Predicting Internet Gaming Disorder symptoms in young adolescents: A one-year follow-up study

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ABSTRACT

Background and Aims: Problematic gaming behavior in adolescence is becoming a bigger societal problem. An increasing number of adolescents have difficulties in controlling their game play and are at risk for the development of Internet Gaming Disorder (IGD) symptoms already at a young age.
Design: In this longitudinal study, 354 adolescents (mean age = 13.9, 48.9% boys) were followed over 12 months. It was hypothesized that attention problems, social vulnerability, and life satisfaction uniquely and interactively predict increase in IGD symptoms.
Results: The findings of a zero-inflated model revealed main effects of social vulnerability (B = 0.297, SE = 0.142) and attention problems (B = 0.298, SE = 0.134) on IGD symptoms while controlling for gender differences. In addition, the effect of attention problems on IGD was the strongest among adolescents who were more socially vulnerable (B = −0.681, SE = 0.140) and less satisfied with life (B = −0.485, SE = 0.199).
Conclusions: Adolescents with attention problems might have difficulties in directing their attention towards other tasks, placing them at an increased risk for developing problematic gaming behavior. This risk is further exacerbated by social vulnerability and dissatisfaction with life.

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1. Introduction

Since the introduction of online video games (Massively Multiplayer Online Role Playing Games, MMORPG), compulsive gaming has become a significant and growing societal problem (van Rooij, Schoenmakers, van den Eijnden & Mheen, 2010; Young, 2009). Depending on the definition of gaming addiction that has been used, prevalence rates among adolescents fluctuate between five and ten percent (Kuss & Griffiths, 2012). In the Netherlands, about 3% of the adolescents between 13 and 16 years has been identified as addicted to online gaming (van Rooij, Kuss, Griffiths, Shorter, Schoenmakers, & Van de Mheen, 2014; van Dorsselaer et al., 2016). In addition, a nearly 6% increase in the number of addicted gamers (adolescents and adults) looking for professional help has been reported from 2013 (N = 514) to 2014 (N = 544) by the Dutch addiction care system (Leeuwen & Goossens, 2016). The American Psychiatric Association (APA) recognizes the fact that game addiction can be a serious threat to the psychosocial

development of adolescents, since Internet Gaming Disorder (IGD) has been added to Section III as a "condition warranting further study" in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5).

Although an increasing number of studies have addressed possible risk factors causing the shift from normal to compulsive gaming behavior in adolescents, important research questions remain unanswered because most existing research uses cross-sectional designs (Bavelier et al., 2011). Hence, there is a strong need for comprehensive longitudinal research on gaming addiction (Petry & O'Brein, 2013) that would utilize a generally accepted definition and diagnostic criteria, for instance the definition and criteria used by the DSM-5. Although some researchers (Griffiths et al., 2016) have criticized this DSM-5 definition, they appear to agree that the nine DSM-5 criteria for IGD reflect problematic gaming behavior. For this reason, rather than applying strict criteria to identify adolescents with IGD (cf. Gentile et al., 2011), i.e., those who meet five out of nine criteria, the aim of this study is to address increased symptoms of IGD and look at possible risk factors underlying this increase. By doing so, we try to get a better understanding of the risk factors involved in the development of IGD symptoms. In the following we will therefore refer to problematic

gaming behavior instead of gaming addiction.

One of the problems of studying IGD in young adolescents is the low prevalence rates of IGD symptoms (van Rooij et al., 2014), contributing to analytical difficulties and challenges. A way of dealing with the many zero counts on IGD symptoms is using a zero-inflated model (ZIP; Peeters et al., 2012). The present study will use such zero-inflated model to evaluate three different theoretical models that could non-exclusively explain the increase in IGD symptoms in adolescence. To the best of our knowledge, this longitudinal study will be the first to use advanced statistical methods (ZIP-models) that allow us to look at a continuous outcome measure while taking into account the many zeros which are characteristic for low prevalence rates such as with IGD symptoms in young adolescents.

1.1. Theoretical models possibly explaining the transition from problematic to compulsive gaming behavior

1.1.1. Social vulnerability mechanism

A possible explanation for why some adolescents are more likely to engage in game play and eventually develop IGD is that it could serve basic psychological needs, such as the need for belonging, autonomy, and competence (Przybylski, Rigby, & Ryan, 2010). Those who have difficulties in social relationships and who lack social skills (i.e. are social vulnerable) may be more likely to find reassurance in gaming (Lemmens, Valkenburg, & Peter, 2011). Games have the potential to create new (online) social relationships, and playing games might increase feelings of belongingness and increase perceived social competence of adolescents (Beranuy, Carbonell, & Griffiths, 2013; Forrest, King, & Delfabbro, 2016; King & Delfabbro, 2014; Young, 2009; van Rooij et al., 2014). For socially vulnerable youngsters, power and status attainment through playing games may be particularly rewarding since these youngster may more likely experience low social power and social status in the real world (King & Delfabbro, 2014). Particularly boys appear to be sensitive for the achievement of status and power in competitive settings (Byrnes, Miller, & Schafer, 1999; Wilson & Daly, 1985; de Boer, Peeters, & Koning, 2016). The need to achieve status might therefore particularly place boys at increased risk for excessive game play, which could partly explain the higher rates of IGD among boys (Gentile et al., 2011).

Social vulnerability is a broad concept used in different fields of research and capturing several aspects of social dysfunction (Crick & Dodge, 1994). In this paper we will operationalize social vulnerability as the degree to which individuals experience problems with social relationships such as forming and maintaining friendships. We hypothesize that individuals who have difficulties with friendship formation in real life, and thus feel more social vulnerable, might be more attracted towards playing games to fulfill the need of belonging and social competence (Przybylski et al., 2010).

1.1.2. Life dissatisfaction mechanism

As is the case for many addictive behaviors, gaming could also be a result of coping with negative emotions and unwanted feelings (Young, 2009). Playing games could help some individuals to cope with the negative emotions in daily life (cf. review Kuss & Griffiths, 2012; for a detailed overview). Nevertheless, playing games to deal with negative emotions may be a risky coping strategy with respect to the development of problematic gaming behavior. That is, coping motives for the engagement in certain behaviors (e.g. eating, drinking, drug use) are associated with many compulsive and addicted behaviors, like alcohol misuse (Cooper, 1994; Littlefield, Sher, & Wood, 2010), drug misuse (Sinha, 2007), and they could in a similar way be related to compulsive game play (Bischof-

Kastner, Kuntsche, & Wolstein, 2014; Kuss & Griffiths, 2012).

Kuss, Louws, and Wiers (2012) found that specifically MMORPG players who indicate escapism motives as reasons for playing are at risk for excessive and compulsive game play. A qualitative study by Beranuy et al. (2013) among addicted game players in therapy, revealed that escapism of conflict in daily life was one of the three reasons why these gamers continued playing games. In addition, Festl, Scharkow, and Quandt (2013) found that problematic gamers were less satisfied with life, which may indicate that problematic gaming may be a way to escape from reality. Lemmens et al. (2011) found that lower life satisfaction among adolescents (11–17 years) was associated with pathological gaming cross-sectional, though in their study life dissatisfaction did not predict increase in pathological gaming six months later. Together, these studies suggest that playing games can serve as a coping strategy for dealing with negative emotions and conflict in reality. Coping motives and strategies have been associated with increased risk for addictive behavior (Cooper, Frone, Russell, & Mudar, 1995; Kuntsche, Knibbe, Gmel, & Engels, 2005; Sinha, 2007). Possibly, adolescents who are less satisfied with life and thus are more likely to have to deal with negative emotions and thoughts (Hagström & Kaldo, 2014) are at a greater risk for developing IGD symptoms. We therefore hypothesize that individuals who are less satisfied with life might play games to avoid negative thoughts and emotions, and as such show an increased risk for problematic gaming.

1.1.3. Attention problem mechanism

Lastly, it is proposed that adolescents who experience problems with attention and cognitive control are at risk for developing IGD symptoms. Cross sectional studies have indeed found a relation between video game use and attention problems in adolescents (Swing, Gentile, Anderson, & Walsh, 2010). In contrast, Ferguson and Olson (2013) found no relation between the amount of playing games in general and ADHD symptoms. Though it was found that individuals with ADHD reported more coping motives (e.g. stress, anger, escaping) as reason for their game play. Moreover, Gentile, Swing, Lim, and Khoo (2012) found a bidirectional association over time between playing games and attention problems. Adolescents who played games reported an increase in attention problems after playing games. In addition, the authors found that both attention and behavioral control were predictive of time spent on playing games; adolescents with attention problems and weaker behavioral control skills spent more time on playing games. Ferguson and Ceranoglu (2014) studied pathological gaming and found that attention problems prospectively predicted pathological gaming in adolescents. These longitudinal findings suggest that attention problems might be a risk factor for the development of IGD symptoms in adolescents.

Adolescents with deficits in attention and cognitive control more likely have difficulties in organizing and planning behavior in the long-term (Corbetta & Shulman, 2002; Engle, 2002) and are more inclined to pursue immediate satisfaction (Barkley, 1997). When adolescents with attention problems play games, they might be more preoccupied with the game, and have more difficulties in regulating their attention towards other tasks that require deliberation (Gentile et al., 2012). This preoccupation with the game, also known as "flow" (Kim & Davis, 2009; Kuss & Griffiths, 2012), refers to the psychological process of being absorbed by the game and lose everything else out of sight. This flow might be more pronounced in adolescents with attention problems who already have trouble with anticipating other tasks and organizing their behavior (Barkley, 1997; Engle, 2002). Moreover, the adolescents who otherwise encounter problems in focusing on a specific task may perceive the experience of being able to pay attention to a specific task, in this case game play, as extra rewarding. These

adolescents might therefore be at greater risk for developing IGD symptoms.

1.2. Present study

In this longitudinal study, we evaluated three different theoretical mechanism (social vulnerability, life dissatisfaction, attention problems) that could explain an increase in IGD symptoms and perhaps shed light on the social or cognitive risk factors involved in the development of IGD in adolescents. Recent studies (cf. Ferguson & Olson, 2013; Przybylski et al., 2010) suggest that adolescents can have different social (e.g. social interaction) and cognitive (e.g. stress reduction) motivations for playing games. Ferguson and Olson (2013) found that the need for autonomy and control was the highest amongst those with mental health problems. They argued that because of the fact that individuals with mental health problems, and more specifically with attention problems, might experience a lower level of autonomy and control in real life, it is perhaps reason for them to search for these needs in games. This suggests that there might be a cumulative risk of the different mechanism proposed. Therefore, interactions between the three mechanisms are examined. The two central questions in this study are:

1) Do differences in social vulnerability, life satisfaction, and attention problems predict an increase in IGD symptoms (one-year follow-up) in young adolescents?
2) Do interactions between social vulnerability, coping, and attention predict an increase in IGD symptoms (one-year follow-up) in young adolescents?

2. Method

2.1. Participants

The data for this study were collected as part of the Digital Youth Project (DYP), a longitudinal research project on online behaviors of Dutch adolescents. Adolescents in the first and second year of two public secondary education schools (grades 7 and 8) participated in two measurement waves with one-year interval between waves. The first measurement (T_1) was conducted in February 2015 and the second in February 2016.

At T_1, the sample (48.9% boys) averaged 13.90 years ($SD = 0.74$; range 11–15) of age. Most participants (82%) had a Dutch background, with both parents also born in the Netherlands. Of the 544 participants included at T1, 354 (65%) were also included at T2. Non-response was mainly due to the dropout of complete classes because some teachers were not able to schedule classroom time for the online measurement or were absent during the measurement days. Some teachers declined further participation. In addition, some individual students dropped out because they had left school, or they were absent on the measurement day. Since full classes were missing (declined further participation) and only two waves were available, we decided to perform an attrition analyses and use full information maximum likelihood (FIML) to deal with missing data only on specific variables and not on entire waves. This resulted in a sample of 354 adolescents. Compared to participants who completed both waves, participants who dropped out at T2 were somewhat older (t (558) = 4.090, p < 0.001), had lower education (t (558) = 4.511, p < 0.001), and had a slightly greater number of IGD symptoms at wave 1 (t (457) = 2.122, p = 0.034). No significant differences between drop-outs and the remaining sample were found for social vulnerability, life satisfaction, and attention problems at T1.

2.2. Procedure

Adolescents were recruited from two secondary schools in two medium to large cities in the Netherlands. Prior to the first measurement, parents received information describing the aims of the study, confidentiality safeguards, and procedures for declining or ending participation. If adolescents wished to participate, their parents had to provide passive informed consent (>99% of parents agreed upon participation). At both measurements, adolescents completed a computer-based questionnaire at school during regular school hours. Research assistants were present to supervise the data collection, answer student questions, and ensure maximum privacy.

2.3. Measures

2.3.1. IGD symptoms

IGD symptoms were measured with nine dichotomous (no, yes) items of the Internet Gaming Disorder Scale (Lemmens, Valkenburg, & Gentile, 2015). These nine items were based on the diagnostic criteria of Internet Gaming Disorder, i.e., *Preoccupation, Persistence, Tolerance, Withdrawal, Displacement, Escape, Problems, Deception,* and *Conflict,* as described in Appendix of the DSM-5. A sample item measuring Persistence is, "During the last 12 months …. were you unable to reduce your time playing games after others had repeatedly told you to play less?" A sum score was calculated and used as outcome measure in this study. Cronbach's α was 0.74 (T1) and 0.77 (T2).

2.3.2. Social vulnerability

Social vulnerability was assessed with a Dutch version (Competentiebelevingsschaal voor Adolescenten CSBA; Treffers, Goedhardt, Veerman, van den Bergh & Ackeart, 2002) of the Harters' Self Perception Profile of Adolescents (Harter, 1988). We used the subscale "Close Friendships," which assesses the ability to establish and retain close friendships. This subscale includes five items, which could be answered on a five-point scale ("totally agree" to "totally disagree"). Examples of items are, "I find it hard to get friends on whom I can count" and "I have no close friend to do things together". Mean scores on the five items were calculated and used as a measure of social vulnerability. Higher scores indicated more problems with establishing and retaining close friendships and thus higher social vulnerability.

2.3.3. Life satisfaction

The respondents' life satisfaction was measured using the five-item Satisfaction with Life Scale (SWLS) developed by Diener, Emmons, Larsen, and Griffin (1985). Construct validity of the SWLS has been established through strong correlations with ten other measures of subjective well-being (Diener et al., 1985). Examples of items are, "I am satisfied with my life" and "In most ways, my life is close to my ideal." Response categories ranged from one "totally agree" to six "totally disagree". Cronbach's alpha for this scale was 0.86 at T1. Lower scores indicate less satisfaction with life.

2.3.4. Attention problems

The respondents' attention problems were measured using a subscale of the AVL (Scholte & van der Ploeg, 2005), which measures the behavioral symptoms of ADHD, including attention problems, impulsivity, and hyperactivity. This study included the attention problems subscale measured with nine items (e.g., "I have little attention for details and tend to make unnecessary mistakes") on a 5-point scale ranging from one "never' to five "very often". Mean scores of nine items were calculated and used as measure of attention. Higher scores indicate more attention problems.

Cronbach's alpha for this subscale was 0.90 at T1.

2.4. Analyzing strategy

Descriptive statistics and Pearson correlations were conducted first. Second, a simple path analysis was performed that included all three predictors together (e.g., social vulnerability, life satisfaction, and attention problems) to test their unique contribution to IGD symptoms at T2 as an outcome variable while controlling for T1 IGD symptoms and gender. Since the outcome IGD symptoms measure contained many zeros (70%), a zero-inflated Poisson model (ZIP) was used (Peeters et al., 2012). The interaction effects between the predictors were evaluated in the last model, including the interactions between (1) social vulnerability and life satisfaction, (2) social vulnerability and attention problems, (3) life satisfaction and attention problems, which were examined is separate models. Again, we controlled for gender and previous IGD symptoms in all 3 interaction models. Because of the use of a ZIP-model, no model fit indicators like the comparative fit index (CFI) or root means square error of approximation (RMSEA) were available (Peeters et al., 2012). Maximum likelihood with robust standard errors (MLR) was chosen as an estimation method, and FIML was used to deal with missing data. All analyses were performed using Mplus version 7.3. We used the clustering option in Mplus to control for the fact that students were nested within schools.

3. Results

Table 1 presents the descriptive statistics and Pearson correlations of all study variables. A slight non-significant (t (336) = 0.475) increase in IGD symptoms was observed from T1 to T2. Boys scored significantly higher on T1 and T2 IGD symptoms, and also scored higher on social vulnerability at T1. Positive significant correlations emerged between social vulnerability and attention problems on the one hand and IGD symptoms at T1 and T2 on the other hand. Life satisfaction had a negative significant relation only with T1 IGD symptoms.

3.1. Main effects

Table 1 presents means, standard deviations and Pearson correlations. IGD symptoms at T1 are positively correlated with social vulnerability and attention problems at T1 and negatively with life satisfaction at T1. T2 IGD symptoms are only positively correlated with attention problems and social vulnerability. Boys more likely report IGD symptoms in comparison with girls. Table 2 shows the main and unique effects of social vulnerability, life satisfaction, and attention problems on increase in IGD symptoms. Gender was a significant predictor of increase in IGD symptoms, with boys revealing a stronger increase in IGD symptoms compared to girls (B = -0.765, SE = 0.024). In addition, IGD symptoms at T1 predicted IGD symptoms at T2. For social vulnerability, a significant main effect on increase in IGD symptoms was found. Those who were

Table 2
Multivariate main effects and interaction by social vulnerability, life satisfaction and attention problems predicting internet gaming disorder symptoms (ZIP model).

Main effect	B	SE	P (two-tailed)
Sex	−0.765	0.024	<0.001
IGDT1	0.344	0.153	0.024
Social vulnerability	0.297	0.142	0.036
Life satisfaction	0.069	0.116	0.556
Attention problems	0.298	0.134	0.026
Interaction			
Social x Lifesat	0.365	0.602	0.277
Social x Attention prob	−0.681	0.140	<0.001
Lifesat X Attention prob	−0.485	0.199	0.016

Social = social vulnerability (higher scores is more vulnerability; Attention prob = attention problems (higher scores is more problems); Lifesat = life satisfaction (lower scores is less satisfied).

more socially vulnerable at T1 increased more strongly in IGD symptoms assessed at T2 (B = 0.297, SE = 0.142). A similar finding was found for attention problems, with more attention problems predicting a stronger increase in IGD symptoms (B = 0.298, SE = 0.134). No significant main effect of life satisfaction was found.

3.2. Interaction effects

All three interaction effects were analyzed in separate models, which included IGD and gender as covariates and the main effects of the interaction variables. The interaction between social vulnerability and attention problems was significant, revealing a stronger effect of attention problems on increase in IGD symptoms for those who were more socially vulnerable (Fig. 1, B = -0.425,
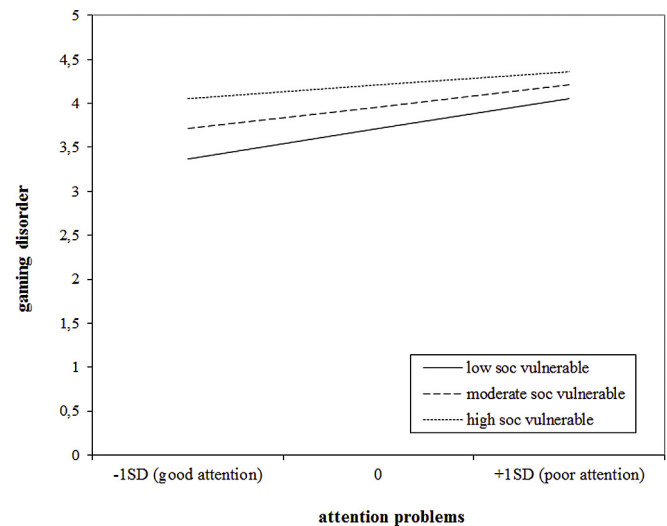

Fig. 1. Visual representation of the interaction between social vulnerability and attention problems on increase in IGD symptoms.

Table 1
Descriptive statistics and Pearson correlations for all study variables.

	M (SD)	1	2	3	4	5
1. Boy (%)	49%					
2. IGDT1	0.686 (1.348)	−0.312**				
3. IGDT2	0.738 (1.453)	−0.270**	0.481**			
4. Social vulnerability	1.579 (0.602)	−0.141*	0.234**	0.204**		
5. Life satisfaction	4.801 (0.823)	−0.072	−0.211**	−0.086	−0.370**	
6. Attention problems	2.222 (0.795)	−0.002	0.273**	0.116*	0.226**	−0.348**

* = p < .05; ** = p < .01.

SE = 0.125). A similar interaction was found for life satisfaction and attention problems, with a stronger effect of attention problems on IGD symptoms of adolescents who were less satisfied with life (Fig. 2, B = −0.485, SE = 0.199).

This longitudinal study evaluated social and cognitive risk factors that could contribute to an increase in IGD symptoms in young adolescent gamers by evaluating three different theoretical mechanisms: (1) a social vulnerability mechanism, (2) the coping mechanism, and (3) an attention problem mechanism.

The results indicated that social vulnerability and attention problems uniquely predicted an increase in IGD symptoms while controlling for gender differences and IGD symptoms at T1. These significant effects were found while controlling for the influence of the other predictors (life satisfaction, social vulnerability, and attention problems respectively). No main effect of life satisfaction on the development of IGD symptoms was found. A significant interaction of life satisfaction with attention was found as well as an interaction between social vulnerability and attention. Adolescents with attention problems who were high in social vulnerability were at higher risk for increased IGD symptoms one year later. Surprisingly, adolescents with good attention and who reported high satisfaction with life revealed stronger increase in IGD symptoms compared to adolescents who reported low life satisfaction. When adolescents reported attention problems this situation was reverse; adolescents who were less satisfied with life reported stronger increase in IGD symptoms. Growth differences for IGD symptoms were particularly visible for individuals with relatively few attention problems (Fig. 2).

The findings of the study support the attention problems mechanism. Adolescents with attention problems seem more preoccupied by playing games. Because of their difficulties with attention, they could have more problems with redirecting their behavior towards other tasks and goals (Gentile et al., 2012). Adolescents with attention problems also more likely experience problems with organizing and planning their behavior (Barkley, 1997; Corbetta & Shulman, 2002; Engle, 2002). Their problems with attention might place these adolescents in a susceptible position when playing games. The naturally occurring "flow" while playing games (Kim & Davis, 2009; Kuss & Griffiths, 2012) might be more pronounced in these adolescents, increasing their

vulnerability to the development of IGD symptoms over time.

In addition, the findings of this study also support the social vulnerability mechanism. Difficulties with social relations and friendships in real life might increase vulnerability for the development of IGD, particularly since games have the potential to create online friendships, and playing games might reinforce a feeling of belongingness (Beranuy et al., 2013; Forrest et al., 2016; King & Delfabbro, 2014; Young, 2009). Moreover, adolescents who feel less socially competent might, unlike in real life, feel successful and satisfied with social (online) interactions while playing games. The rewarding aspect of game playing may be much higher for these socially vulnerable adolescents compared to their more socially competent peers, which might increase the chance of developing problematic gaming behavior.

In contrast to the findings of Festl et al. (2013), we did not find a main effect of life satisfaction; however, this might be explained by the fact that Festl and colleagues evaluated the cross sectional relation instead of assessing an increase in IGD symptoms over time. Similar to the findings of Lemmens et al. (2011) who also examined life satisfaction in relation to increase in problematic gaming over time, no predictive effect was found, although a cross-sectional correlation between IGD symptoms at T1 and life satisfaction was observed. This suggests that although both concepts are associated, we cannot conclude that life dissatisfaction predicts an increase in IGD symptoms.

With respect to the interaction between social vulnerability and attention problems, individuals with attention problems might more likely experience unfulfilled needs (e.g. the need for belonging or autonomy) in real life (Ferguson & Olson, 2013) or are at greater risk for social isolation as a result of their attention problems. As such, attention problems could reinforce social vulnerability, increasing the need for belonging in real life. When games have the potential to fulfill this need, adolescents who experience feelings of social competence and belonging by playing games might be at risk for developing IGD symptoms. Though it should be mentioned however that our sample was not necessarily diagnosed with ADHD, but more or less experienced problems with attention (i.e. 7.6% reported ADHD or ADD). In the study of Ferguson and Olson (2013) this explanation was raised in combination with clinically diagnosed individuals with ADHD.

There is an ongoing discussion whether IGD should be regarded a clinical condition (Griffiths et al., 2016). The present findings add to that discussion by suggesting that IGD is not only a proxy for life distress, but is also resulting from other life concerns. The results suggest that attention problems as well as social vulnerability are important predictors of the increase in IGD symptoms in adolescents. Vulnerabilities within the person, as is the case with attention problems, increase the risk of IGD symptoms. In addition, vulnerabilities that often find their source in the environment, such as having few friends (social vulnerability) or experiencing negative emotions and stress (life dissatisfaction), might boost the negative effect of having attention problems on the development of IGD symptoms. As such, the social environment in which adolescent grow up, regardless of whether they are affected by individual vulnerabilities, might play a crucial role in the transition from regular game play to more problematic and compulsive game play.

3.3. Limitations

The results of this study should be interpreted in light of some limitations. First, adolescents from higher education level were overrepresented in the sample (60%) relative to the vocational track. This might have limited the generalizability of these results to adolescents from lower educational levels. Moreover, generalizability to clinical population might also be limited. The current
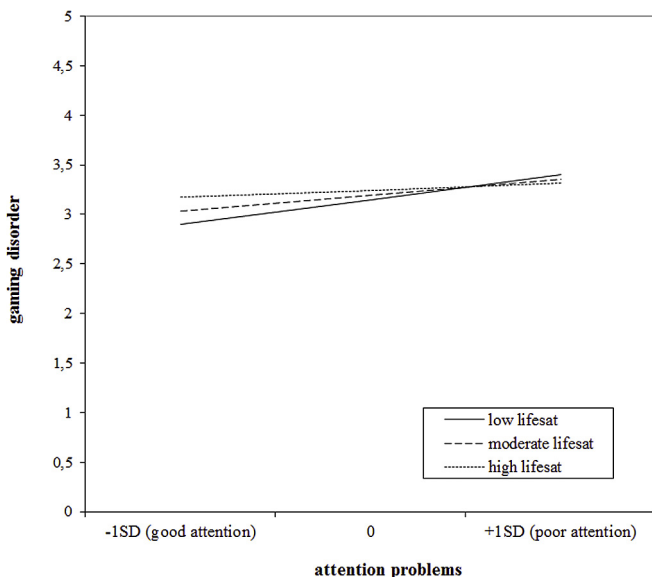

Fig. 2. Visual representation of the interaction between life satisfaction and attention problems on increase in IGD symptoms.

paper focused on risk factors preceding the development or increase in IGD symptoms. By studying a young population we attempted to include adolescents in a period before gaming problems would have been developed. Nevertheless, by applying such model, it is possible that some adolescents already developed serious problems and showed no increase in symptoms. Moreover, future research could investigate bidirectional relations between IGD symptoms and risk factors, as vulnerability may increase as a result of playing games excessively. Second, some classes dropped out of the study due to organizational issues. We decided to perform an attrition analyses on the missing sample instead of imputing the data or using full information maximum likelihood because entire classes were excluded from the second wave. These classes were excluded from further follow-up due to practical and organizational issues (e.g., non-response of a school mentor). Third, self-report questionnaires were administered in the classroom setting. Although anonymity of participants was guaranteed, self-reports might have biased the results. Though self-reports do provide relevant data, additional reports of parents and teachers could have strengthened this study. Fourth, although our measure of life satisfaction may also include the assessment of negative thoughts and emotions in adolescents' life, playing games might not necessarily be a result of coping with these thoughts and emotions. The same reasoning can be applied to the other two explanatory mechanism, social vulnerability and attention problems. Nevertheless, the described mechanisms in this study are a first step in identifying a risk profile of general characteristics that place adolescents at risk for developing IGD symptoms. Future research could include reasons and motives for playing online games to get a better understanding of the underlying mechanism of the development of IGD symptoms in youth (cf. Ferguson & Olson, 2013. Finally, many adolescents ($\pm70\%$) did not report any IGD symptoms in either wave, resulting in highly skewed distribution. ZIP-models accounted for these skewed distribution; however, model fit measures, like the CFI and RMSEA, were not available. Nevertheless, ZIP-models are the best way to deal with many zeros while retaining a continuous outcome measure (Peeters et al., 2012).

3.4. Conclusion

These longitudinal findings contribute to our understanding of the different mechanisms and risk factors underlying the development of IGD in adolescents. The findings support the attention problems mechanism and social vulnerability mechanism as processes explaining the increase in IGD symptoms in young adolescents. Particularly, for adolescents with attention problems, game play might be a behavior of preference because of the potential of games to create a flow, causing adolescents to forget everything else (Kim & Davis, 2009). Once involved in playing games, these adolescents might have more difficulties compared to their peers to focus on other tasks that require attention (Gentile et al., 2012). This process might be of particular concern in the early phase of the development of problematic gaming (Kuss & Griffiths, 2012) during which habits and automatic behavior emerge (Peeters et al., 2012), and it may place some young adolescents at risk while playing games. Early identification and prevention methods to intervene during the phase of problematic game play might be warranted to identify adolescents who are the highest risk for developing a game disorder and to prevent further escalation.

Declaration of interest

No conflicts to declare.

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