although our study used a competitive multiplayer online game, our results cannot be generalized to all games, since they include very different structural characteristics and uses (King et al., 2019). Another limitation inherent to using objective indicators of gaming behavior is the impossibility of taking into account the entire amount of time participants spend gaming when they play multiple games, which is the rule rather than the exception. Our population of highly engaged Rainbow 6 : Siege players allowed us to limit this pitfall, although it was virtually impossible to control for involvement in multiple games. In addition, the tracking of behavioral data can be subject to errors that are difficult to detect (e.g., the game is paused but recorded as time played). However, this bias was limited in our study because we took into account only PvP game time in which it is not possible to pause the game for a long period. Another limitation was attrition, although this problem was limited by studying a competitive multiplayer game in which players are more likely to be engaged over the long term than with single-player games, as well as by the use of compensation for participants.

Regarding the assessment of GD symptoms, our approach was used in two previous studies (Jo et al., 2019; Ko et al., 2020), but the criteria as formulated in the *DSM-5* do not entirely overlap with the criteria specified by the WHO, particularly the fifth ("give up other activities") and sixth ("continue despite problems") criteria (Higuchi et al., 2021). In this regard, there is a need to develop psychometrically robust instruments to detect GD in order to produce comparable epidemiological data and to support clinical practices by allowing the evaluation of therapeutic interventions. Efforts are currently being made to develop such an instrument, with the help of clinical and research experts (Carragher et al., 2022). Given the COVID-19 pandemic context in which this study took place, at least to some extent, the results may not be generalizable to other contexts. Finally, the complementary analyses investigating the roles played by personality and impulsivity in our models were not a priori planned, and so the corresponding results should be considered with some caution and replicated in preregistered studies.

6. Conclusions

On the whole, our study provides a deeper understanding of the prospective links between intensive and problematic video game use and QoL through the use of a longitudinal design, objective measures of gaming behavior, and statistical models to differentiate within- and between-person effects. To our knowledge, this is the first study to include both objective granular indicators of gaming behavior (playtime and duration of sessions), as well as measures of GD symptoms and QoL. The general absence of within-person effects and the identification of between-person effects linking QoL and GD symptoms support the common causes hypothesis to account for this relationship in the literature. Moreover, our data show that playing an online competitive multiplayer video game represents, for the vast majority of players, a leisure activity that has neither a positive nor a negative impact on QoL.

The identification of motivational clusters and their distinction in terms of QoL and risk factors allow us to conclude that it is necessary to refocus the evaluation of video game use on the reasons that underlie these uses rather than on their intensity. However, we cannot exclude the possibility that potential negative effects of intensive and/or problematic use could be limited to extreme cases constituting a very small number of at-risk individuals and may not be detectable in populations of online players, even intensive players. Indeed, it has been postulated that functional impairment would only emerge from extreme use (8–12 h per day), which we were unable to assess in the present study considering our sample's engagement. Clinical samples should therefore be the primary target of future studies that aim to better understand the underlying mechanisms of GD and the role played by associated risk factors in at-risk individuals.

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Author contributions

M. Larrieu: Conceptualization & Methodology, Formal analysis, Writing - Original Draft, Visualization; G. Décamps: Conceptualization & Methodology, Writing - Original Draft, Supervision; Y. Fombouchet: Formal analysis, Writing - Original Draft, Writing - Review & Editing; J. Billieux: Writing - Original Draft, Writing - Review & Editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: This study is part of the first author's thesis work, financially supported by Ubisoft International and the ANRT (National Agency of Research and Technology, France) via CIFRE grant 2018/1498. After completing this work, the first author was hired by Ubisoft International as an impact researcher. The third author of this article, Prof. Joël Billieux, serves as an editorial board member of Computers in Human Behaviors. Please note, however, that he was not involved at any stage during the editorial process. All other authors declare that there were no conflicts of interest with respect to the authorship or the publication of this article.

Data availability

The data for this study are industrially sensitive and are not publicly available.

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