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FULL-LENGTH REPORT

A three-wave longitudinal study on the underlying metacognitive mechanism between depression and Internet gaming disorder

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ABSTRACT

Background and aims: Internet Gaming Disorder (IGD) and depression have negative consequences on individuals' mental health, but their relationships are complex. This three-wave longitudinal study aimed to detect the metacognitive mechanisms underlying the association between IGD tendency and depression based on the self-regulatory executive function model. *Methods:* A total of 1,243 Chinese undergraduate student gamers (57% female, $M = 19.77$, $SD = 1.29$) were recruited at the baseline survey (Wave 1 [W1]), with 622 and 574 of them taking part in the two follow-up surveys (Wave 2 [W2] at 6 and Wave 3 [W3] at 12 months later), respectively. *Results:* The three-wave path model demonstrated, after controlling for the autoregressive effect of each variable, that depression consistently predicted IGD tendency but not vice versa, while negative but not positive metacognitions about online gaming (MOG) significantly predicted both depression and IGD tendency. Moreover, two statistically significant mediation paths: (i) negative MOG [W1] → depression [W2] → IGD tendency [W3]; and (ii) depression [W1] → negative MOG [W2] → IGD tendency [W3] were identified. *Discussion and conclusions:* These findings extend the understanding of the associations among depression, IGD tendency, and MOG, highlighting how negative MOG has a stronger prospective effect than positive MOG on depression and IGD tendency, and also reveal the mutual mediation effects of depression and negative MOG on IGD tendency. Integrated programmes with both emotional regulation training and Metacognitive Therapy are recommended for IGD treatment.

KEYWORDS

depression, Internet Gaming Disorder, longitudinal study, metacognitions about online gaming

INTRODUCTION

Internet Gaming Disorder (IGD) is an emerging global mental health problem. It has been highlighted for further research in the fifth Diagnostic and Statistical Manual of Mental Disorder (DSM-5) (American Psychiatric Association [APA], 2013), and recognized as an official addictive disorder in the 11th Revision of the International Classification of Diseases (ICD-11; World Health Organization [WHO], 2018). Empirical data has shown that it is associated with various adverse health consequences in physical, cognitive, emotional, and social domains, including affective disorders like depression (Cheng, Cheung, & Wang, 2018; Mihara & Higuchi, 2017; Wong et al., 2020). Despite the strong positive association consistently reported between depression and IGD, the prospective effects of depression on

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IGD and its underlying mechanisms remain unclear (for a review, see Ostinelli et al., 2021). To fill in this research gap, this three-wave longitudinal study aims to examine the potential metacognitive mechanisms underlying the positive relationship between IGD and depression, based on the Self-Regulatory Executive Function (S-REF) model of psychopathology (Wells & Matthews, 1994, 1996).

IGD and depression

IGD and depression have shown high comorbidity (ranging up to 75%, Ostinelli et al., 2021). It may not be a surprise because they share a number of similar concurrent health issues, such as insomnia, fatigue, social withdrawal, and suicide ideation (Achab et al., 2011; Ohayon & Roberts, 2021; Wartberg, Kriston, & Thomasius, 2020; Yu et al., 2020). Common abnormal neural functioning in amygdala, prefrontal cortex, gyrus, and the connection between frontoparietal lobe and amygdala was also found in IGD gamers with comorbid depression (Choi et al., 2017; Liu et al., 2018). Despite these similar health correlates and neurological substrates between IGD and depression, longitudinal studies of IGD and depression have revealed inconsistent findings regarding their prospective effects on each other. To our best knowledge, among the six longitudinal studies testing both the cross-lagged and autoregressive effects of depression and IGD, two of them have provided supportive evidence to the risk effect of depression on IGD, but not in the reverse direction, among children and/or adolescents (Teng, Pontes, Nie, Griffiths, & Guo, 2021; Wang, Yang, Yan, Tian, & Wang, 2021). By contrast, the prospective effects of IGD on depression but not vice versa were found in two other longitudinal studies among adolescents (Wang et al., 2022; Wartberg, Kriston, Zieglmeier, Lincoln, & Kammerl, 2019), while the remaining two studies found reciprocal predictive effects between depression and IGD using cross-lagged panel models (Jeong et al., 2019; Liu et al., 2018).

Given the aforementioned inconsistent findings, the temporal relationship between IGD and depression still remains an open question. According to the escape theory, addictive behaviours have been conceptualized as maladaptive coping strategies to avoid stressor(s) and/or alleviate associated distress such as depression (Heatherton & Baumeister, 1991; Kwon, Chung, & Lee, 2011). Conversely, addictive behaviours threaten one's self-control system and bring about rumination and negative feelings that can worsen depressive emotions (Presnell, Stice, Seidel, & Madeley, 2009). The current study, consistent with previous studies (e.g., Jeong et al., 2019), hypothesized a bi-directional prospective model between depression and IGD tendency in Chinese young adults, who are a vulnerable group (Dang, Chen, Zhou, Spada, & Wu, 2022). More importantly, the previous inconsistent findings on the depression-IGD link highlight that further research is warranted to understand in more detail mechanisms that may underly such link, and this study aimed to investigate whether and how metacognitions, which have been found to be a transdiagnostic construct in addictive behaviours (Spada, Caselli, Nikcevic, & Wells, 2015), may be involved in this link.

The influences of metacognitions about online gaming on IGD and depression

In psychopathology, metacognitions have been defined as specific beliefs about one's cognitive-affective experiences and coping strategies related to the regulation of affective states (Wells & Matthews, 1994). Metacognitions have been observed to be present in addictive behaviours (Spada, Caselli, et al., 2015) including alcohol use (Spada & Wells, 2006), gambling (Spada, Giustina, Rolandi, Fernie, & Caselli, 2015), and online gaming (Spada & Caselli, 2017). Regarding gaming-specific metacognitions, namely, metacognitions about online gaming (MOG), it is proposed that these are expressed in two distinct domains (Spada & Caselli, 2017): positive MOG and negative MOG. Positive MOG are beliefs about the benefits of online gaming as a cognitive and affective self-regulation strategy, while negative MOG refer to the beliefs about the uncontrollability and dangers of online gaming.

According to the S-REF model extended to addictive behaviours (for a review, see Spada, Caselli, et al., 2015), metacognitions play a crucial role in the activation and persistence of maladaptive coping strategies (e.g., extended thinking and thought suppression) in psychopathology (e.g., addictive behaviours). To be specific, the model posits that positive metacognitions (e.g., the belief that "*online gaming reduces my negative feelings*") directly motivate individuals to engage in gaming, while negative metacognitions (e.g., the belief that "*online gaming makes me lose control*") perpetuate gaming engagement by weakening self-regulatory drives and attempts to control behaviours as well as triggering negative emotional states that may become avoidant-type motivators for the escalation into maladaptive behaviours and eventually addiction. Furthermore, evidence has shown that these metacognitions are associated with increased negative affect as well as craving for engagement in addictive behaviours (Bonner, Allen, Katsikitis, Love, & Kannis-Dymand, 2022). Thus, metacognitions should be expected to be the antecedent of addictive behaviours and negative emotional experiences and/or disorders. As expected, published cross-sectional studies have provided support to the S-REF model by presenting significant and positive associations between MOG and IGD (Akbari, Bahadori, Milan, Caselli, & Spada, 2021; Dang et al., 2022; Gandolfi, Soyturk, & Ferdig, 2021; Marino et al., 2020; Nazligül & Süsen, 2021). These studies do, however, share the crucial limitation of data collection occurring at a single time point.

Furthermore, based on S-REF model, addictive behaviours may also fuel metacognitions (Spada, Caselli, et al., 2015; Wells & Matthews, 1994). This is because individuals engaging in an addictive behaviour (e.g., IGD) will often excessively attend to it (e.g., being alerted to signs of danger and negative outcomes), which will, in turn, typically lock them in a 'cognitive attentional syndrome' (Wells, 2000) characterised by rumination, worry, and catastrophic

thinking (Efrati & Spada, 2023; Wells & Matthews, 1996). Some empirical findings have supported such speculation by demonstrating a vicious cycle between illness-specific metacognitions and insomnia (Palagini et al., 2013) as well as anxiety disorder (Cucchi et al., 2012). Therefore, this study hypothesized a bidirectional relationship between MOG and IGD tendency, which has not, as of yet and to our knowledge, been longitudinally tested.

Based on S-REF model, it is theoretically logical to expect that metacognitions, particularly negative ones, would induce depression related cognitive and attentional responses (e.g., rumination), which may further activate or strengthen metacognitions to engage in addictive behaviour (Spada, Caselli, et al., 2015). In the existing literature, positive associations of MOG with depression were reported among Italian adults (Spada & Caselli, 2017) and Iranian adolescents (Akbari, Bahadori, et al., 2021). However, only negative, but not positive MOG, were found to be positively correlated to depression in Turkish adults (Nazligül & Süsen, 2021). Indeed, there is a lack of empirical research on the prospective effects of MOG on depression and vice versa. In this study, we aimed to address this knowledge gap by exploring the bidirectionality between MOG and depression.

The present study

To our knowledge, there is a lack of longitudinal research evaluating the applicability the S-REF model to depression and IGD by examining any prospective effects among MOG, depression, and IGD. The present study adopted a three-wave longitudinal research design and used a self-reported survey among a sample of young adult gamers. It aimed to not only replicate the anticipated bidirectional relationship between depression and IGD tendency, but also test its underlying metacognitive mechanisms proposed by the S-REF model. It is also the first study to empirically investigate the bidirectionality between MOG and psychopathologies (i.e., depression and IGD tendency). In this study, we first hypothesized a positive and bidirectional relationship between depression and IGD tendency (H1), then a positive reciprocal prospective effect between both MOG factors and depression (H2) as well as IGD tendency (H3), respectively (see Fig. 1).

METHOD

Participants and procedures

This three-wave longitudinal study, with 6-month interval for each wave, used a convenience sampling method at a public university in Henan province, China. The first wave (W1), the second wave (W2), and the third wave (W3) survey were conducted in the period between June 2021 and June 2022. We recruited the participants from university-wide courses with various majors, and all the participants were undergraduate students aged 18 years or above and with past-year gaming experience. Each survey was conducted in a classroom setting during a 20-min class break when the course instructors were absent in the classroom. The survey was conducted by a trained research assistant with the procedures: 1) she provided a short introduction of the current project to participants, and explained their rights, including the anonymous and voluntary nature of their participation, opt-out option available at any time without any punishment, confidentiality of their responses, and aggregated data analysis and report; 2) those participants who were eligible and willing to take part in the survey provided their consent by scanned a QR code with their own smartphones and selected the button "*I acknowledged participants' rights, and agree to take part in this survey*"; and 3) after giving the consent, participants clicked the button

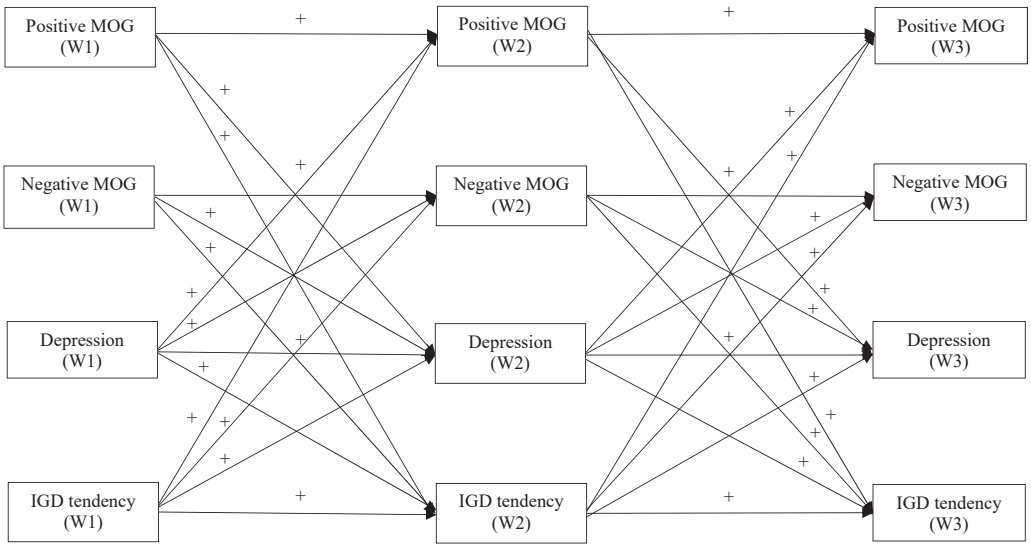

Fig. 1. The hypothesized model

Note. MOG = Metacognitions about online gaming; IGD = Internet Gaming Disorder; W1 = Wave 1, W2 = Wave 2, W3 = Wave 3.

"*Next*" to start the survey which generally took around 15 min to complete; 5) during the survey, the research assistant was present in the classroom for answering any questions related to this survey. The ethics approval for conducting this project was obtained from the research ethics committee of the affiliated department of the corresponding author.

In the surveys, all items of the online questionnaire were set to be answered mandatorily, with an option "*Not Applicable*" for the participants to choose if they either regarded the question not suitable for them or refused to answer the question. Those responses were considered as "*missing*" in this study. The collected cases were further checked by the first co-first author and those cases who showed an extreme response style (i.e., selecting extreme endpoints on rating scales) and/or had missed responding to one or more measures ($n = 10$) were considered as invalid and excluded (Wu, Yang, Zhou, Dang, & Chen, 2023). In the baseline survey (i.e., W1), 1,243 valid cases were collected and invited to take part in the W2 and W3 surveys in their classes. The responses of each participant at different waves were matched with a personal code (consisting of the birth date of the participants, the family name of the participants' mother, and the last number of participants' student ID) he/she developed. All the matched data were used in the formal statistical analysis.

Measures

IGD tendency. The 27-item Chinese Internet Gaming Disorder Checklist (C-IGDC; Chen et al., 2020) was specifically developed for Chinese background gamers based on the IGD criteria of DSM-5 (APA, 2013). It consists of nine dimensions (i.e., preoccupation, withdrawal, tolerance, unsuccessful control, continued playing despite psychosocial problems, loss of interest, deception, escape, and physical problems). Participants were asked to rate their gaming experience during the previous 12 months on a 3-point scale (0 = *never*, 1 = *sometimes*, and 2 = *often*). A sample question is "*How often did you feel anxious and/or irritated while not being able to play Internet games?*" Higher summation scores of all items indicate higher IGD tendency. In the current study, the internal reliabilities of this scale at the three waves were satisfactory, with Cronbach's $\alpha = 0.946$, 0.936, and 0.960.

MOG. The validated Chinese version of Metacognitions about Online Gaming Scale (C-MOGS; Dang et al., 2022) was used to assess positive and negative MOG. The scale has two factors, namely, positive MOG, which refers to the usefulness of online gaming as cognitive-affective self-regulatory strategy and consists of 5 items (e.g., "*Online gaming helps me to control my negative thoughts*"); and negative MOG, which refers to the thoughts of uncontrollability and dangers of online gaming and consists of 6 items (e.g., "*I have no control over how much time I play*"). Participants were asked to rate the extent of their agreement to each item on a 4-point scale (ranging from "*do not agree*" to "*agree very much*"). A higher mean score on each subscale represents a higher level of the corresponding metacognitions. The Cronbach's α for the positive subscale at three waves were 0.923, 0.899, and 0.929. The values for the negative subscale at three waves were 0.900, 0.848, and 0.910.

Depression. Depression was measured by the depression subscale of Lovibond and Lovibond's (1995) Depression Anxiety Stress Scale (DASS-21; the Chinese version, Wang et al., 2016), which is a cost-effective self-report instrument for depression as no special skills are required to administer it. DASS-21 was developed for the evaluation of negative emotional syndromes of depression, anxiety, and stress. This scale has been applied to various clinical and non-clinical populations in many countries (Beaufort, De Weert-Van Oene, Buwalda, de Leeuw, & Goudriaan, 2017; Bibi, Lin, Zhang, & Margraf, 2020; Lee, Lee, & Moon, 2019). The Chinese version has also been widely used across populations, including young adults (e.g., Chen, Yu, Su, Tong, & Wu, 2021; Lu et al., 2018; Wu et al., 2022). The depression subscale of DASS-21 showed high internal consistency and good criterion validity (for a review, Lee et al., 2019). Its seven items (e.g., "*I felt that I had nothing to look forward to*") were rated on a 4-point scale, in which 0 = *Do not apply to me at all* to 3 = *Apply to me very much*. DASS-21 considers depression as intrinsically dimensional and varying along a continuum of severity and thus a higher summation score (which should be further multiplied with 2; Gomez, 2016) represents a higher level of depression. Based on the user guide of DASS-21 (Gomez, 2016), the summation scores can be also used to categorize people who are experiencing depression and being at risk of developing more extreme symptoms, with 0–9 = *normal*, 10–13 = *mild*, 14–20 = *moderate*, 21–27 = *severe*, 28 and above = *extremely severe*. The Cronbach's α of the depression subscale were 0.919, 0.916, and 0.938, at the three surveys of this study.

Demographic information. The participants' age and gender at the first wave were also collected in the current study.

Data analysis

Descriptive statistics, reliability analyses, and correlation analyses were conducted in SPSS 26. A three-wave path model analysis, in which the auto-regressive effects of each variable in its longitudinal variation and the cross-sectional (residual) correlations among all variables at the same time point were controlled for, was conducted in Mplus 8.3 to test the hypothesized longitudinal and reciprocal relationship between depression and IGD tendency, as well as the bidirectional and prospective effects of positive/negative MOG on depression and IGD tendency. As result of the Henze-Zirkler's multivariate normality test (Henze & Zirkler, 1990; HZ = 3.80, $p = 0.091$) did not reject the null hypothesis that our data conform to multivariate normality distribution, the full-information maximum likelihood (FIML) estimation was hence adopted to handle missing values in the three-wave data set (Enders, 2010). Considering the relatively high

dropout rates of participants across the three waves, sensitivity analyses were conducted by: (i) a complete case analysis; and (ii) a re-test of the proposed path model using multiple imputation to handle missing values in order to check the robustness of the model results. Based on the recommendation of Hu and Bentler (1999), the comparative fit index (CFI; acceptable > 0.90), Tucker-Lewis index (TLI; acceptable > 0.90), standardized root mean square residual (SRMR; acceptable < 0.08), and root mean square error of approximation (RMSEA; acceptable < 0.08) were adopted to evaluate the goodness of model fit. A bootstrapping approach with 5,000 re-samples was further applied to test potential longitudinal mediation effects in Mplus 8.3.

Ethics

The ethics approval for conducting this project was obtained from the research ethics panel of the affiliated department of the corresponding author. The study was conducted in accordance with the Declaration of Helsinki and according to requirements of all applicable local and international standards.

RESULTS

Descriptions of demographics and psychological variables at three waves

The descriptive statistics of all variables at three waves are shown in Table 1. Among the 1,243 participants at W1, 57.0% were females, with their ages ranging from 18 to 25 years (M = 19.77, SD = 1.29). Their mean IGD tendency score was 9.61 (SD = 8.84, scale range = 0–54), and 63.0% of them had no risk of depression, 5.8% were mildly depressed, and 19.3% were moderately depressed risk; the rest were in severe (6.9%) and extremely severe (5.0%) depression status.

Table 1. Descriptions of variables at three waves

Variables	Wave 1 (N = 1,243)	Wave 2 (N = 622)	Wave 3 (N = 574)
Gender (%)			
Male	43.0	37.9	39.9
Female	57.0	62.1	60.1
Depression status (%)			
No	63.0	81.7	72.2
Mild	5.8	4.2	6.5
Moderate	19.3	9.4	14.0
Severe	6.9	2.4	4.0
Extremely severe	5.0	2.3	3.3
Positive MOG (range = 1–4)	1.77 (0.68)	1.73 (0.68)	1.65 (0.65)
Negative MOG (range = 1–4)	1.47 (0.56)	1.37 (0.49)	1.39 (0.53)
IGD tendency (range = 0–54)	9.61 (8.84)	9.09 (8.44)	9.32 (9.65)
Age (range = 18–25)	19.77 (1.29)	–	–

Note. MOG = Metacognitions about online gaming; IGD = Internet Gaming Disorder; Values for gender and depression status represent percentages; Values for positive MOG, negative MOG, IGD, and age represent means (standard deviations).

In W2 and W3, 622 and 574 further participated in the survey, respectively. Comparisons were made between participants who followed-up and dropped to W2 and W3 surveys, respectively, using their baseline data. No significant differences were found in terms of IGD tendency (t = 1.27, p = 0.205 and t = −0.36, p = 0.716), positive MOG (t = 0.89, p = 0.376 and t = 0.39, p = 0.696), and depression status (χ^2 (4) = 8.89, p = 0.064 and χ^2 (4) = 6.36, p = 0.174). Older participants are more likely to drop out in W3 survey (t = 6.08, p < 0.001) while male participants were more likely to drop out in both W2 and W3 surveys (χ^2 (1) = 12.80, p < 0.001 and χ^2 (1) = 4.09, p = 0.043). The negative MOG also differed in those who attended and dropped to both W2 and W3 surveys (t = 3.75, p < 0.001 and t = 2.36, p = 0.019).

Preliminary analysis

The inter-correlations among variables are shown in Table 2. Depression was represented by the raw total scores of the depression subscale of DASS-21 as a continuous variable. All psychological variables at all waves are significantly associated with each other in the expected direction (r = 0.14 to 0.71, p < 0.001). Regarding demographic effects, only gender was significantly associated with all psychological variables at all waves (r = 0.18 to 0.35, p < 0.001). Considering both the results of correlation analysis and its significant effect on attrition rate, gender was controlled for in all psychological variables in the subsequent analyses. A significant association of age was found with only W1 depression, but not other psychological variables, and thus the effect of age on W1 depression was controlled for in the subsequent analyses (r = −0.06, p = 0.027).

Testing the proposed three-wave path model

Path analysis was conducted to test the proposed model, and results showed an acceptable model fit, χ^2 (31) = 131.76, p < 0.001, CFI = 0.96, RMSEA = 0.05, 90% CI [0.042, 0.060], SRMR = 0.04. The standardized path coefficients of the model are shown in Fig. 2. For the hypothesized positive bi-directional associations between depression and IGD tendency, we found only depression significantly and positively predicted IGD tendency at the next wave (W1 to W2, β = 0.12, p = 0.006 and W2 to W3, β = 0.14, p = 0.027), but not vice versa, indicating H1 was only partially supported.

Regarding the hypothesized bidirectional associations between MOG and depression (H2) as well as IGD tendency (H3), negative MOG significantly predicted depression (W1 to W2, β = 0.14, p = 0.040 and W2 to W3, β = 0.17, p = 0.023) in the expected direction and vice versa (W1 to W2, β = 0.17, p < 0.001 and W2 to W3, β = 0.18, p = 0.010), whereas no significant longitudinal associations between positive MOG and depression were found. Hence H2 was only partially supported. On the other hand,

Table 2. Correlations among variables at three waves

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. PMOG (W1)	–												
2. NMOG (W1)	0.52***	–											
3. Depression (W1)	0.27***	0.48***	–										
4. IGD tendency (W1)	0.46***	0.54***	0.35***	–									
5. PMOG (W2)	0.37***	0.17***	0.21***	0.34***	–								
6. NMOG (W2)	0.20***	0.40***	0.35***	0.35***	0.45***	–							
7. Depression (W2)	0.14***	0.30***	0.44***	0.27***	0.23***	0.45***	–						
8. IGD tendency (W2)	0.31***	0.41***	0.34***	0.51***	0.50***	0.69***	0.46***	–					
9. PMOG (W3)	0.40***	0.22***	0.22***	0.33***	0.39***	0.28***	0.24***	0.34***	–				
10. NMOG (W3)	0.26***	0.39***	0.37***	0.36***	0.27***	0.51***	0.43***	0.50***	0.59***	–			
11. Depression (W3)	0.17***	0.29***	0.43***	0.27***	0.15***	0.37***	0.43***	0.31***	0.28***	0.54***	–		
12. IGD tendency (W3)	0.25***	0.36***	0.34***	0.43***	0.26***	0.48***	0.40***	0.51***	0.51***	0.71***	0.43***	–	
13. Gender#	0.18***	0.27***	0.29***	0.32***	0.21***	0.32***	0.30***	0.35***	0.20***	0.30***	0.27***	0.31***	–
14. Age (W1)	0.00	0.02	−0.06*	−0.01	−0.04	−0.05	−0.03	−0.07	−0.08	−0.03	0.01	−0.06	−0.01

Note. #Dichotomous variable (0 = Female, 1 = Male); PMOG = Positive metacognitions about online gaming; NMOG = Negative metacognitions about online gaming; IGD = Internet Gaming Disorder; W1 = Wave 1, W2 = Wave 2, W3 = Wave 3; * $p < 0.05$, *** $p < 0.001$.

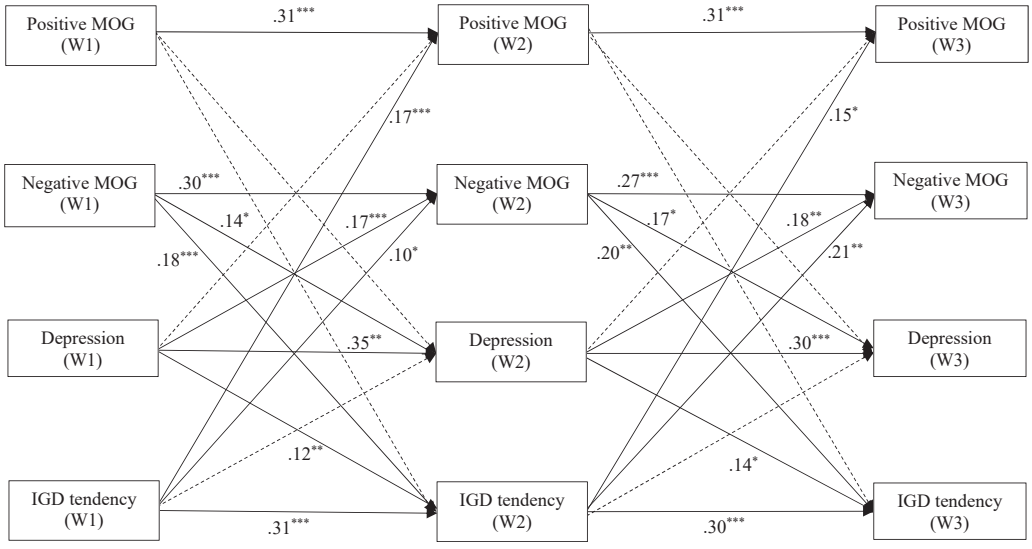

Fig. 2. Results of the three-wave path model analysis

Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. MOG = Metacognitions about online gaming; IGD = Internet Gaming Disorder; W1 = Wave 1, W2 = Wave 2, W3 = Wave 3; Gender was controlled for all variables at three waves in the model, while age (W1) was controlled for Depression (W1). Standardized coefficients are presented. The cross-sectional correlations among positive MOG, negative MOG, depression, and IGD at W1 and their residual correlations at W2 and W3 (ranging from −0.14 to 0.60, $p < 0.01$) were controlled for when testing the path model but are not shown in the figure for its clarity. Coefficients of non-significant paths (dotted-line) (range from −0.05 to 0.10) are also not shown.

negative MOG and IGD tendency were found to reciprocally predict each other at the next wave (negative MOG to IGD tendency: W1 to W2, $\beta = 0.18$, $p < 0.001$ and W2 to W3, $\beta = 0.20$, $p = 0.004$; IGD tendency to negative MOG: W1 to W2, $\beta = 0.10$, $p = 0.050$ and W2 to W3, $\beta = 0.21$, $p = 0.006$), while IGD tendency predicted later positive MOG (W1 to W2, $\beta = 0.17$, $p = 0.001$ and W2 to W3, $\beta = 0.15$, $p = 0.021$) but not inversely. So, H3 was only partially supported.

Exploring the potential mediation effects

The resultant path model supported the bidirectionality between negative MOG and depression as well as their stable predictive effects on later IGD tendency and thus provided

the basis for further examination of potential mediation of negative MOG/depression. Specifically, we further tested the indirect predictive effects of both depression and negative MOG at W1 on IGD tendency at W3. Results of the bootstrap analysis showed depression (W1) predicted IGD tendency (W3) through negative IGD tendency (W2), with standardized mediation effect = 0.03, 95% CI [0.009, 0.071], and negative MOG (W1) predicted IGD tendency (W3) via depression (W2), with standardized mediation effect = 0.02, 95% CI [0.001, 0.058].

Sensitivity analyses

First, a complete case analysis with a subsample of 380 participants who had no missing values on all the three waves was conducted as a sensitivity check. The proposed three-wave path model fit the data of these 380 complete cases well, χ^2 (31) = 86.21, $p < 0.001$, CFI = 0.97, RMSEA = 0.07, 90% CI [0.052, 0.086], SRMR = 0.04. Moreover, the statistical significance of the coefficient of each cross-lagged path remained unchanged, except that the standardized path coefficient of the path from negative MOG (W1) to depression (W2) was statistically non-significant despite it being consistently positive and mild in value (see Table S1 in Supplementary material for detailed information).

In addition, we re-tested the proposed longitudinal path model using multiple imputation to deal with the missing values among all the 1,243 cases, and the model fit stayed satisfactory, χ^2 (31) = 126.10, $p < 0.001$, CFI = 0.96, RMSEA = 0.05, 90% CI [0.041, 0.059], SRMR = 0.04. The statistical significance of all the proposed paths remained the same, except that: (i) the path from positive MOG (W1) to IGD tendency (W2) became significant; and (ii) the path from IGD tendency (W1) to negative MOG (W2) became non-significant, while their path coefficients remained mild and positive (see Table S2).

In sum, the results of the two sensitivity analyses supported the robustness of the current findings.

DISCUSSION

Under the framework of S-REF model of psychopathology (Wells & Matthews, 1994, 1996) and the metacognitive theory of psychological disorders (Wells, 2000, 2010), this three-wave longitudinal study tested the temporal relationships among depression, IGD tendency, and MOG. Its data showed that depression consistently predicted IGD tendency but not vice versa, and only negative MOG, but not positive MOG, had prospective and bidirectional associations with both depression and IGD tendency across waves. It is also noteworthy that depression (W1) would indirectly heighten IGD tendency (W3) via negative MOG (W2), while depression (W2) also mediated the effect of negative MOG (W1) on IGD tendency (W3). These findings deepened our understanding of the interplay among depression, IGD tendency, and metacognitions (i.e., positive MOG and negative MOG) across time, particularly the role of metacognitions, which may be of value as a target in the prevention and intervention efforts to address behavioral addictions using metacognitive-based methods.

Instead of bidirectionality, our data supported that only depression predicted IGD tendency but not vice versa, and this finding is consistent with the results of Teng et al. (2021) that depression predicted IGD tendency six months later but not inversely among Chinese children and adolescents. The one-way predictive effect of depression was found not only on IGD tendency, but on other behavioral addictions. For example, in Zhou and colleagues' (2021) longitudinal study, depression also predicted later smartphone addiction, but not inversely, among Chinese adolescents. So, these findings suggest depression is an antecedent of symptoms of behavioral addictions as technological use is commonly taken as a convenient form of coping for psychological distress (Chang, Chang, Hou, Lin, & Griffiths, 2021; Friedman, 2020). However, those symptoms do not necessarily increase one's psychological distress, at least in a period of one or two years.

Regarding the longitudinal associations of MOG with depression and IGD tendency, only the negative facet of MOG had reciprocal effects with both depression and IGD tendency while positive MOG was not able to predict later depression or IGD tendency. Indeed, previous cross-sectional studies consistently found that, compared to its positive component(s), the negative component(s) of behaviour-specific metacognition had stronger correlations with not only corresponding addiction (e.g., IGD, smartphone addiction, and gambling disorder; Nazligül & Süsen, 2021; Zhou et al., 2022) but also depression (Akbari, Zamani, Fioravanti, & Casale, 2021; Nazligül & Süsen, 2021) across ethnic groups. Drawing upon the metacognitive theory of psychological disorders applied to addictive behaviours (Spada, Caselli, et al., 2015), positive and negative MOG may play different roles at IGD development and be associated with different outcomes. Specifically, positive MOG, the recognition of the usefulness of online gaming, may trigger individuals to start gaming but not necessarily bring about problematic gaming behaviours. Negative MOG, referring to the recognition of the harm and uncontrollability of online gaming, may cause extended and perseverative styles of thinking over online gaming and reduce individuals' perceived self-control over gaming behaviours. Such thoughts can result in negative emotions that exacerbate psychopathology symptoms and weaken motives to control the cause extensive gaming. It is hence not surprising that negative MOG was found to be more closely related to depression than positive MOG in this study.

While negative MOG increased one's risk for both depression and IGD, IGD tendency was also associated with higher levels of positive and negative MOG assessed in subsequent waves in our study. Disordered gamers are more vulnerable to the automatic attentional bias to gaming-related stimuli (Kim et al., 2019), and such excessive attention to gaming may cause repetitive thinking and/or introspection about online gaming, increasing both positive and negative MOG. Moreover, the prospective effect of

depression on negative, but not positive, MOG was also observed. One possible explanation is that the general depressive mood could drive negative thinking (Teasdale, 1983), such as negative MOG, rather than positive thinking.

This study further added longitudinal evidence to the literature that negative MOG mediates the effect of depression on IGD tendency. The findings were consistent with those from previous cross-sectional studies of addictive behaviours, in which negative (but not positive) metacognitions about smoking and smartphone use mediated the effect of social anxiety on nicotine dependence and the effect of psychological distress on problematic smartphone use, respectively (Casale, Fioravanti, & Spada, 2021; Izadpanah, Najafi, & Khosravani, 2021). Moreover, this study also identified the significant mediating effect of depression on the prospective relationship between negative MOG and IGD tendency. Although Zhou et al.'s (2021) two-wave longitudinal study similarly suggested baseline depression mediating the relationship between baseline metacognitions and follow-up smartphone addiction, this study is the first to provide 3-wave evidence for such mediation. Echoing the prior findings, our findings not only showed the bidirectional link between depression and negative MOG and their risk effect on IGD tendency but also reassure us that altering negative MOG may be a promising strategy in integrated treatment programmes for IGD.

There are three major limitations in this study. First, the non-probability sample recruited with convenience sampling method might limit the generalizability of the current findings to all Chinese gamers as well as gamers of other ethnicity. In particular our sample mainly consists of those undergraduates who just entered their adulthood. One should also note that the attrition rate in this longitudinal study was relatively high, as about half of the participants recruited in the baseline wave dropped out from the two follow-up surveys. Although FIML was implemented to try to retain all collected data of all cases in model testing, the generalizability of the present findings may still be weakened by this high attrition (Gustavson, von Soest, Karevold, & Roysamb, 2012). Last, but not least, both depression and IGD symptoms were self-reported by the participants and such measures were susceptible to bias. If resource allows future research with a cross-cultural design, probability sampling in a general adult population, monetary incentives, as well as clinical assessment and family/peer report for the disorder variables are encouraged to test the replicability of the current findings.

Despite the aforementioned limitations, this is the first longitudinal study that tested the prospective effects of depression, IGD tendency, and MOG on each other. In addition to the hypothesized cross-lagged effects of MOG on both depression and IGD tendency, the significant mediating role of depression between MOG and IGD tendency illustrated that metacognitions increase one's vulnerability to behavioral addictions (e.g., IGD in our case) not only directly and cognitively (e.g., extended thinking and thought suppression), but also indirectly and emotionally by aggregating negative emotions (e.g., depression). In particular negative MOG was more salient predictor than positive MOG. In future IGD interventions, metacognition-focused interventions (e.g., Metacognitive Therapy [MCT]; Wells, 2011; 2013) can be applied to break the vicious cycle comprising negative MOG, depression, and IGD. The aim of MCT is to address gamers' maladaptive metacognitive processes by interrupting maladaptive metacognitive control strategies (e.g., rumination, worry, and desire thinking regarding gaming) as well as identifying and restructuring metacognitions related to these control strategies (Wells, 2013). A variety of MCT techniques can be employed to achieve these goals, including attention training, detached mindfulness, and postponement of engagement. MCT can also help gamers become more aware of their gaming-related thoughts and enhance their capacity to take a decentered (metacognitive) perspective on such thoughts in turn facilitating self-regulation (Wells, 2013; Wells et al., 2009). Given the risk-enhancing role of depression, we also recommend future IGD interventions to evaluate and monitor the depression risk among online gamers, screen those with high depression risk as of high IGD risk, and simultaneously provide them with emotional regulation training (e.g., emotion regulation skills training, Berking, Ebert, Cuijpers, & Hofmann, 2013) in order to simultaneously reduce their risks for IGD and depression.

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SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1556/2006.2023.00072.

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