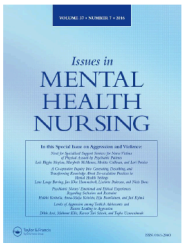

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Fear of missing out (FoMO) and gaming disorder among Chinese university students: Impulsivity and game time as mediators

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Abstract

Background and aims: Research into the fear of missing out (FoMO) has greatly increased in recent years. Given the negative consequences of gaming disorder (GD) among a small minority of individuals, there is an increasing need for research examining the impact of FoMO on GD. However, little is known about the roles of impulsivity and gaming time as mediators in the relationship between FoMO and GD. The present study examined whether impulsivity and gaming time mediated the relationship between FoMO (trait-FoMO and state-FoMO) and GD among Chinese university students, as well as the prevalence of GD.

Methods: A total of 1127 university students completed an online survey including the Chinese Trait-State Fear of Missing Out Scale (T-SFoMOS-C), the Barratt Impulsiveness Scale-Brief (BIS-Brief), gaming time survey, and the Chinese Gaming Disorder Scale (CGDS).

Results: The prevalence of GD was 6.4% among Chinese university students. Trait-FoMO was found to indirectly impact GD via impulsivity and gamine time, whereas the direct effect of trait-FoMO on GD and the mediation effects of gaming time were not confirmed. State-FoMO impacted on GD both directly, and indirectly via the mediation effects of impulsivity as well as impulsivity and gaming time.

Conclusion: Trait-FoMO on GD was fully mediated via impulsivity and gaming time, whereas state-FoMO on GD was partly mediated via impulsivity and gaming time. Individuals with high levels of FoMO were more likely to show impulsivity and spend a longer time gaming, and these factors were associated with GD. These findings provide

insights to incorporate into health prevention programs to help regulate emotion, control impulsivity, and decrease GD.

Keywords: trait-FoMO; state-FoMO; gaming disorder; impulsivity; gaming time

Introduction

The online game industry has been developing rapidly in China in recent years. According to a report from the China Internet Network Information Centre (2019), the number of Chinese online gaming users has increased from 55.1% (391 million out of 710 million online users) in June 2016 to 57.8% (494 million out of 854 million online users) in June 2019. Additionally, the number of smartphone gaming users has increased from 46.1% (302 million out of 656 million smartphone users) in June 2016 to 55.2% (468 million out of 847 million smartphone users) in June 2019. Consequently, smartphone gaming has become an increasingly ubiquitous phenomenon among Chinese university students (Zhang, Ye & Huang, 2019; Niu & Gao, 2018).

The primary aim of online gaming is for leisure and recreation accompanied by motivations associated with achievement, social, and immersion factors (i.e., factors that make the player feel like they are actually in the games [e.g., role-playing, customization] and/or so involved in the game that it provides reinforcing mood modifying experiences such as relaxation or escape from real life). (Yee, 2006). However, among excessive gamers, the activity can become problematic gaming and result in 'gaming disorder' (GD) for a minority of individuals (King et al., 2019; King et al., 2020; Wichstrøm et al., 2019; Scerri et al., 2019; Throuvala et al., 2019). The World Health Organization (WHO) has now formally recognized GD as one of behavioral addictions in the eleventh revision of the *International Classification of Diseases* (ICD-11; WHO, 2019). The move is similar to that of the American Psychiatric Association who proposed 'internet gaming disorder' (IGD) as a tentative condition worthy of further study in the latest (fifth) version of *Diagnostic and Statistical*

Manual of Mental Disorders (DSM-5) (American Psychiatric Association, 2013). GD is characterized by a pattern of persistent or recurrent gaming behavior (digital gaming or videogame playing), which may be online or offline. GD results in impaired control, priority given to gaming, continuation or escalation of gaming as well as significant function impairment (i.e., personal, family, social, education, and occupation).

Gaming disorder (often referred to as 'gaming addiction') has become a topic of increasing research interest (Griffiths, Kuss, & King, 2012). Although the DSM-5 claimed that internet use disorder and internet gaming disorder were the same, Griffiths and Pontes (2014) argued that they were two different constructs and was empirically shown to be the case in a large nationally representative study of Hungarian adolescents (Király et al., 2014). Brand et al. (2019, 2016, 2014) proposed the Interaction of Person-Affect-Cognition-Execution (I-PACE) model to explain all kinds of addictive behaviors, including gaming disorder and gambling disorder. The revised multidimensional model refers to factors that may increase a player's risk of developing GD including an individual's core characteristics, perception of external and internal triggers, and gratification/compensation in early and later stages of addictive processes (Brand et al., 2019).

Some studies have reported that GD is associated with individual attachment, which may comprise maladaptive cognitions, including overvaluing gaming rewards and overly relying on gaming for self-worth and identity (Allison et al., 2006; Beard & Wickham, 2016; King & Delfabbro, 2016). The specific types or different characteristics of games may heighten player enjoyment as well as gaming time, and can be associated with

problematic gaming or GD (Griffiths & Nuyens, 2017; Kim et al., 2010; King, Delfabbro, & Griffiths, 2010, 2011; King et al., 2019; Laconi, Piron, & Chabrol, 2017; Westwood & Griffiths, 2010; Wood et al., 2004). Moreover, individual demographic differences (e.g., sex, age) (Andreassen et al., 2016; Durkee et al., 2012; Hawi, Samaha, & Griffiths, 2018; Tejeiro et al., 2012; Kuss & Griffiths, 2012), psychological features (e.g., personality, psychopathological symptoms) (Billieux et al., 2015; Bonnaire & Baptista, 2019; Braun et al., 2016; Gervasi et al., 2017; Mehroof & Griffiths, 2010; Rho et al., 2018; Şalvarlı & Griffiths, 2019; Schimmenti et al., 2017; Wang et al., 2017) as well as neurobiological nature (Argyrious, Davison, & Lee, 2017; Decker & Gay, 2011; Ko et al., 2009, 2017; Pawlikowski & Brand, 2011; Schiebener & Brand, 2017; Weinstein et al., 2016) may be considered as risk factors for GD.

In recent years, the concept of 'fear of missing out' (FoMO) has become widespread in the context of social media use (Przybylski et al., 2013; Alt, 2017). FoMO has been defined as "a pervasive apprehension that others might be having rewarding experiences from which one is absent" (Przybylski et al., 2013, p. 1841). FoMO is also regarded as a dispositional trait based on it being a relatively stable individual characteristic (i.e., trait-FoMO), as well as being important in the context of using internet-communication applications (i.e., state-FoMO) (Wegmann et al., 2017). Therefore, FoMO may be a more complex phenomenon that reflects a specific cognition in terms of the fear of missing out on something that occurs online as well as a specific personal predisposition.

Some scholars have asserted that FoMO is associated with personality traits (Stead & Bibby, 2017; Alt & Boniel-Nissim, 2018), psychological need satisfaction (Przybylski et al.,

2013; Oberst et al., 2017; Xie et al., 2018), and social media use (Andreassen et al., 2016; Primack et al., 2017; Błachnio & Przepiórka, 2018). Additionally, some studies have reported that FoMO may be a predictor of smartphone addiction/problematic smartphone use (PSU), social networking site (SNS) addiction, problematic internet use (PIU), and *Facebook* addiction (Elhai et al., 2020; Dempsey et al., 2019; Long et al., 2019; Wang et al., 2019; Tunc-Aksan & Akbay, 2019; Alt & Boniel-Nissim, 2018; Pontes, Taylor, & Stavropoulos, 2018). Moreover, FoMO may mediate the relationship between social identity and online game addiction (Duman & Ozkara, 2019). FoMO may also be used as an impulsive tool in marketing and communication activities aimed at increasing impulsive consumption (Aydin et al., 2019).

Impulsivity is associated with a variety of features such as carelessness, impatience, seeking excitement, taking risks, and lack of deep thinking (Savci, & Aysan, 2015; Chamberlain, & Sahakian, 2007). Loss of control (i.e., diminished impulse control) is central in problematic mobile phone use (Billieux, 2012) as well as a key component of all kinds of addictive behaviors (Weafer, Mitchell, & de Wit, 2014; Cao et al., 2007; Canale et al., 2015). In addition, impulsivity has been found as one of the most predictive personality factors of IGD/GD, especially in adolescent and emerging adult populations (Argyriou, Davison, & Lee, 2017; Bargeron & Hormes, 2017; Gonzeses-Bueso et al, 2018; Hu et al., 2017; Kim et al., 2017; Paulus et al, 2018; Şalvarlı & Griffiths, 2019). Self-determination theory and recent studies have suggested that poor self-control (i.e., impulsivity, deficits in the ability to regulate emotion and behaviors) may be one mechanism by which daily need frustration (i.e., being unable to meet basic needs such as

autonomy, competence and relatedness) is associated with IGD symptoms (Allen & Anderson, 2018; Mills, Milyavskaya, Mettler, & Heath, 2018). Mills and Allen (2020) have reported that daily need frustration on GD may be mediated via impaired self-control.

Adolescents with problematic internet use spend excessive amounts of time online and fail to manage their time efficiently (Alt & Boniel-Nissim, 2018) as well as having more health-related problems and poor school performance (Gentile, 2009). Online gamers who play to escape real society also spend more time within the virtual environment (Kaczmarek & Drążkowski, 2014). Some scholars have asserted that gaming time is a significant predictor of IGD/GD (Laconi, Piron, & Chabrol, 2017; Kuss, Louws, & Wiers, 2012; Kaczmarek & Dr zmareki, 2014) although gaming excessively is not necessarily problematic for some individuals (Griffiths, 2010). ICD-11 described characteristics of GD, including 'increasing priority given to gaming to the extent that gaming takes precedence over other life interests and daily activities'.

Problematic social network site (SNS) users and gamers commonly have social anxiety (e.g., FoMO), which indicates that it is possible for FoMO to have an effect on gaming players (Duman & Ozkara, 2019), a finding that was first reported by Griffiths (2000) over 20 years ago. To escape from social anxiety and avoid FoMO, gamers may lose control and invest more time in gaming, which in turn may cause GD. Therefore, the present study examined the association among trait-FoMO/state-FoMO, impulsivity, gaming time, and GD. It was hypothesized that (i) impulsivity, gaming time, and GD would be associated with trait-FoMO; (ii) impulsivity, gaming time, and GD would be associated with state-FoMO; (iii) impulsivity and gaming time would mediate the association between trait-FoMO and GD;

and (iv) impulsivity and gaming time would mediate the association between state-FoMO and GD.

Methods

Participants

The original sample included 1,258 students from three universities in two provinces of China (Jiangxi and Liaoning). However, 131 students did not complete the online survey, leaving a sample of 1,127 participants (478 males, 649 females). The response rate was 89.6%. Participant ages ranged from 17 to 25 years (M = 20.1 years; SD = 1.6).

Measures

Chinese Trait-State Fear of Missing Out Scale (T-SFoMOSC)

Fear of missing out was assessed using the trait-state fear of missing out scale (T-SFoMOS; Wegmann et al., 2017). The T-SFoMOS contains 12 items assessing two domains: trait-FoMO and state-FoMO. Each item is responded to from 1 (*totally disagree*) to 5 (*totally agree*). The Cronbach's alpha value of the trait-FoMO and state-FoMO were 0.82 and 0.81, respectively. In the present study, using the Chinese T-SFoMOS (Xiao & Liu, 2018) (χ^2 = 177.49, df = 50, p < .01; TLI = .959; CFI = .960; SRMR = .038; RMSEA = .050), the Cronbach's alpha for the total scale was 0.82, 0.78 for the trait-FoMO, and 0.81 for state-FoMO.

Barratt Impulsiveness Scale-Brief (BIS-Brief)

Impulsivity was assessed using the Barratt Impulsiveness Scale-Brief (BIS-Brief; Steinberg et al., 2013) which has good reliability and validity (Fields et al., 2015; Mathias

et al., 2018). The eight-item BIS-Brief was developed based on the Barratt Impulsiveness Scale (BIS) (Patton, Stanford & Barratt, 1995), which was translated into Chinese by Zhou et al. (2006). Each item is responded to from 1 (*rarely/never*) to 4 (*almost always/always*). In the present study, the Cronbach's alpha of the BIS-Brief was 0.70.

Gaming time

In the present study, gaming time referred to the average time spent gaming via smartphones and computers (including consoles). Participants reported the number of hours spent on gaming each day (Kaczmarek, & Drąż&owski, 2014).

Chinese Gaming Disorder Scale

GD was assessed using a new instrument – the Chinese Gaming Disorder Scale (CGDS) – developed by the authors especially for this study. The items were based on the diagnostic items in both the 11th revision of *International Classification of Diseases (*ICD-11) and the fifth version of *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5). The CGDS comprises nine items. Items 1,2, 5 and 9 originated from ICD-11, whereas other items was from IGD9-SF (Pontes, & Griffiths, 2015): (1) My control over gaming is impaired (e.g., onset, frequency, intensity, duration, termination, context); (2) My priority given to gaming is increasing to the extent that gaming takes precedence over other life interests and daily activities; (3) I have lost interest in previous hobbies and other entertainment activities as a result of my engagement with the game; (4) I have a strong desire to participate in gaming to temporarily escape or relieve a negative mood (e.g., helplessness, guilt, anxiety; (5) My gaming is continuing or escalating despite the occurrence of negative consequences; (6) I feel preoccupied with my gaming behavior; (7) I feel the need to spend

increasing amount of time engaged gaming in order to achieve satisfaction or pleasure; (8) I feel more irritability, anxiety or even sadness when I try to either reduce or stop my gaming activity; and (9) the gaming behavior pattern is of sufficient severity to result in significant impairment in my personal, family, social, educational, occupational or other important areas of functioning. Participants answer 'yes' or 'no' to each question (1=Yes, 0=No). Exploratory factor analysis (EFA) was performed using Mplus 7.0 and model estimator was conducted using robust maximum likelihood estimator (MLR). The nine-item and single-factor model did not fit the data well (χ^2 = 84.65, *df* = 27, *p* < .001; TLI =0.896; CFI = 0.922; SRMR = .043; RMSEA = .044), whereas the two-factor model did (χ^2 = 43.21, *df* = 19, *p* < .01; TLI =0.938; CFI = 0.967; SRMR = .027; RMSEA = .034). Next, confirmatory factor analysis (CFA) was performed and verified the two-factor model (χ^2 = 64.71, *df* = 26, *p* < .01; TLI =0.927; CFI = 0.947; SRMR = .036; RMSEA = .036). The Cronbach's alpha of the CGDS in the present study was 0.77.

Procedure

From October 2019 to November 2019, three universities in two provinces of China were used to recruit a large university student sample. Participants were informed about the aim of the investigation and completed an online survey in order to gain course credit in normally scheduled classes. The aim and meaning of scientific research was emphasized repeatedly. Participants were also informed that they could decline to participate and were free to withdraw at any time. They completed a series of self-report psychometric

scales including the T-SFoMOSC, the BIS-Brief, the gaming time survey, and the GD screen Completion of all the scales took approximately 10 minutes.

Statistical analysis

All data were analysed using SPSS 20 and Mplus 7.0. The data distribution was analysed by skewness and kurtosis levels (skewness cut-off of 2.0 and kurtosis cut-off of 7.0) (Curran, West, & Finch, 1996). The participants' socio-demographic characteristics were analysed using descriptive statistics and frequency analysis. The gender difference in gaming disorder was analysed using a chi-square test. EFA and CFA for the GD screen as well as T-SFoMOSC were performed using Mplus 7.0. Pearson's correlation was performed among the variables under investigation. Hayes's (2013) PROCESS macro (Model 6) was used to test the mediation models of trait-FoMO/state-FoMO on GD via impulsivity and gaming time.

Ethics

The study was approved by the institutional review board and Ethics Committee of Gannan Medical University. Ethical standards in the 2013 Declaration of Helsinki were followed. Each participant provided written informed consent after receiving a full explanation of the study's purpose and procedure. All participants were assured that their data would be anonymous and confidential.

Results

Descriptive statistics and correlation analyses

Descriptive statistics for the study variables are shown in Table 1. The skewness levels of the study variables were all less than 2 and the kurtosis levels were all less than 7, indicating solid estimation of maximum likelihood to the present study. Gender and age were considered as control variables. FoMO was significantly positively associated with impulsivity (r = 0.16, p < .001) and GD (r = 0.12, p < .01), but not significantly associated with gaming time (r = 0.02, p = 0.522). Trait-FoMO and State-FoMO were significantly positively associated with impulsivity (r = 0.16, p < .001; r = 0.12, p < .001) and GD (r = 0.09, p < .01; r = 0.11, p < .001), but not significantly associated with gaming time (r = -0.01, p = 0.807; r = 0.04, p = 0.246), respectively. Impulsivity was significantly positively associated with gaming time (r = 0.13, p < .001) and GD (r = 0.24, p < .001). Gaming time was also significantly associated with GD (r = 0.17, p < .001).

The prevalence of gaming disorder

The cut-off score, 5 out of 9 suggested by DSM-5 (American Psychiatric Association, 2013) and Pontes and Griffiths (2015), was used as reference in the present study. Endorsing six out of nine criteria was considered to be a rigorous cut-off score to differentiate normal gaming from GD. Based on 6 as the cut-off score for the GD screen, 72 participants (6.4%) were classed as having gaming disorder. The numbers of males with gaming disorder was 57 (11.9%) and the number of females was 15 (2.3%) which was significantly different (χ^2 = 42.54, p < .001).

Testing of the mediation effects from trait-FoMO to GD via impulsivity and gaming time

The serial multiple mediation effects of trait-FoMO on GD via impulsivity and gaming time were examined utilizing Hayes' PROCESS v3 Model 6. Gender and age were considered as control variables. As Figure 1 shows, trait-FoMO was positively associated with impulsivity (β = 0.16, t = 5.31, p < .001), but not associated with gaming time (β = -0.01, t = -1.13, p = 0.305) and GD (β = 0.01, t = 1.85, p = 0.065). Impulsivity was positively associated gaming time (β = 0.13, t = 4.44, p < .001) and GD (β = 0.17, t = 7.44, p < .001). Gaming time was also positively associated with GD (β = 0.11, t = 4.98, p < .001). In addition, the total effect (β = 0.065, 95%CI: 0.020, 0.110) and total mediation effect (β = 0.031, 95%CI: 0.012, 0.050) of Trait-FoMO and GD via impulsivity and gaming time were both significant. The direct effect (β = 0.040, 95%CI: -0.004, 0.084) from trait-FoMO to GD as well as the indirect effect via gaming time (β = -0.004, 95%CI: -0.016, 0.007) were both non-significant. Two of three indirect paths of trait-FoMO on GD via impulsivity (β = 0.032, 95%CI: 0.017, 0.049), and impulsivity and gaming time (β = 0.003, 95%CI: 0.001, 0.005), were significant. Furthermore, differences in the two paths were examined utilizing PROCESS v3 Model 6. There was a significant difference (β = 0.029, 95%CI: 0.018, 0.045) between Path 1 (trait-FoMO on GD via impulsivity) and Path 3 (trait-FoMO on GD via impulsivity and gaming time) (Table 2).

Testing of the mediation effects from state-FoMO to GD via impulsivity and gaming time

State-FoMO was positively associated with impulsivity (β = 0.12, t = 3.98, p < .001), but not associated with gaming time (β = 0.02, t = 1.78, p = 0.076). Impulsivity was positively

associated with gaming time (β = 0.13, t = 4.23, p < .001) and GD (β = 0.17, t = 7.47, p < .001). Gaming time was positively associated with GD (β = 0.11, t = 4.88, p < .001). In addition, the direct effect (β = 0.061, 95%CI: 0.017, 0.106) and total effect (β = 0.085, 95%CI: 0.040, 0.131) from state-FoMO to GD were both significant. The total indirect effect of state-FoMO and GD via impulsivity and gaming time was also significant (β = 0.029, 95%CI: 0.014, 0.045). Two of three indirect paths of state-FoMO on GD via impulsivity (β = 0.025, 95%CI: 0.012, 0.038), and impulsivity and gaming time (β = 0.002, 95%CI: 0.001, 0.004) were significant, whereas the indirect effect via gaming time (β = 0.002, 95%CI: -0.005, 0.011) was non-significant. Furthermore, differences in the two paths were examined utilizing PROCESS v3 Model 6. There was a significant difference (β = 0.023, 95%CI: 0.011, 0.036) between Path 1 (state-FoMO on GD via impulsivity) and Path 3 (state-FoMO on GD via impulsivity and gaming time). The proportion of total effect of state-FoMO on GD mediated via impulsivity and gaming time was 34.12%.

Discussion

The present study examined the prevalence of GD and the mediation effect of trait-FoMO/state-FoMO on GD via impulsivity and gaming time among Chinese university students. The prevalence of gaming disorder was estimated to be 6.4% (11.9% among males and 2.3% among females), which is similar to previous findings among Chinese samples and other countries' samples (Pan et al., 2013; Choo et al., 2010; Gentile, 2009). Furthermore, the prevalence was higher among males than females, which finding is consistent with almost all studies (Griffiths, Kuss, & King, 2012; Király et al., 2014; Mihara,

& Higuchi, 2017).

FoMO was significantly positively associated with impulsivity, which is similar to impulsive buying (Aydin et al., 2019). FoMO is a state of anxiety created by a compulsive concern that an individual might miss an opportunity for social interaction or a novel experience. The feeling of FoMO may trigger impulsive behavior (i.e., the urgency to check a phone and the inability to focus on a task), which has been found to be positively associated with impulsive digital communication behavior (Hefne, Knop, & Vorderer, 2018). In addition, FoMO, one of psychological traits, has been considered as a type of social anxiety (Duman & Ozkara, 2019), and social anxiety has been positively associated with the online gaming addiction (Park et al, 2016). In the present study, FoMO was also significantly positively associated with GD. However, Wegmann et al. (2017) reported that psychopathological symptoms (i.e., depression and interpersonal sensitivity) had no direct effect on IGD, and that the impact of psychopathological symptoms on IGD were serially mediated via state-FoMO and avoidance expectancies, but not trait-FoMO and avoidance expectancies. The direct effects from trait-FoMO/state-FoMO to IGD were both non-significant. Based on self-determination theory (SDT; Ryan & Deci, 2017), the satisfaction of basic psychological needs is strongly associated with proactive behavioral regulation (e.g., videogame playing and sports) (Przybylski et al., 2009; Hagger, & Chatzisarantis, 2007).

Results showed that trait-FoMO on GD was fully mediated via impulsivity and gaming time, whereas state-FoMO on GD was partly mediated via impulsivity and gaming time. FoMO is considered as self-regulatory limbo state arising from situational or chronic

deficits in psychological need satisfactions (Przybylski et al., 2013). In some online games (e.g., massively multiplayer online role-playing games [MMORPGs] and real-time strategy [RTS] games), social interaction is one of the most important motivations for gamers (Griffiths, Davies & Chappell, 2003, 2004; Peterson, 2012). Trait-FoMO has been described as a relatively stable individual characteristic, representing the general fear of a person of missing out on something. On the contrary, state-FoMO is considered important in the context of using internet-communication applications to update and exchange messages, and even increasing general trait-FoMO (Wegmann et al., 2017). Therefore, the direct effect of state-FoMO on GD is more significant than trait-FoMO on GD.

In addition, based on the Brand et al.'s I-PACE model, individuals' predisposing variables (e.g., genetics, early childhood experience, psychopathology) predict specific cognitions or interact with certain aspects that specific situations deliver (i.e., perception of external and internal triggers), consequently leading to specific types of behavioral addiction (e.g., GD, gambling disorder, and internet-use disorder) (Brand et al., 2019). Because a specific personal predisposition (trait-FoMO) or specific cognition (state-FoMO), FoMO may trigger poor impulse control or impulsive behavior, this may impair individual executive function and lead to excessive gaming, which for a small minority may result in GD. Moreover, gaming addicts need to satisfy individual motivations, including achievement, socializing, and escapism (Kuss, Griffiths, & Pontes, 2017). Based on SDT (Ryan & Deci, 2017), IGD is associated with daily frustration of basic needs and stronger extrinsic gaming motivation (Mills & Allen, 2020). Therefore, one possible explanation is that owing to fear of missing out the social interaction or successful chance from gaming, disordered gamers lose

control over gaming, increase impulsivity regardless of negative outcomes, invest a larger time in gaming, and subsequently leading to GD in some individuals.

GD has become an issue not just in China bit in many countries all over the world. While the majority of gamers have little or no problem associated with gaming (and has beneficial effects), for a small minority, gaming can become a serious issue that mental health professionals need to be aware of so that problematic gamers can get access to the help they need. In terms of clinical practice, practitioners need to educate themselves about signs and symptoms of GD, engage in awareness-raising of the issue (e.g., posters on notice boards and flyers in waiting room areas), provide access to self-diagnostic screening instruments online or offline), and facilitate referrals to appropriate services that can treat GD (e.g., psychiatrists, clinical psychologists.

Limitations

Impulsivity and gaming time as mediators may impact on the relationship between FoMO and gaming disorder. Nevertheless, several limitations must be considered when interpreting these results. First, all the data were self-report among a self-selected sample from three universities, and is therefore subject to well-known biases (e.g., individual motivation, social desirability, memory recall), as well as suffering from a lack of generalizability to the total Chinese student population and the Chinese general population.

Further research and conclusions

Future studies should be carried out on more representative samples and use more objective methods to provide a more robust insight into the relationship between FoMO,

impulsivity, gaming time, and GD (e.g., clinical diagnosis and neuroimaging studies). Second, further research is required to more deeply explore the characteristics of trait-FoMO and state-FoMO (e.g., studies evaluating the difference between trait-FoMO and state-FoMO as predictors). Third, further research is necessary to explain the important gaming type factors across different genres (e.g., MMORPGs and RTS games) responsible for the relationships studied here. Overall, the results here demonstrate the mediation effects of impulsivity and gaming time between trait-FoMO/state-FoMO and GD. Based on the findings, the impact of FoMO on GD may be mediated via impulsivity and gaming time among Chinese university students. Finally, longitudinal research is needed to establish whether students acquire GD at university or whether this behavior began at a younger age and intensified in university. Such research should also examine the extent to which GD affects their university life, studies, and physical and psychological health.

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Availability of data and materials

The datasets supporting the conclusions of this article are available from the corresponding author upon reasonable request.

Author Contributions

Conceived and designed the experiments: LL, ZMN. Performed the experiments: LL, ZMN. Analysed and interpreted the data: LL, MDG. Contributed reagents/materials/analysis tools: SLM. Wrote the first draft of the paper: LL, ZMN. Edited and contributed to the revised paper: MDG.

Competing interests

There are no financial or non-financial competing interests. None of the research staff received incentives for recruiting participants or for any other purpose directly associated with the study.

Consent for publication

Not applicable.

Ethics approval and consent to participate

This study was approved by the institutional review board and Ethics Committee of Gannan Medical University. We followed the ethical standards in the 2013 Declaration of

Helsinki. Each participant provided written informed consent after receiving a full explanation of the study's purpose and procedure.

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Table 1

Descriptive statistics and correlation analysis of the study variables.

		M	*SD*	Skewness	Kurtosis	1	2	3	4	5	6
1.	FoMO	29.08	6.80	-0.160	0.151	1.00					
2.	Trait-FoMO	12.18	3.58	0.008	-0.170	0.80***	1.00				
3.	State-FoMO	16.90	4.56	0.121	-0.007	0.88***	0.40***	1.00			
4.	Impulsivity	18.87	2.75	-0.003	0.205	0.16***	0.16***	0.12***	1.00		
5.	Gaming time	3.11	3.05	1.909	5.896	0.02	-0.01	0.04	0.13***	1.00	
6.	Gaming disorder(GD)	1.18	2.03	1.905	2.961	0.12**	0.09**	0.11***	0.24***	0.17***	1.00

***p < .001, **p < .01, *p < .05.

Table 2

Total effect, direct effect, and mediation effects of trait-FoMO/state-FoMO on GD via impulsivity and gaming time

Path (Trait-FoMO→GD)	B	SE	95%CI	Path (State-FoMO→GD)	B	SE	95%CI
Total effect	0.065	0.023	0.020, 0.110	Total effect	0.085	0.023	0.040, 0.131
Direct effect	0.040	0.022	**-0.004, 0.084**	Direct effect	0.061	0.023	0.017, 0.106
Total mediation effect	0.031	0.010	0.012, 0.050	Total mediation effect	0.029	0.008	0.014, 0.045
Ind1	0.032	0.008	0.017, 0.049	Ind1	0.025	0.007	0.012, 0.038
Ind2	-0.004	0.006	**-0.016, 0.007**	Ind2	0.002	0.004	**-0.005, 0.011**
Ind3	0.003	0.001	0.001, 0.005	Ind3	0.002	0.001	0.001, 0.004
C1	0.036	0.010	0.018, 0.057	C1	0.022	0.008	0.006, 0.039
C2	0.029	0.008	0.015, 0.045	C2	0.023	0.007	0.011, 0.036
C3	-0.007	0.006	-0.021, 0.004	C3	0.001	0.004	-0.008, 0.009
				Effect ratio (%)	34.12		

Note. Confidence intervals for effects are bias corrected based on 5000 bootstrap samples. a1. Trait-FoMO/State-FoMO to impulsivity, a2. Trait-FoMO/State-FoMO to gaming time, b1. Impulsivity to GD, b2. Gaming time to GD, d1. Impulsivity to gaming time. Ind1 = Trait-FoMO/State-FoMO→Impulsivity→GD, Ind2 = Trait-FoMO/State-FoMO→Gaming time→GD, Ind3 = Trait-FoMO/State-FoMO→Impulsivity→Gaming time→GD. CI = Ind1 minus Ind2, C2 = Ind1 minus Ind3, C3 = Ind2 minus Ind3. Effect ratio = Total mediation effect/Total effect

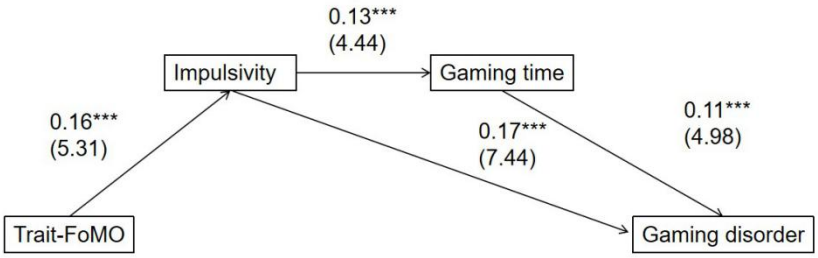

Fig. 1. The mediation model of impulsivity and gaming time on trait-FoMO and GD (n=1127). Coefficients are standardized and *t*-statistics are in parentheses.

***$p < .001$.

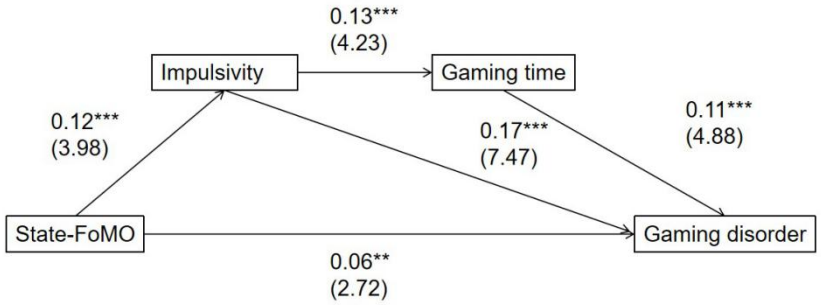

Fig. 2. The serial multiple mediation model of impulsivity and gaming time on state-FoMO and GD (n=1127). Coefficients are standardized and *t*-statistics are in parentheses.

***$p < .001$; **$p < .01$.