VIDEO GAME PLAY, SOCIAL INTERACTIONS AND FRIENDSHIP QUALITY IN ADOLESCENTS: A LATENT CLASS ANALYSIS

by

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Abstract

Rationale. Video games and the Internet are an indispensable part of teens' lives and are tightly woven into their daily routines. The ever-changing nature of games and online settings poses challenges for public health researchers who categorize exposures to determine how they affect health. Previous research has identified a range of correlates and outcomes of problematic gaming; many of these are shared with addiction to Internet activities such as social networking and instant messaging, which are also very popular with adolescents (D. L. King, Haagsma, Delfabbro, Gradisar, & Griffiths, 2013; D. J. Kuss, Griffiths, Karila, & Billieux, 2013). Since most youth use a variety of Internet social applications at once (Rideout, Foehr, & Roberts, 2010), it is important to consider how these concurrent activities affect the nature, course, and outcomes of problematic gaming.

Given the overlapping nature of Internet use, some forms of gaming, and social interactions, the outcomes of heavy or excessive gaming are likely vary as a function of online social interactions (e.g., those occurring through instant messaging, social media use and chat; S. Caplan, Williams, & Yee, 2009; Ng & Wiemer-Hastings, 2005). This thesis adds to the literature by first providing a systematic examination of factors related specifically to problematic gaming (as opposed to problematic Internet use) in representative samples of adolescents, then conducting two empirical studies to determine (1) how patterns of self-reported problematic gaming symptoms, video game and social Internet use help distinguish adolescents whose high levels of gaming are associated with high problematic gaming symptoms and (2) how these patterns are associated with psychosocial well-being, and how these associations change when online and offline friendship quality is considered.

Methods. We used survey results from 9738 adolescents in the 2009-2012 waves of the Monitor Internet and Youth study (Meerkerk, van den Eijnden, & van Rooij, 2006), a yearly survey on technology use and addiction in the Netherlands. We conducted a latent class analysis using indicators of problematic gaming symptoms (as measured by the Videogame Addiction Test; van Rooij, Schoenmakers, van den Eijnden, Vermulst, & van de Mheen, 2012a) and high levels of use (4+ hours per day for 6 -7 days per week) of social networking, instant messaging and three types of video games. This analysis was then extended to a multivariate latent class regression that examined associations between the estimated latent classes and depression, social anxiety, loneliness and low self-esteem. Finally, we evaluated moderation by friendship quality.

Results: In both boys and girls, we identified several classes of gamers with varying levels of problematic gameplay. Classes were generally split into those having high probabilities of highly engaged online social interaction and those having lower probabilities, and classes with more online social interaction showed fewer symptoms of problematic gaming at the same levels of gaming. Classes with higher self-reported problematic gaming were associated with lower values of self-esteem and more social anxiety overall, whereas boys and girls estimated to be in the Social Engaged Gamers classes had less loneliness and social anxiety. All classes with high levels of gaming also reported more depressive symptoms. However, these associations changed for some subgroups when interactions with online and offline friendship quality were considered. Specifically, for girls who had good online friendships but poor real-life friendships, the chance of membership in the Social Engaged Gamers class compared to the Average class decreased as depression scores increased. High self-esteem was negatively associated for most boys who were At-Risk Social

Gamers, but for boys who had high quality online and offline friendships, the relationship was positive. In addition, social anxiety was only associated with the most symptomatic Problematic Gamers class for boys with high-quality online friendships, but was associated with both heavy gaming classes for girls who had high-quality online and real-life friendships**.**

Conclusion: Adolescent gamers who were more socially active online reported lower distress related to gaming. Although all highly engaged gamers reported more depression than average classes, high-quality online friendships negated this finding for girls who reported low-quality real-life friendships. Exploring moderation also revealed that associations between social anxiety and certain classes were much stronger for those with high-quality online friendships, and self-esteem was higher for some social gamers if both online and offline friendship quality were high. Online social interaction, especially when it is associated with high-quality online friendships, may have positive implications for some heavy gamers but may be associated with more negative psychological functioning in others.

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Chapter 1 Introduction: Video Game Use, Problematic Use and Need Satisfaction in Adolescents

For most adolescents, video game play is a normal part of daily life, providing entertainment and social opportunities or just filling time. Most research on video games has focused on negative outcomes such as the effects of exposure to violence (Anderson et al., 2010) or excessive/problematic gaming (Ferguson, Coulson, & Barnett, 2011), but games may also be associated with aspects of positive youth development (Adachi & Willoughby, 2012). Video game play, including extensive or highly engaged play, may satisfy many developmental needs of adolescence such as peer affiliation and self-affirmation, with individual and game characteristics interacting with parental, social, cultural and other mediators and moderators to influence both positive and negative effects ("EU Kids Online," 2014; Kutner, Olson, Warner, & Hertzog, 2008). The tendency in public health and addiction-oriented research to describe heavy or excessive media use as problematic may fail to distinguish adaptive from maladaptive patterns of use and carries the risk of inducing moral panic (Livingstone, 2013; Tzavela et al., 2015). As more and more adolescents are joining their peers as well as strangers (and potential friends) around the world in online gaming settings, it becomes even more important to view the potential risks and harms associated with gaming from a developmental perspective that appropriately includes the social and media contexts in which games are played (Ferguson et al., 2011; McHale, Dotterer, & Kim, 2009).

Research and popular literature are replete with news of negative effects of video games. Scientists, parents, and even young gamers agree that time gaming has the potential to displace other important activities, to change social norms around violence, and to impede the development of social skills through isolation (Kutner et al., 2008; McHale et al., 2009; Tzavela et al., 2015). These concerns are magnified in gamers who play extensively,

compounding worries about video game effects with worries about addictive-like behaviors. Since the beginning of research into technology use and overuse in the late 20th century, researchers have disagreed about what constitutes problematic use, how overuse might be problematic, and whether addiction to technology can even exist (Grohol, 1999; D. L. King et al., 2013; J. Morahan-Martin, 2005). Levels of game use have been characterized along a continuum from normal to heavy to at-risk to problematic, with problematic gaming possibly being qualitatively different from lower levels, i.e. at-risk or engaged (D. L. King et al., 2013). Recent research into the neurobiology of addictions has strongly influenced how problematic gaming is viewed, leading to a focus on intrinsic properties of the "seductive" Internet activities themselves as drivers of problematic use (Leung, 2004). Video games are designed using behavioral principles of reinforcement to "override [boring tasks] by plugging into [players'] pleasure centres and giving them scheduled rewards" (Hill, 2007). The rewarding feelings that occur during gaming are thought to lead to brain changes (Ko et al., 2013; Koepp et al., 1998); strength and immediacy of neurological responses may be indicative of the pathological levels of play that cause "clinically significant impairment or distress" (*American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition.*, 2013; Ko et al., 2013). Decades of literature have employed the terms *problematic gaming* (excessive use of video games that leads to harm) and *problematic Internet use (*excessive use of the Internet or online video games that leads to harm), often interchangeably. Citing neuroscience evidence as well as similarities between compulsive playing of Internet games and gambling/substance use disorders, the American Psychiatric Association (APA) ultimately selected the title Internet Gaming Disorder for the condition proposed for further study in DSM 5, and allowed offline video games to be included as well

(*American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition.*, 2013).

Since the purpose of this thesis is to clarify how concurrent Internet activities affect gamers' development and maintenance of problematic gaming (problematic gaming) as well as problematic gaming correlates, this thesis will be specific about terminology used to distinguish high levels of media use from potentially maladaptive use. I will use the term *problematic gaming* to refer to any research on compulsive, problematic or addicted use of video games, whether it is studied as a subset of problematic Internet use or by itself. I will discuss *problematic Internet use* (PIU) separately when comparing and contrasting the two concepts. Further, as described in Tzavela et al. (2015), because heavy use in and of itself may reflect simply enthusiasm and related characteristics such as cognitive salience and euphoria, I will use the term *high engagement* or *engaged* to describe heavy use of games and the Internet when associated risks and harms are unclear.

Global prevalence figures for problematic gaming vary greatly for a variety of reasons including differences in how problematic gaming is defined and measured across studies, as well as cultural and contextual factors that vary across study samples and affect development and course (D. L. King et al., 2013; Shaw & Black, 2008). In a recent review, King and colleagues reported a range of prevalence of problematic gaming from 0.3% to 47% worldwide (D. L. King et al., 2013), with higher values associated with studies in Asian countries, psychiatric populations, and lower diagnostic cut-offs. The King review also noted 18 separate assessment instruments for problematic gaming, amounting to one instrument per year of the research cited. In addition to problematic gaming, some studies support lower levels of problems or engaged gaming, which is usually defined as extensive time spent

gaming with few or no associated problems (Charlton, 2002; Charlton & Danforth, 2007). While problematic gaming may be thought of as a maladaptive coping response to life stresses or a way to self-medicate the "pain of growing up" (Ream, Elliott, & Dunlap, 2013b), highly engaged gaming may represent an adaptive use of games to connect with others (Olson, Kutner, & Warner, 2008), spend time in a challenging and stimulating environment (Adachi & Willoughby, 2012), and experience positive emotional and cognitive states such as flow (Johnson, Jones, Scholes, & Colder Carras, 2013). On the other hand, it might also represent a step on the path toward problematic gaming (Charlton, 2002; Seok & DaCosta, 2014). For adolescents overall, the relationship between time spent gaming and psychosocial well-being seems to be u-shaped, with moderate levels of play being associated with better mental health and adjustment than high levels or no play (Durkin & Barber, 2002; Przybylski, 2014).

Adolescents of the 21st century spend significant amounts of time engaged with online media. Video games, therefore, are not played in a media vacuum, and a significant aspect of problematic gaming research that has received little attention is the place of extensive play in the context of other media use. Other forms of Internet use such as instant messaging, social networking (Facebook, Twitter) and chatrooms have also been associated with severe problems in functioning and negative outcomes, and studies of Internet addiction find significant effects of other forms of Internet use on psychosocial outcomes (Chang, Chiu, Lee, Chen, & Miao, 2014; Daria J. Kuss, van Rooij, Shorter, Griffiths, & van de Mheen, 2013; D J Kuss et al., 2013; Leung & Lee, 2012; Tsitsika et al., 2014). People—especially adolescents—usually use more than one form of media at once: Internet users send instant messages while on Facebook, and gamers may also be in a chat room while

playing World of Warcraft (Borzekowski, 2007; Durkee et al., 2012; Lenhart, Amanda, Lewis, & Rainie, n.d.). Research on patterns of Internet use seem to indicate that adaptive and maladaptive patterns are based less on amounts of use than combinations of media used and reasons for use, as well as the perceived importance of use, and these patterns may provide more information than scales measuring problematic use (S.-Y. Chen & Tzeng, 2010; Romer, Bagdasarov, & More, 2013; Tzavela et al., 2015). For example, online games are by definition embedded in the Internet, and thus are likely to be played in inherently social online settings. Certain types (i.e., genres) of games and game platforms are associated with higher normative levels of play (Ream, Elliott, & Dunlap, 2013a) as well as more problematic use (Festl, Scharkow, & Quandt, 2013; Müller, Janikian, et al., 2014; van Rooij, Schoenmakers, van de Eijnden, & van de Mheen, 2010). As use of different genres and platforms may lead to problematic gaming through different mechanisms (e.g., reducing or increasing arousal or social interaction(Metcalf & Pammer, 2014; Ream et al., 2013a), the paths to problematic, engaged or normative play may vary.

Several developmental needs of adolescence may be met through gaming, but also may heighten the risk for problematic gaming. Increasing needs for social contact and social support and increasing interest in development of meaningful relationships may be satisfied through games and Internet use (Desjarlais & Willoughby, 2010; Valkenburg & Peter, 2011). Social support is a crucial factor for many developmental and health outcomes (O'Connell, M & the National Research Council, 2009; Substance Abuse and Mental Health Services Administration, Center for Mental Health Services, 2007) and acts as a buffer for the negative consequences of stress to help prevent mental disorders (Cohen & Hoberman, 1983). Researchers, parents and gamers recognize that gaming provides social benefits in the

form of game-based online communities such as guilds or teams (Trepte, Reinecke, & Juechems, 2012; Williams, 2006) and opportunities to discuss shared experiences (Desjarlais & Willoughby, 2010; Kutner et al., 2008), thus games may meet these needs well. Highly engaged gamers, therefore, have the potential for longer-term benefits if they successfully expand social networks and find support through their game play. Another developmental task for adolescents is identity formation; games foster this by allowing individuals to identify with idealized characters and to "test drive" customizable representations of themselves (Bessière, Seay, & Kiesler, 2007). In these ways, games may be very useful in meeting developmental needs. Similar findings have been obtained with Internet use. Adolescents use online communication such as instant messaging and social networking sites to both broaden their social support network and keep in touch with friends and family, thus augmenting existing relationships (Kraut et al., 2002; Daria J Kuss & Griffiths, 2011). For individuals with vulnerabilities such as anxiety or physical disabilities that make social interaction difficult, the anonymity and accessibility of Internet-based communications may be especially beneficial (S. E. Caplan, 2005; Greenfield & Yan, 2006; Valkenburg & Peter, 2011). Thus, online social interactions could contribute to healthy identity development in vulnerable individuals, which is associated with positive health outcomes (World Health Organization, 2001).

However, maladaptive patterns of Internet use—and perhaps game use—are associated with using the Internet to compensate for an offline world that is seen as unappealing or difficult in the setting of poor self-control and an unwillingness to change (Tzavela et al., 2015). Those who rely primarily on online communication for social contact and friendships may experience social anxiety, depression, and poor psychosocial well-being

(S. E. Caplan, 2005; Shen & Williams, 2011; Snodgrass, Lacy, Dengah, Fagan, & Most, 2011a). When Internet or game use is excessive, time online may displace the beneficial time spent in other social environments, weakening real-life friendships and the potential for a "real world" network of social support (Kowert, Domahidi, Festl, & Quandt, 2014; Nie, 2001; Shen & Williams, 2011). Gamers differ in their motivations for playing games (Yee, 2006), and those online gamers who play to compensate for real-life difficulties are likely to be at greater risk for problematic use, depending on the structure and quality of their online and offline social environments (S. E. Caplan, 2007; Kowert, Festl, & Quandt, 2014; van Rooij, Schoenmakers, Van Den Eijnden, Verm, & Van De Mheen, 2013). Ultimately, for both normally-developing youth and those with vulnerabilities, the strength of both online and offline friendships may be an important moderator of the development and outcomes of problematic gaming (Selfhout, Branje, Delsing, ter Bogt, & Meeus, 2009; van Rooij et al., 2013).

Finally, changes in motivational and inhibitory brain pathways that occur during adolescence may directly promote excessive or addictive behaviors (Chambers, Taylor, & Potenza, 2003). During adolescence, dopamine-mediated reward systems are increasingly activated by natural rewards such as food and sex, novel environmental stimuli, substances, and reward-related stimuli such as video games (Chambers et al., 2003; Koepp et al., 1998). Inhibitory mechanisms have yet to fully develop and pathways that respond to aversive stimuli are less responsive (Spear, 2013), so adolescents seek out new and rewarding experiences without the benefit of sufficient cognitive control to choose the most adaptive behaviors(Chambers et al., 2003). Video games are specifically designed to provide frequent rewards at irregular intervals in a way that encourages frequent and intense use, which may

increase the drive to seek those rewards in a vicious circle (Hill, 2007; Koepp et al., 1998; Yee, 2001).

Based on the above considerations and qualitative research in adolescents, Tzavela and colleagues (2015) proposed a set of risk and protective factors that may provide a framework for understanding how highly engaged video game use might differ based on social interactions. The framework proposed in this dissertation (Figure 1.1) suggests that highly engaged gaming in the absence of highly engaged social Internet use might be maladaptive. In this case, highly engaged gaming may represent an attempt to compensate for difficult life conditions or psychosocial vulnerabilities and may be associated with more problematic gaming symptoms, lower friendship quality, and negative psychosocial correlates. However, when highly engaged gaming occurs in conjunction with highly engaged online social interaction, this may indicate adaptive use. In this case, adolescents may be using games to build on existing interests and friendships or may be successfully compensating for unmet psychological needs through the development of online friendships and belonging in a community of like-minded others.

Despite an acknowledgement of the social nature of video game play, no studies have evaluated associations of various types of video game play with problematic gaming and related psychosocial well-being within the setting of mediated communication (i.e., communication through computers), online and offline friendships. Associations between problematic gaming and well-being have been difficult to characterize due to overlap between studies of problematic gaming and PIU, and the fact that problematic gaming is usually examined as an individual behavior rather than in the naturalistic setting of other media use. While research on moderation of problematic gaming effects by various factors is

increasing, few studies have examined these together in the setting of multiple indicators of well-being. To date, no studies have evaluated how patterns of Internet and game use combine with self-reported problematic gaming in order to characterize the across gamers. Combining measures of intensity of use of social Internet applications with intensity of game use and associated levels of self-reported problematic gaming will facilitate identification of subgroups of adolescents who may be at risk for problematic gaming, as well as those for whom even heavy game use may be benign or even protective. To that end, this thesis aims to:

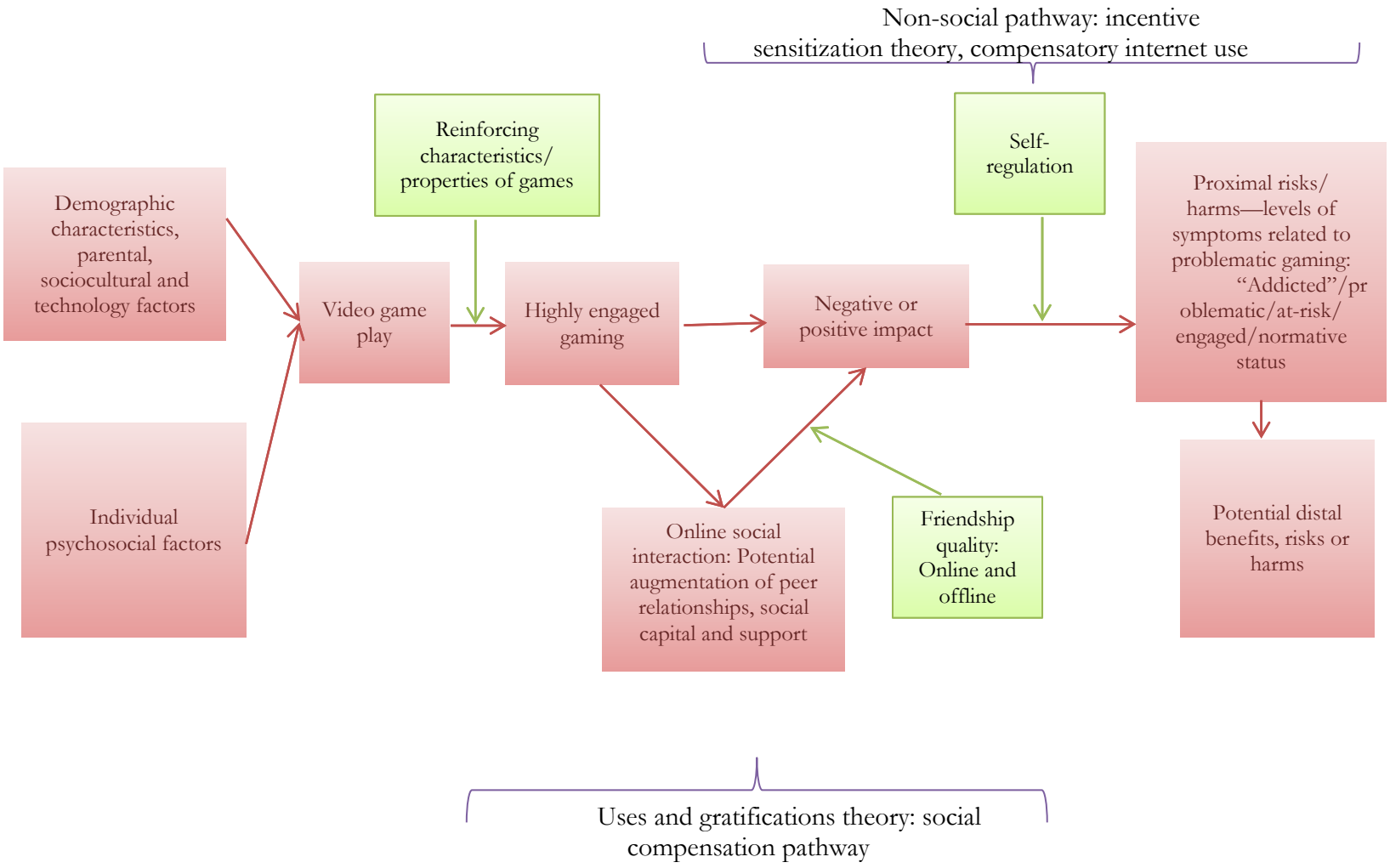
- Aim 1: Review and synthesize evidence specific to problematic gaming (as opposed to problematic internet use) and psychosocial well-being. We conducted a systematic review to characterize the descriptive and analytic epidemiology for problematic gaming in adolescents based on video game-specific measurement instruments (as opposed to those measuring problematic Internet use. Our goal was to help identify risk factors from methodologically rigorous studies, including individual, media, social and sociocultural factors, in order to promote research on modifiable risk and protective factors that could be targeted for intervention.
- Aim 2: Identify subgroups of adolescents at risk for self-reported problematic gaming, as well as those for whom high levels of video game use may be benign or even protective. We used data from the Monitor Internet and Youth study, a yearly school-based survey conducted in the Netherlands, to conduct latent class analysis on a representative sample of adolescents. We combined indicators for highly engaged use of three types of video games, two types of online social interactions, and self-reported symptoms of problematic gaming to identify subgroups of

adolescents who differed by their combinations of media use and problematic gaming symptoms.

- Aim 3: Investigate associations between problematic gaming and potential correlates of psychosocial well-being in the context of both online and offline friendship quality. We extended the latent class analysis conducted in Aim 2 to include a latent class regression using depression, social anxiety, loneliness and self-esteem as covariates, and then examined moderation by friendship quality. We used a multivariate approach, first examining relationships with sociodemographic and control variables, then including all psychosocial covariates, then adding friendship quality, and finally including important interactions (those with a p value of <.15) in our final model.

Problematic gaming and PIU have been associated with a variety of similar comorbidities, correlates, predictors and outcomes, with studies often finding conflicting results. This heterogeneity may result from the fact that there are several subtypes of gamers who vary on characteristics such as use of other (non-game) Internet activities and who may have different psychosocial strengths and challenges. The current study uses a person-centered approach to group adolescents by both intensity and types of online behavior in addition to self-reported gaming, which may be a more powerful way to identify correlates and outcomes of problematic gaming. Ultimately, the ability to understand heterogeneity in problematic gaming risk classes, their correlates and their relationship with moderators such as friendship quality can help clarify potential etiologic pathways for problematic gaming that could be targeted for intervention.

Figure 1.1: Proposed dual pathways framework for the development of problematic gaming



Chapter 2 Epidemiology and Correlates of Problematic Gaming in Adolescents: A Systematic Review of the Literature

Abstract

Background: Video games are an integral part of the daily lives of youth, yet playing games excessively may lead to problems. Previous research on problematic gaming has produced conflicting findings, likely due to varying instruments used to measure problematic gaming, differences in samples, and an atheoretical approach that fails to account for multiple influential factors and potential confounding.

Objectives: This review synthesizes research on problematic gaming in adolescents with the aim of describing the epidemiology and correlates of problematic gaming.

Criteria, participants and measures: This review included English-language peer-reviewed empirical studies that measured problematic gaming in adolescent samples.

Study appraisal and synthesis methods: After deduplication and screening, all outcomes from bivariate adjusted analyses or multivariate analyses were abstracted; if no adjusted analyses were found then unadjusted analyses were recorded. Outcomes were counted as positive or negative based on statistical significance at a study level and aggregated across studies based on domains of adolescent health and well-being, media use, parent, and sociodemographic factors.

Results: Out of 715 citations originally identified, thirty-four studies met inclusion criteria. The average problematic gaming prevalence was 5.32% with a range of 0.6% to 15.6%, and prevalence was higher for boys than girls. Prevalence of lower level (at-risk) problematic gaming was 11.7%, and four studies identified a group of engaged gamers (average prevalence 16.9%). Problematic gaming with co-occurring problematic Internet use was examined in three studies; average prevalence was 5.37%. Longitudinal studies showed an average problematic gaming incidence of 1.12%, while approximately 44% of categorically identified cases resolved after one to two years. Of the many significant findings

reported in these studies, only 13 were replicated in multivariate models. Anxiety, depression, ADHD symptoms, lower subjective well-being, lower academic achievement, aggressive behavior/conduct problems, problematic internet use, and gaming as dysfunctional coping were reported as cross-sectional correlates. Impulsivity, social competence, and academic achievement as well as use of Massively Multiplayer Online Games (MMORPGs) were identified as potential predictors in longitudinal studies, and depression, anxiety, ADHD symptoms, lower academic achievement, aggressive behaviors/conduct problems and hostility were identified as longitudinal outcomes.

Limitations, conclusions, and implications: The majority of studies reviewed lacked methodological rigor, and factors such as differences in measurement made comparisons between studies difficult. Problematic gaming seems to be a time-limited condition for most adolescents and may be rooted in the impulsivity of normal adolescent development and the social challenges that adolescents face. The impact of problematic gaming on longitudinal outcomes is unclear; future research is needed to contextualize problematic gaming to determine whether it represents a risk factor for future harm or a harm in and of itself. The findings with regard to impulsivity and emotional functioning/behavioral control suggest that prevention programs focusing on healthy use of games and strategies for self-regulating behavior may be useful for both intervention and treatment.

Intro/Rationale

Although video games were a popular form of recreation for decades before the Internet, public health concerns about addiction to video games were few until video games became playable in an online setting (M. D. Griffiths & Hunt, 1998). Shortly after the development of the Internet, concerns about its overuse prompted research on "problematic use" or Internet "addiction", with early research pointing to online chat and gaming as the primary activities of concern (Young, 1998). However, low to moderate levels of video game play are associated with well-being in adolescents compared to no gaming (Hofferth & Moon, 2012; Przybylski, 2014), and some studies suggest that many who play video games extensively are not only not experiencing problems, but participating in a rewarding form of recreation (Charlton & Danforth, 2007; Tamborini, Bowman, Eden, Grizzard, & Organ, 2010).

The study of problematic gaming in adolescents is further complicated by the place of video game play in modern cultures. Video games are played by the vast majority of adolescents in developed countries around the world (Chang et al., 2014; Choo et al., 2010; "EU Kids Online," 2014; Lee et al., 2007; Rideout et al., 2010). As a form of popular media use, games influence youth development in positive and negative ways and also reflect the multi-level influences that provide opportunities and set constraints on adolescents' everyday lives (McHale et al., 2009; Southwell & Doyle, 2004). As a reflection of youth development, gameplay shows the opportunities and constraints at play in an adolescent's life (e.g., psychopathology or financial constraints) that may lead to favoring certain games or certain amounts of play. Play may take place with parents or friends in Internet cafes, it may be limited to those games that are affordable or accessible, and if online, might additionally include the potential benefits and problems associated with Internet use in general. As an

influence on youth development, games may provide an opportunity for youth to develop online relationships and social support (Desjarlais & Willoughby, 2010; McHale et al., 2009), learn to self-regulate emotional arousal (Agina, 2012; Olson et al., 2008), to cope with stressful life events (Kardefelt Winther, 2014b), and to feel included in a new and popular digital community (Livingstone, 2013).

Previous approaches to the study of media in public health have focused on the risks of excessive exposure to television, video games, or the content therein. Compared to the concrete and passive exposure of television however, games are interactive. They have emergent properties—they change as they are played (Malaby, 2007). While it is relatively simple to measure the finite amount of time an adolescent spends watching television, it is much more difficult to understand the choices and actions that constitute playing a video game and how they change the nature of the "exposure" as it occurs. Those games that are played online, by definition, exist in a setting that is constantly being co-created by its users (Greenfield & Yan, 2006), which satisfies many developmental needs for adolescents but also presents a moving target for epidemiologists attempting to classify aspects of video gaming that are important to health. The need to consider a broader sociocultural perspective on everyday media activities has been supported by researchers in a variety of fields, who point to the necessity of understanding the settings—the what, who, how and why (see Figure 2.1)—of media use and their interactions, especially in the lives of youth, to better understand their implications ("EU Kids Online," 2014; Ferguson et al., 2011; McHale et al., 2009; Przybylski, 2014; Southwell & Doyle, 2004).

These concerns make it even more important to understand the risks, benefits, and harms associated with video gaming. Traditionally, research on mental disorders has focused

on the clinical validity and utility of case definition to define populations with disorders, to determine the natural history/course and burden associated with disorders, and to identify potentially modifiable risk factors in order to reduce harm and the burden of disorder (W. Eaton, Mojtabai, Stuart, Leoutsakos, & Kuramoto, 2012). However, when risk and harm are studied in the setting of media use, a lack of appropriate context for research findings can lead to confusion and concern on the part of parents, clinicians and policymakers (Livingstone, 2013). Concerns about research into excessive gaming and other media use include the extent to which highly engaged gaming is, at times, a normal and even beneficial part of child and adolescent development (or even adult life) and may facilitate resilience, whether the subject of measurement is actually a harm (i.e., excessive game play as a biologically-based addiction in and of itself or a problem behavior, e.g. .Chang et al., 2014; Mößle & Rehbein, 2013) or rather a risk—a behavior that may lead to more clear harms such as depression, substance abuse, or school failure (D. L. King, Haagsma, et al., 2013; Livingstone, 2013). Measures of risk and resiliency factors during adolescence should be sensitive to changes in individual and social factors as well as behaviors that may affect health status. For adolescents, appropriate domains through which to assess health-related aspects of development include physical and emotional comfort, resilience, subjective well-being, risk avoidance and achievement (Bevans, Riley, & Forrest, 2010).

Recent research on potential risks of problematic gaming has been criticized for taking an ill-specified, atheoretical approach that limits understanding of the etiology of problems related to video gaming and does not adequately characterize the extent of risks and/or benefits of game play (Kardefelt Winther, 2014a; Suissa, 2015). To help address these concerns, the proposed framework for understanding problematic gaming (see Chapter 1)

addresses the potential uses, benefits and risks of highly engaged gaming and how these may be associated with negative or positive outcomes. Figure 2.2 introduces theories that may be relevant to understanding problematic gaming in this framework. Rather than considering media as an exposure whose effects must be measured, *uses and gratifications theory* proposes that media use is goal-oriented, and that the goals of media use drive outcomes(Chan, 2010). For example, s*ocial compensation* describes the behavior of people who use media to make up for social deficits such as social anxiety or poor real-life social networks (J. M. Morahan-Martin, 1999; Valkenburg & Peter, 2011). Media are chosen that allow for social interaction, and media use subsequently changes as individuals' needs, social settings and media availability change. Consequently, excessive media use may lead to problematic gaming or may not, but individuals may also benefit through media-facilitated social contact. Kardefelt Winther extends this concept to the *theory of compensatory Internet use*, which posits that excessive Internet use (including online gaming) that leads to problems results from attempts to cope with real-life issues or escape dysphoric moods (Kardefelt Winther, 2014a) In contrast, the *augmentation hypothesis* (sometimes called the stimulation hypothesis) posits that video games and online media are not only a valid way to keep in touch with family and friends and find social support, but also a place to expand one's network of like-minded friends (Kraut et al., 2002; Valkenburg & Peter, 2007). This hypothesis suggests that media use is beneficial when used to augment or facilitate a thriving social life. These can be contrasted with theoretical approaches to problematic gaming that use an addiction approach. For example, according to the *incentive sensitization theory,* behaviors that repeatedly activate reward circuits (such as video game use) may lead to neurological changes that bias attention and motivation toward use of whatever is rewarding (Robinson & Berridge, 2008).

For specific activities like social networking and online gaming, more use means strong rewards: fresh and interesting profiles on sites like Facebook get more attention and friends (Daria J Kuss & Griffiths, 2011) and massively multiplayer online games (MMOs) use specific game elements called appointment mechanics to encourage frequent and intense use (Pomeroy, 2011). In fact, activities with a strong social component and relatively rapid feedback are most associated with compulsive use (Thatcher, Wretschko, & Fisher, 2008; van den Eijnden, Meerkerk, Vermulst, Spijkerman, & Engels, 2008). The strengths of social and game-task rewards, when combined with other contextual and individual factors, may lead to persistent or worsening problems for some video game and Internet users.

Research on problematic gaming has struggled with two major issues. First, studies have often combined research on problematic Internet use and problematic gaming, conflating two potentially different constructs (Pápay et al., 2013; Rehbein & Mößle, 2013). For example, although the proposed diagnosis names online gaming as the focus of Internet gaming disorder, the majority of the studies cited as supporting evidence focus on problematic Internet use (American Psychiatric Association, 2013). This makes it challenging to determine which mechanisms in video game play might contribute to potential problems. For instance, successful game design includes game mechanics that foster repeated and intense use, which can lead to excessive use and subsequent life problems for some gamers (Hopson, 2001; Yee, 2001). These reinforcing properties of video games have been emphasized as potentially leading to the neurological changes associated with addiction (Daria J. Kuss & Griffiths, 2012). However, the proposed IGD description also notes that "team aspects"—something usually thought of as beneficial in other contexts--may be a key motivation for those with the proposed disorder. Team play in an online environment

usually involves concurrent use of online communications such as instant messaging or voice chat, which are also independently associated with both problems (S. Caplan et al., 2009) and benefits (Trepte et al., 2012). This aspect of Internet-mediated communication occurring in the context of gaming represents an aspect of setting that is not adequately addressed by the narrow focus of "online games" in the proposed IGD. Thus, the criteria proposed to evaluate the risks associated with highly engaged video game play may not be adequate to distinguish harmful from non-harmful use.

Second, measurement methods for problematic use of games and other technologies have applied different, often arbitrary cut-offs to attempt to distinguish normal from "disordered" use, potentially overclassifying heavy, engaged use that does not result in harms as problematic (Ferguson et al., 2011). Conclusions about potential harms may be weakened if individuals who are simply enthusiastic gamers are combined with those who experience clinically significant impairments in functioning or mental health problems associated with their gaming.

In order to identify potential harms associated with excessive gaming in adolescents, it is vital to put gaming in the context of normal adolescent behavior with associated risks, benefits, and changing levels of participation and interference/problems over time. If we are to understand whether problematic gaming can indeed be harmful, video games must be specified as the media construct for which harms are being investigated (e.g., excessive video game play as opposed to Internet use) and the associated harms, if any, must be assessed using appropriate methods. Also, without controlling for potential confounders that may influence media use and/or problematic use, it is impossible to make inferences about whether effects observed are due to problems with gaming rather than competing causes

such as family conflict, personal stressors, underlying psychopathology, or simply the desire to relieve boredom and/or connect with others through electronic recreation.

The current review was undertaken to summarize the epidemiological literature specific to problematic use of video games in order to clarify these relationships. By identifying key variables and measures, exploring common analyses and comparing these across groups, settings, and study designs, this review will not only clarify associations between problematic gaming, covariates and outcomes in adolescents, but also help identify methodological strengths and weaknesses of the body of research to date. The aim is to help identify risk factors at various contextual levels, including individual, media, social and sociocultural settings and promote research on modifiable risk and protective factors that could be targeted for intervention. By targeting research on problematic gaming specifically, this study aims to:

1. Characterize the descriptive epidemiology for problematic gaming in adolescents based on video game-specific measurement instruments (as opposed to those measuring problematic Internet use) used in population-based studies,
2. Enumerate correlates, predictors and outcomes of problematic gaming from cross-sectional and longitudinal designs, as compared with less-risky video game use, normative use and patterns of game and other media use, by
    - assessing findings across individual, media use, family and sociocultural factors in all studies regardless of analysis type;

- determining which associations above, if any, are also found in studies that control for potential confounding factors and/or examine problematic gaming in multivariate models.

Methods

A search was conducted in PubMed and PsycInfo to access English-language, peer-reviewed empirical research on associations between problematic gaming and mental and behavioral health. Search terms differed slightly between databases; the terms used for PubMed were "(Internet gaming disorder[Title/Abstract]) OR (((((("video games"[MeSH Terms]) OR ((games[Title/Abstract] OR gaming[Title/Abstract] OR game[Title/Abstract]))))) AND ((online OR internet OR video OR digital OR media OR games OR gaming))) AND ((problematic OR compulsive OR pathological OR addict*))) AND adolescen*) AND English[lang])". Articles were included if they (1) used a representative sample of adolescents, (2) included a specific measure of problematic gaming other than time spent gaming, (3) examined associations between problematic gaming and individual, social, and/or well-being predictors, correlates and/or outcomes (4) examined any form of video or computer gaming (i.e., not just online gaming). Articles were excluded if (1) they were not empirical journal articles, (2) did not describe the sampling method or used convenience samples, (3) did not include separate analyses for adolescents, (4) focused on clinical populations or physiological measures (5) assessed problematic Internet use without assessing problematic gaming or (6) reported on outcomes that overlapped with other published studies of the same data. After deduplication, titles and abstracts were reviewed for appropriateness. Full text was retrieved for relevant articles, which were again reviewed, until arriving at the final selection of articles for the study. From these, key

variables were abstracted from studies into a database, and described in a summary table. Similar variables were then combined into composite variables by domains of health and well-being, media use, parent, and sociodemographics. For example, the variables "number of friends", "social capital", "loneliness", "peer relationships", "social capital", "relationships with classmates", "time with friends", and "social support" were combined to represent peer connectedness. This summary information was presented in a separate table, specifying any individual variables that had two or more significant associations in multivariate studies.

Results of variables used in adjusted analyses were abstracted; if no adjusted analyses were reported then unadjusted analyses were abstracted. Due to the non-quantitative nature of this review and a lack of consistency in measurement of exposure and outcome domains across included studies, a vote counting approach was used to aggregate effects across studies (Higgins & Green, 2011). In keeping with the Bradford Hill criterion (*Epidemiology*, 2006) of consistency as one factor supporting causation, a variable was said to be associated with problematic gaming if the majority of the studies that examined it found a significant p-value or confidence interval at the level specified. Results in tables and text, therefore, were listed as showing an association if more than half of the studies that assessed the variable reported the same finding. If a study assessed more than one outcome for a domain, positive and null findings were compared at the study level to arrive at a single domain-specific value. If the same outcome was assessed in two separate papers using overlapping samples (e.g., a cross-sectional study and a longitudinal study by the same authors), results that overlapped were excluded on a domain-level basis.

Results

From the initial literature searches, 715 articles were identified, of which 133 were duplicates (see Figure 2.3: PRISMA Flow Diagram), leaving 582 citations. After title/abstract review, 458 articles were excluded, leaving 124 full-text articles reviewed for inclusion. Of these, 90 did not meet inclusion criteria, leaving 34 articles in the qualitative summary.

Study characteristics. Characteristics of studies measuring problematic gaming and primary analyses of predictors, correlates and outcomes are included in Table 2.1. While studies differed in the terms they use to describe problematic gaming, in the text we will use the term *problematic gaming* to refer to any status associated with Internet gaming disorder, game addiction, dependence, compulsive, or pathological gaming. We will use *at-risk* to refer to any sub-threshold level as determined by studies that reported these. Similarly, we will use *problematic Internet use (PIU)* to refer to the analogous situation for Internet use.

Measurement of problematic gaming. The 34 included studies featured 30 different ways to measure problematic gaming. Five studies focused exclusively on online games (Jap, Tiatri, Jaya, & Suteja, 2013; Jeong & Kim, 2011; Király et al., 2014; Lee et al., 2007; van Rooij, Schoenmakers, Vermulst, Van den Eijnden, & Van de Mheen, 2011). The vast majority of scales were based on conceptualizing problematic gaming as an addiction; Table 2.2 compares dimensions assessed by these scales and includes dimensions assessed by IGD (as reported by Petry et al., 2014) for comparison. Six studies introduced new scales; two of these new scales (Fisher, 1994; D. Gentile, 2009) were used in at least one other study. Of the domains assessed in IGD, preoccupation/salience, tolerance, mood management, withdrawal and conflict were assessed by over half of the instruments, continuing use despite negative consequences was assessed by 31%, lying/deception was assessed by 15%, and "give up other activities" was assessed directly only by 6%. One of the

criteria, "Has jeopardized or lost a significant relationship, job, or educational or career opportunity because of participation in Internet games," was not assessed by any scale, although the more moderate criteria of conflict with others as a result of gaming or in life functions was assessed by 84%. A single study had a new scale with no overlapping domains (Desai, Krishnan-Sarin, Cavallo, & Potenza, 2010). The average prevalence of problematic gaming differed significantly by scale (Kruskal-Wallis chi-square 33(13), $p<.01$). Five studies adapted the scales used (Festl et al., 2013; Jeong & Kim, 2011; Johansson & Gotestam, 2004; Turner et al., 2012; van Rooij et al., 2010) and two studies (Brunborg et al., 2013; Wang et al., 2014) used a unique approach to cut-offs for commonly-used scales. Psychometric properties of scales are reviewed thoroughly elsewhere (King et al., 2013) and will not be discussed here.

Aim 1: Descriptive epidemiology of problematic gaming

Prevalence of problematic gaming and at-risk gaming and factors affecting prevalence. The vast majority of studies on problematic gaming were cross-sectional and most of these reported prevalence estimates. Among those studies that reported a population-level prevalence and did not limit samples to gamers or Internet users (n=25), the average prevalence and standard deviation of problematic gaming in adolescents was 5.32 (4.48)%, with a range of 0.6% to 15.6%. In studies that reported prevalence separately for boys and girls, problematic gaming rates were higher in boys; most studies that compared rates statistically found significant differences. The average prevalence in boys was 10.9%, SD (7.9), range 1.7-27.9%; for girls the rate was 2.9%, SD(2.6), range 0-8.7%. Several methodological factors seemed to affect prevalence. For example, the three studies with a prevalence of <1.0% were conducted by phone, mail or a combination of phone, mail and web-based (Festl et al., 2013; Mentzoni et al., 2011; Mößle & Rehbein, 2013). Samples

mattered; most studies that restricted samples to gamers, online gamers or Internet users showed prevalence ranging from 6% to 11%, and three out of the five studies showing a prevalence of 10% or higher were conducted in Asian countries. Sampling methods (e.g., stratified random sample, universal sample, multi-stage cluster sample), however, did not seem to affect prevalence (Kruskal-Wallis chi-square 8.31[6 d.f.], $p<.22$). Scales based on the ICD-10 criteria for substance dependency such as the KFN-CSAS were found only in studies reporting prevalence of 4.4% or less, while scales such as the GAS based on other models (e.g., DSM-IV criteria for pathological gambling) had a wider range of prevalence. Three studies used a latent mixture modeling approach, estimating classes of problematic gaming based on binary endorsement of nine scale items (Faulkner, Irving, Adlaf, & Turner, 2014), average of items for scale domains (Pápay et al., 2013), or a combination of scale score and time gaming (van Rooij et al., 2011).

Prevalence of at-risk and engaged gaming. Twelve studies assessed multiple levels of excessive use (i.e., "addicted", "at-risk" or "engaged"). The average prevalence of "at-risk" for problematic gaming was 11.7% (SD 17.5) and ranged from 1.3 to 65.6%. Four studies described a group of "heavy" or "engaged" gamers that were identified as being at less or no risk. Brunborg et al. (Brunborg et al., 2013) used a criteria-based approach to identify 12.9% of their sample as engaged gamers: those who endorsed three items of the GAS seen as assessing "engaged gaming" , but did not endorse "core" addiction criteria (i.e. relapse, withdrawal, conflict and continued use despite problems). In the latent class analysis by van Rooij et al. (van Rooij et al., 2011) a class of "heavy" gamers (1-2% of the weighted online gaming sample) was estimated to spend extreme amounts of time online gaming (>45 hours/week) but did not have elevated symptoms of problematic gaming. A latent class

analysis by Faulkner and colleagues (Faulkner et al., 2014) identified a "low Problematic Videogame Playing" class (36% of the sample) who had a higher probability of endorsing criteria for relapse and family/school disruption compared to the "normative" class. As part of a validation analysis, Rehbein et al. (Rehbein, Kliem, Baier, Mossle, & Petry, 2015) identified a group of "extensive players" (17.3% of the sample) who played for more than 2.5 hours/day but did not meet criteria for at-risk or problematic gaming.

Prevalence of joint problematic gaming and PIU. Three studies measured joint problematic gaming and PIU (Chérif, Ayadi, Khemekhem, Moalla, & Ghribi, 2014; D. L. King, Delfabbro, Zwaans, & Kaptsis, 2013; Király et al., 2014). In the study of Tunisian high schoolers by Chérif et al. (Chérif et al., 2014), problematic gaming was present in 14.0% of the sample, PIU in 18%, and co-occurring problematic gaming and PIU in 6.1%. The study by King and colleagues(D. L. King, Delfabbro, et al., 2013) of Australian secondary school students reported a prevalence of 1.8% for problematic gaming, 6.4% for PIU, and 3.3% for co-occurring problematic gaming/PIU. Király and colleagues (Király et al., 2014) examined a sample of Hungarian online gamers and found rates of 4.3% for problematic gaming, 8.8% for PIU, and 6.7% for both.

Incidence and transition between states of problematic gaming, at-risk and non-problematic gaming. Of the five longitudinal studies, three reported incidence and remission rates for problematic gaming (See Figure 2.4). A latent growth mixture model by Gentile and colleagues (D. A. Gentile et al., 2011) showed that the class that did not have problematic gaming at time 1 (T1) but developed it (the "starts") comprised 1.3% of the population, while of those who began with problematic gaming, 16.4% had significantly lower scores after two years (the "stops"). A study by Mößle & Rehbein (Mößle & Rehbein,

2013)showed that 1.2% of the sample became problematic gamers, while 1.8% became at-risk after a year. Of those who began with problematic gaming, 50% stopped and 17% became at risk. Of those who began at risk, 42% stopped and 25% became problematic gamers. The longitudinal latent class analysis study by van Rooij and colleagues (van Rooij et al., 2011) showed that of those in the problematic gaming class at T1 (weighted prevalence 1.5%), half were estimated to remain after one year. Although incidence is not given in this study, the estimated incidence , given reported weighting, appears to be about 0.85%.

Aim 2a: Correlates, risk factors and outcomes of problematic gaming in all studies, regardless of analysis

Of the 34 studies, 14 studies reported observed variable measurement models, 6 studies used structural equation modeling, 4 studies used latent variable mixture modeling, and 10 studies reported descriptive statistics. Where adjusted analyses are reported, these are summarized; if adjusted analyses are not available, results of unadjusted analyses are reported. Table 2.3 presents findings by health, well-being, media use, parent, and sociodemographic domains, specifying outcomes that have two or more significant associations in multivariate studies.

Individual-level domains and outcomes. For the risk factors modeled as time invariant, male gender was almost universally found to be associated with increased risk of problematic gaming. Where migration status and education level (e.g., pre-college or university vs. vocational/trade school) were assessed, they were also found to be associated with problematic gaming, but age was not. Many studies examined aspects of emotional comfort, finding depression, anxiety, attention/hyperactivity symptoms and hostility were associated with problematic gaming, but a single-question assessment of stress level was not. Poor sleep and single-item self-rated poor physical health were aspects of physical comfort

that were consistently associated with problematic gaming. In the resilience domain, problematic gaming was associated with social support and family connectedness, but not with loneliness or teacher connectedness. Factors contributing to coping actively with problems such as social competence and impulsivity were very consistently associated with problematic gaming but personality factors were not. Self-esteem was a factor of subjective well-being found to be consistently associated with problematic gaming, but life-satisfaction was not. Two areas of risk behaviors, aggression/conduct problems and drug/alcohol use/problematic behaviors were often associated with problematic gaming, but alcohol use was not associated with problematic gaming. Problems with academic achievement (e.g. grades and time on schoolwork) as well as school engagement (e.g., truancy, extracurricular activities) were associated with problematic gaming but educational progress (e.g., being "held back" a year) was not.

Media use, family, and sociocultural factors. Time gaming was significantly linked with problematic gaming, as would be expected due to the construct of problematic gaming being a loss of control over gaming that leads to harm. Game use characteristics such as use of role-playing games, shooters, strategy games and offline games were associated with a greater likelihood of problematic gaming. Game-related beliefs including attitudes toward gaming and gaming when things are not going well (dysfunctional coping) were related to problematic gaming, but Internet use characteristics such as use of social networking and chat were not consistently associated with problematic gaming. Internet beliefs, however, such as online social self-efficacy, were related.

Some studies included broader social, community, and country-level factors. Family factors such as authoritarian, permissive or neglectful parenting styles (Abedini, Zamani,

Kheradmand, & Rajabizadeh, 2012), mother having no formal education (Müller, Janikian, et al., 2014) and mother's formal employment were associated with problematic gaming, but parents' marital status (Desai et al., 2010; Müller, Janikian, et al., 2014) and father's/both parents' employment were consistently *not* associated. Finally, a single study of multiple countries in Europe (Müller, Janikian, et al., 2014) found differences between certain countries in the prevalence of problematic gaming, association between problematic gaming and game genres used, and differences in associations between well-being and problematic gaming.

Longitudinal studies on the association between problematic gaming and potential predictors and outcomes. While five studies examined problematic gaming at two different time points, only four reported on changes in well-being over time (Brunborg, Mentzoni, & Froyland, 2014; D. A. Gentile et al., 2011; Mößle & Rehbein, 2013; Scharkow, Festl, & Quandt, 2014); these are summarized in Table 2.4. Of these four studies, two measured both predictors and outcomes and one included several analyses, all of which are discussed here. That study was a longitudinal follow-up to an earlier cross-sectional study also included in this review (Choo et al., 2010); outcome domains that overlap between the two studies are reported here and not in the above section. Table 2.5 presents results of all longitudinal studies by outcome.

Antecedents of change in problematic gaming. Among the longitudinal studies, five analyses examined relationships between earlier predictive factors and later problematic gaming. Two separate analyses by Gentile and colleagues used latent growth curve models to assess predictors of being in the "starts" group (i.e., developing problematic gaming) or being in the "stops" group (i.e., resolving problematic gaming, D. A. Gentile et al., 2011)

over three years. Bivariate associations were evaluated in analyses of covariance that controlled for race and gender. Potential risk factors measured at Time 1 that predicted the development of problematic gaming (i.e., associated with the "starts") group were individual factors such as lower values of empathy, greater impulsivity, lower social competence and problems with emotion regulation, as well as media use factors such as LAN center use, more weekly hours of play, greater initial problematic gaming symptoms and MMO play. Identification with game character was not found to be associated with the development of problematic gaming. Time 1 factors predicting resolution (i.e., being in the "stops" group) were lower school performance, higher goal setting, and higher levels of problematic gaming symptoms. A third analysis by Gentile et al. (D. A. Gentile et al., 2011) used a multivariate longitudinal growth model to analyze concurrent changes in multiple Time 1 predictors and continuous problematic gaming score. Higher values of social competence and impulsivity at Time 1 were associated with magnitude of change, but time gaming was not. A study by Mößle and Rehbein (Mößle & Rehbein, 2013) used multivariate longitudinal path modeling to evaluate associations between multiple predictors and degree of problematic gaming measured a year later. Gaming as a form of dysfunctional coping, peer problems and low academic self-concept were found to be associated directly with problematic gaming, while hyperactivity and low parental care were found to affect the development of problematic gaming indirectly. In a cross-lagged structural equation model, Scharkow and colleagues (Scharkow et al., 2014) found that perceived success, life satisfaction, social capital and social support were not significantly associated with later problematic gaming scores.

Longitudinal outcomes of earlier problematic gaming. Three of five longitudinal studies (Brunborg et al., 2014; D. A. Gentile et al., 2011; Scharkow et al., 2014)

examined potential outcomes associated with change in problematic gaming symptoms. In the multivariate longitudinal growth model of Gentile and colleagues(D. A. Gentile et al., 2011), increases in problematic gaming symptoms were associated with higher values of depression, anxiety, and social phobia and lower grades over two years. In the cross-lagged structural equation model of Scharkow et al.(Scharkow et al., 2014), later perceived success, life satisfaction, social support and social capital were not associated with change in problematic gaming over two years. First difference bivariate regressions by Brunborg and colleagues (Brunborg et al., 2014)showed that depression and conduct problems/aggressive behavior were found to be associated with increases in problematic gaming after two years while academic achievement decreased, but past year heavy episodic drinking was not associated.

Another set of analyses by Gentile and colleagues compared longitudinal outcomes associated with developing or abating problematic gaming classification (D. A. Gentile et al., 2011) . Compared to those who never had problematic gaming, those who developed problematic gaming (the "starts") were found to have more symptoms of ADHD, anxiety, social phobia and depression, poorer relationships with parents and more hostility, aggression and victimization after two years. They also had higher levels of violent game exposure and more hours of online gaming. However, there was no significant change in goal setting scores or average grades after two years. Compared to those who continued to be classified as problematic gaming after two years (the "stays" group), those whose problematic gaming abated after two years (the "stops") had more empathy, less impulsivity, less hostility and aggression, and less anxiety, social phobia, and depression. However, scores

on relationally aggressive behavior and violent game exposure were no different between these groups.

Problematic gaming vs. subthreshold ("at-risk") problematic gaming. Fourteen studies assessed varying levels of problematic gaming; of these, four reported prevalence only and did not compare levels (i.e., at-risk or heavy/engaged) to other groups (Festl et al., 2013; Jap et al., 2013; Mentzoni et al., 2011; Mößle & Rehbein, 2013), and three (Ahmadi et al., 2014; Johansson & Gotestam, 2004; Walther, Morgenstern, & Hanewinkel, 2012) combined problematic gaming and lower levels in analysis. All but one study used adjusted bivariate analyses to evaluate separate outcomes by level of problematic gaming or risk. Results are summarized in Figure 2.5.

Brunborg et al. (Brunborg et al., 2013) found that both problematic and at-risk gamers had higher levels of negative psychosocial well-being and problematic gaming symptoms than other gamers when gender and physical exercise were controlled for. Jeong & Kim (Jeong & Kim, 2011) found that students with problematic and at-risk gaming showed similar levels of social efficacy compared to the non-problematic gaming group, but the problematic gaming group felt more positively toward gaming, had lower grades, and reported less positive parental attitudes toward gaming. The at-risk and non-problematic gaming groups did not differ in their attitudes toward gaming, teachers' attitudes toward gaming or grades. The problematic gaming and at-risk groups had equal levels of daily gaming time, frequency of social activities with parents, and teachers' attitudes toward gaming. Müller and colleagues (Müller, Janikian, et al., 2014) found that problematic gaming and at-risk groups were both associated with lower academic performance and activities compared to non-problematic gamers and non-gamers, and both problematic gaming and at-

risk male but not female gamers were found to have higher scores on major Youth Self-Report (YSR) scales. However, problematic gaming and at-risk groups differed on each YSR subscale except Somatic Complaints, with the problematic gaming group showing greater impairment. Using a sample of German boys from their larger study, Rehbein et al. (Rehbein, Kliem, Baier, Mößle, et al., 2015) compared several outcomes in boys with problematic gaming and boys classified as "at-risk" and found that problematic gaming boys played more online and offline games and had more psychosocial and functioning problems, including truancy and thoughts of suicide, than non-problematic gaming boys. Boys considered at-risk were similar to the problematic gaming group in most areas except grades in sports and report of sleep difficulties, where they did not differ from non-problematic gamers.

Three studies used a latent class approach to group respondents by item endorsement on the Problem Video Game Playing (PVP) questionnaire (Faulkner et al., 2014), domain score of the PVP questionnaire (Pápay et al., 2013), or Compulsive Internet Use Scale score and time gaming (van Rooij et al., 2011), although van Rooij et al. identified a "heavy gaming" level rather than an at-risk level as described below. Faulkner and colleagues (Faulkner et al., 2014) identified three classes with elevated endorsement of items. All classes differed in time spent gaming, although the Severe and High PVP classes did not differ from each other, and all classes had more overweight/obesity than the Normative class. Male gender and low SES were associated with both Severe and High classes, but the Severe class was the only one that had worse self-rated mental and physical health and social functioning. However, academic performance in the Severe class was comparable to the Normative class. The High PVP class had a lower prevalence of meeting physical activity

guidelines, worse self-rated mental health and worse academic performance than the Normative class. Pápay and colleagues (Pápay et al., 2013) grouped Hungarian students by their endorsement of dimensions of problematic use, finding that both the problematic gaming and at-risk classes were associated with being male and playing for >5 hrs./day. Their analyses also showed that the problematic gaming class had lower self-esteem and more depression than other classes, while the at-risk class had a lower average age. Compared to the at-risk class, the problematic gaming class had a lower GPA.

Problematic gaming vs. engaged or heavy gaming. Four of the above studies also investigated engaged or non-at-risk heavy gamers. Brunborg et al. (Brunborg et al., 2013) also characterized as "engaged gamers" those who endorsed items specific to engaged gaming as defined by Charlton and Danforth(Charlton & Danforth, 2007) (salience, tolerance and mood modification) but did not endorse "core criteria of addiction", i.e. (conflict, withdrawal symptoms, relapse and reinstatement, and behavioral salience). Engaged gamers showed no differences in psychosocial well-being compared to non-problematic gaming gamers after two years. In their latent class analysis, Faulkner and colleagues (Faulkner et al., 2014) found a Low Problem Video Game Playing (PVP) class that played more games and had a higher likelihood of not meeting healthy weight guidelines than a Normative class but did not show deficits in well-being or functioning. A latent class analysis by van Rooij et al. (van Rooij et al., 2011) found a class of problematic gamers as well as a class identified as heavy gamers who played excessively (>45 hours/week) but did not show elevated problematic gaming scores. In this study, problematic gamers showed more depressive symptoms than heavy gamers at one of two time points, but otherwise showed no significant differences in well-being; heavy gamers were not compared to less

heavy-gaming groups. In contrast with the above, Rehbein et al. (Rehbein, Kliem, Baier, Mößle, et al., 2015)examined boys who played extensively without significantly elevated problematic gaming symptoms and found that they had more sleep problems, fewer activities and lower grades than the non-problematic gaming group, but equal levels of truancy and suicidal ideation.

Problematic gaming vs. PIU and concurrent problematic gaming/PIU. Five studies examined both problematic gaming and PIU, but of those only four allowed for comparisons between the two (Ahmadi et al., 2014; D. L. King, Delfabbro, et al., 2013; Király et al., 2014; Wang, Ho, Chan, & Tse, 2015); results are summarized in Figure 2.6. Problematic gaming alone was found to be associated with Major Depressive Disorder, less openness and higher scores on negative social skills (but no different scores on positive skills, and this was determined in post-hoc analysis to be due to the high prevalence of males in this group).Those with problematic gaming did more information searching, sending emails and downloading. PIU, but not problematic gaming, was associated with having more positive social skills yet more loneliness, more chat and social networking use but not significantly greater amounts of other Internet behaviors such as email and surfing, and more neuroticism. Those with problematic gaming or PIU were more likely to be male, have lower conscientiousness, use the Internet and online gaming for >5h /day, have depressive symptoms and lower self-esteem, and have better grades. Neither was found to be associated with age or agreeableness. Students who had both PIU and problematic gaming fared much worse than those with only one disorder; their panic disorder and separation anxiety scores were in the clinical range.

Aim 2b: Change in associations when confounders and multiple predictors are controlled

As shown in Table 2.3, of the many domains and outcomes assessed in all models, a minority was consistently associated with problematic gaming in well-controlled models. Many associations in multivariate models have not been replicated. Only one study examined longitudinal factors associated with problematic gaming classification as opposed to change in problematic gaming symptoms, and the majority of outcomes in this study were assessed in controlled bivariate analyses. If we take a somewhat conservative approach for the multitude of findings for cross-sectional correlates and assume that only those associations that have been replicated in multivariate models have a robust relationship with the categorical state of problematic gaming, we find support for robust correlates of problematic gaming in multiple domains. Gaming as a coping mechanism; problems with emotional functioning, including anxiety, depression, and ADHD symptoms; behaviors including physical aggression/conduct problems, and problematic Internet use; decreases in academic and subjective well-being including lower levels of school performance, life satisfaction, and self-esteem have all been replicated as cross-sectional correlates in multivariate models. However, the two multivariate longitudinal analyses do not measure the same predictors and outcomes, so the evidence for longitudinal correlates is weaker. Taking a less conservative approach that requires replication in models that have control for confounding but assess only a single potential predictor at a time, we see that factors associated with change in problematic gaming according to these criteria are anxiety, depression, ADHD symptoms, impulsivity, social competence, peer problems, lower academic achievement, physical aggression/conduct problems, hostility and gaming as dysfunctional coping. However, we lack strong evidence for predictors and outcomes of problematic gaming from multivariate

analyses. Combining information about cross-sectional and longitudinal predictors, correlates and outcomes with studies of levels of problematic gaming in Figure 2.7 yields a hypothesized sequence of risk factors, cross-sectional, and longitudinal correlates of problematic gaming. It is of note that for depression and anxiety, clinically significant levels were not assessed in multivariate models. Importantly, no findings in the areas of peer, teacher, school engagement or community connectedness, stress and physical health (including sleep), drugs/alcohol use, or personality factors have been consistently associated in multivariate models.

Discussion

This review of 34 studies that used video game-specific scales to measure problematic gaming found an average prevalence of 5.3% for problematic gaming and 11.7% for sub-threshold (at-risk) problematic gaming in adolescent population samples. Prevalence of problematic gaming differed by gender, but was also affected by study features such as survey type (web, mail, school-based), measurement scale and location, reflecting a continuing lack of consistency in conceptualization and assessment of problematic gaming (D. L. King, Haagsma, et al., 2013). One criticism of measurement regards using criteria based on the DSM criteria for pathological gambling or substance use to evaluate problematic gaming; if these scales were excluded the average prevalence dropped to 4.3%. In this formulation, problematic gaming would be slightly more prevalent than depressive or anxiety disorders in children (Merikangas et al., 2010). The incidence of problematic gaming after one to two years was about 1%; however, problematic gaming seemed to be a transitory state in up to 67% of adolescents, resolving into normal gaming or subthreshold problematic gaming after one or two years. On the other hand, it may be that separate

characteristics determine those who develop shorter-term problematic gaming and those who continue to report symptoms over time. In this review, comparisons between problematic gaming and at-risk groups showed similarities in potential mechanisms of development of problematic gaming (as measured through cross-sectional multivariate models) yet differences in overall mental health and functioning, suggesting that the at-risk level may represent a stage in the progression toward development (or resolution) of problematic gaming. Also, it is encouraging to see that emerging research seemed to be progressing beyond the single-variable associations critiqued in previous reviews of problematic gaming the problematic gaming literature (Ferguson et al., 2011).

Incorporating prior theory about individual vulnerabilities, we found support for factors related to one's ability to cope with or compensate for real-world problems—specifically, social competence, impulsivity, and academic performance—that may predict the onset of problematic gaming. Social competence has been implicated in models of problematic technology use since the turn of the century (J. M. Morahan-Martin, 1999). While some studies have found no difference in social competence in adolescents who play online games as compared with those who are not regular players (Kowert, Festl, et al., 2014), problematic gaming has regularly been associated with lower social competence (D. A. Gentile et al., 2011; Lemmens, Valkenburg, & Peter, 2009, 2011). As suggested by the social compensation hypothesis, adolescents may use gaming to expand smaller offline social circles through online friendships (Kowert, Domahidi, & Quandt, 2014) or strengthen offline friendships through co-located play (Desjarlais & Willoughby, 2010); should compensation be unsuccessful, play may become problematic. Peer acceptance is vital to positive developmental outcomes for adolescence (Bevans et al., 2010; Valdez, Lambert, &

Ialongo, 2011), thus the opportunity for mediated communication and interaction—potential benefits for those who are less facile in face-to-face interactions—may both lead to difficulties (excessive gaming and problematic gaming) but also benefits (more and better friends) for vulnerable adolescents. Impulsivity is a factor commonly associated with excessive or problematic gambling and problematic Internet use (Billieux et al., 2015; S. E. Caplan, 2002; Davis, 2001), including at a neurological level (Littel, 2012). Developing emotional regulation capacity is associated with normal adolescent development (Tottenham, Hare, & Casey, 2011), and it may be that those with less ability to regulate emotions and behavior are more likely to play excessively and report problematic gaming symptoms at some point during development. In fact, some children may seek the excitement and frustration associated with gaming as a way to learn emotional regulation (Agina, 2012), in effect using games to develop resilience. In this review, social competence and impulsivity improved in those who "stopped" having problematic gaming (D. A. Gentile et al., 2011), which could indicate that problematic gaming is associated with aspects of immaturity, and as substance use and antisocial behavior do (Burt, 2012; Johnston, O'Malley, Bachman, Schulenberg, & Miech, 2015), may lessen through the normal maturation process. It may be that this is the case only for certain subgroups; further studies should examine these temporal relationships more thoroughly and for longer time periods and explore motivations for gaming.

One important question that was not sufficiently addressed in well-controlled studies was the temporal relationships between categorical problematic gaming, predictors and outcomes of emotional and behavioral well-being. Specifically, aspects of emotional problems such as depression and anxiety were not measured as predictors of categorical

problematic gaming, while subjective well-being was not assessed as an outcome. Emotional problems including depressive symptoms and social anxiety can lead to withdrawal from society, which may be associated with more media use (Romer et al., 2013). However, the variables that researchers of problematic gaming choose to include are both influenced by and influence theory and evidence; if emotional problems are seen only as a negative outcome, knowledge generation about alternative hypotheses (e.g., media use resulting from depressive symptoms) will be limited. In this study, categorical problematic gaming was associated with later depression, anxiety and hostility, but these findings were not evaluated in multivariate models. To better support the clinical relevance of categorical problematic gaming as well as inform theoretical models, future studies should consider aspects of emotional functioning as predictors as well as outcomes.

Overall, most studies primarily focused on measuring problematic gaming and its associations in a limited number of emotional and behavioral domains. Additional data from representative samples is sorely needed on potential mechanisms outside of individual vulnerabilities, including which media adolescents are using (outside of video games), the patterns of media use in their everyday lives, who they use it with, and why they use media in the way that they do. Qualitative research in media psychology and communication using representative sampling methods would provide useful information about adolescent populations. It would be particularly helpful to replicate the qualitative work of Tzavela and colleagues with a population of highly engaged gamers. In addition, very few studies reviewed here evaluated other potential social opportunities and constraints such as ethnicity, education level, aspects of home life and number or quality of friendships. Although few of the studies here examined levels of problematic gaming or the comparisons

between problematic gaming and PIU, it seems that clear that while being classified as at-risk for problematic gaming is qualitatively similar to having problematic gaming, having PIU is qualitatively different from having problematic gaming and having both problematic gaming and PIU seems to be much worse than having either alone. These findings support previous work and early theory that suggest that understanding patterns of Internet use and excessive use as well as motivations for use are vital to understanding the development of problems related to gaming (Billieux et al., 2015; S.-Y. Chen & Tzeng, 2010; Romer et al., 2013). New technologies such as social networking continue to shape the way we interact (Greenfield & Yan, 2006; Suissa, 2015), reflecting not only an extension of normal social rhythms and relationships, but also the co-creation of a novel, constantly online, multitasking reality for younger individuals who grow up with new media (boyd, 2014; Greenfield & Yan, 2006). The benefits and detractions of these new technologies, their interactions with gaming, and continuing changes in games themselves will necessitate rapidly-adapting methodological approaches that can incorporate changes in relationships and the emergence of new patterns (Galea, Riddle, & Kaplan, 2010).

Limitations

Several potential threats to validity weaken the strength of the studies reviewed here. First, as discussed in previous reviews and commentaries, the disparity in measurement instruments for problematic gaming, in samples and comparison groups examined, and in metric and time course for related variables makes comparisons between studies difficult. However, this heterogeneity in measurement has not affected our most robust findings. Going forward, it would be useful to ensure that outcome measures are clearly specified using scales that have been appropriately validated in adolescent populations.

Second, although the studies featured sample sizes ranging from just over 100 to over 25,000, many studies had significant non-response, and some studies described differential nonresponse or attrition, making it likely that the analysis samples did not accurately reflect the target population (Brunborg et al., 2014; Mentzoni et al., 2011). Several studies also limited analyses to gamers (Desai et al., 2010; Festl et al., 2013; Scharkow et al., 2014), online gamers (Jap et al., 2013; Király et al., 2014; van Rooij et al., 2011) or Internet users (D. Gentile, 2009), making comparisons between samples harder to interpret. Missing data was sometimes handled using listwise deletion (Abedini et al., 2012; Festl et al., 2013) or not discussed (Ahmadi et al., 2014; Wang et al., 2015) in most studies, another factor that may threaten the validity of conclusions. However, several more recent studies used weighting or newer techniques to address the potential bias resulting from these limitations (Brunborg et al., 2014; Mentzoni et al., 2011; Rehbein, Kliem, Baier, Mößle, et al., 2015). In addition, about half of the studies examined here used a bivariate approach to examine associations between problematic gaming and well-being, which does not account for the multiple simultaneous effects of potential predictors of problematic gaming. As some studies reported up to one hundred comparisons, this bivariate approach could lead to an increase in Type I error. It is of note that some studies seemed to report selected outcomes in analyses either by design (e.g., stepwise regression modeling) or some other form of selection that was not apparent (e.g., reporting on three time points for some outcomes and only one or two time points for others) (D. A. Gentile et al., 2011). Appropriately designed studies often limit the number of comparisons in order to reduce the likelihood of Type 1 error. However, without a quantitative synthesis of all measured outcomes including an evaluation of potential publication bias, there is no way to determine whether this affects findings.

Conclusions

As reviewed here, problematic gaming is a condition affecting about 5% of adolescents that is characterized by excessive use of video games (and sometimes other media) and is associated with some symptoms traditionally seen in substance use disorders and pathological gambling. The findings here support a model of the development and resolution of problematic gaming that suggests that problematic gaming may be a time-limited state for a small minority of adolescents that is accompanied by varying levels of distress. Several potential cross-sectional and longitudinal correlates have been identified and replicated in controlled (longitudinal) or multivariate (cross-sectional) models, including problems in emotional and social functioning and school achievement, risky and aggressive behaviors, and lower subjective well-being (see Figure 2.7). Building on prior theory and research, these results are consistent with a dual pathways model, where development of problematic gaming may reflect attempts to cope with real-life problems but may also be related to problems with impulse control. Brain pathways related to reward sensitivity and impulse control change during adolescence, so difficulties with self-regulation may be limited to adolescence or indicative of early vulnerability to mental or behavioral problems (Chambers et al., 2003). Impulsive adolescents may have trouble in school, leading to low academic achievement and more problems with peers and family. Avoidance is a common coping mechanism for adolescents, and many adolescents who are not classified as having problematic gaming report that they play to escape (D. L. King, Haagsma, et al., 2013). For individuals with high levels of stress, playing video games to escape is associated with more compulsive play and greater numbers of problems (Kardefelt Winther, 2014b).

However, a full picture of relevant health, functioning and well-being domains as they apply to adolescent gamers is still lacking: there is little evidence from methodologically

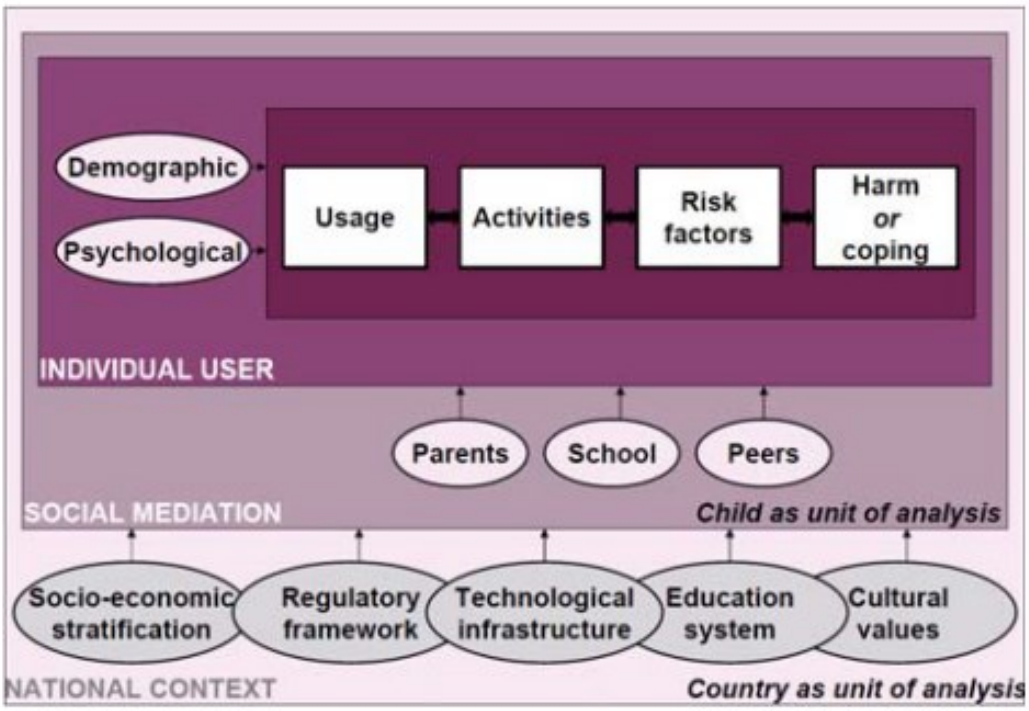
rigorous studies for social-ecological mediators such as parent, peer, or sociocultural variables. Given that both choice and outcomes of media use may be influenced by peers, parental limits, national technological infrastructure, and game availability, future studies should aim to incorporate variables at as many levels as is feasible.

This synthesis may be useful for intervention development and policymaking. First, the prevalence of problematic gaming (0.6% to 15.6%) is low compared to the prevalence of game use by adolescents in general (80%). There is a need to understand and develop interventions to promote the healthy use of games tailored for the subgroup(s) of adolescents at risk for problematic gaming. Programs such as these could be incorporated into existing media literacy programs or developed for dissemination in gaming communities, at gaming conventions, or through games themselves. Second, while some countries have seen gaming as a substantial public health threat (Koo, Wati, Lee, & Oh, 2011; Xing, 2007), this review shows that negative aspects of functioning associated with problematic gaming may resolve in most adolescents. In settings that do not have other cultural forces such as LAN centers and professional e-sports that promote heavy game play (Elson, Breuer, & Quandt, 2014; Daria J. Kuss, 2013), it may be sufficient to promote industry- or indie-developer (including academic researcher/developer) sponsored changes to games through add-on content that could promote self-regulation. For example, limits on time gaming that can be set by the account holder, or customizable game features could help users establish the self-regulation methods that work for them and incorporate them into game play. In addition to those self-regulation ideas, the highly profitable game industry has already taken steps to reward less-heavy play through game mechanisms such as "rested experience", which requires players to "retire" a character to rest in order to make faster

progress through normal game play later. Cooperative efforts between researchers, policymakers and the video game industry would be especially fruitful for developing a variety of intervention approaches.

Clinical research into the newly-proposed Internet Gaming Disorder diagnosis is underway ("Home - ClinicalTrials.gov," n.d.), and this can only be expected to increase. This review provides greater understanding as to the potential mechanisms behind the development of problematic gaming in adolescents that may be useful in informing subsequent individualized treatment. Social skills deficits may be important factors leading to problematic gaming for some adolescents, whereas impulsivity and problems coping in general may be more appropriate treatment targets for others. In addition, further study of the relation of problematic gaming to gender and other contextual factors including family setting, parental supervision and associated conflicts may ultimately help inform aspects of treatment planning and care.

Figure 2.1: Multi-level context of online media use in children



(Reproduced from EU Kids Online 2014, p.15)

Figure 2.2: Proposed dual pathways framework for the development of problematic gaming

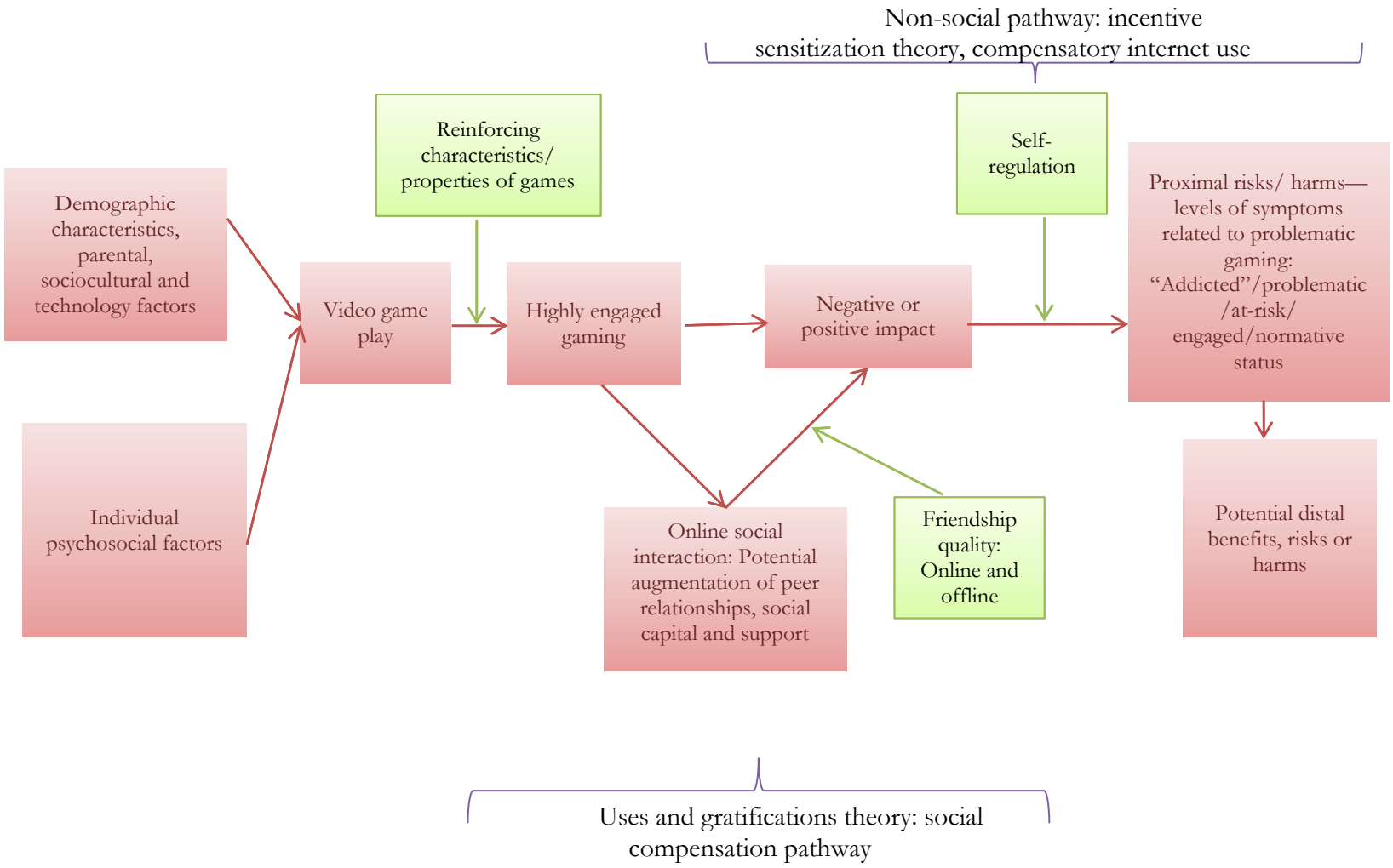


Figure 2.3: PRISMA Flow Diagram

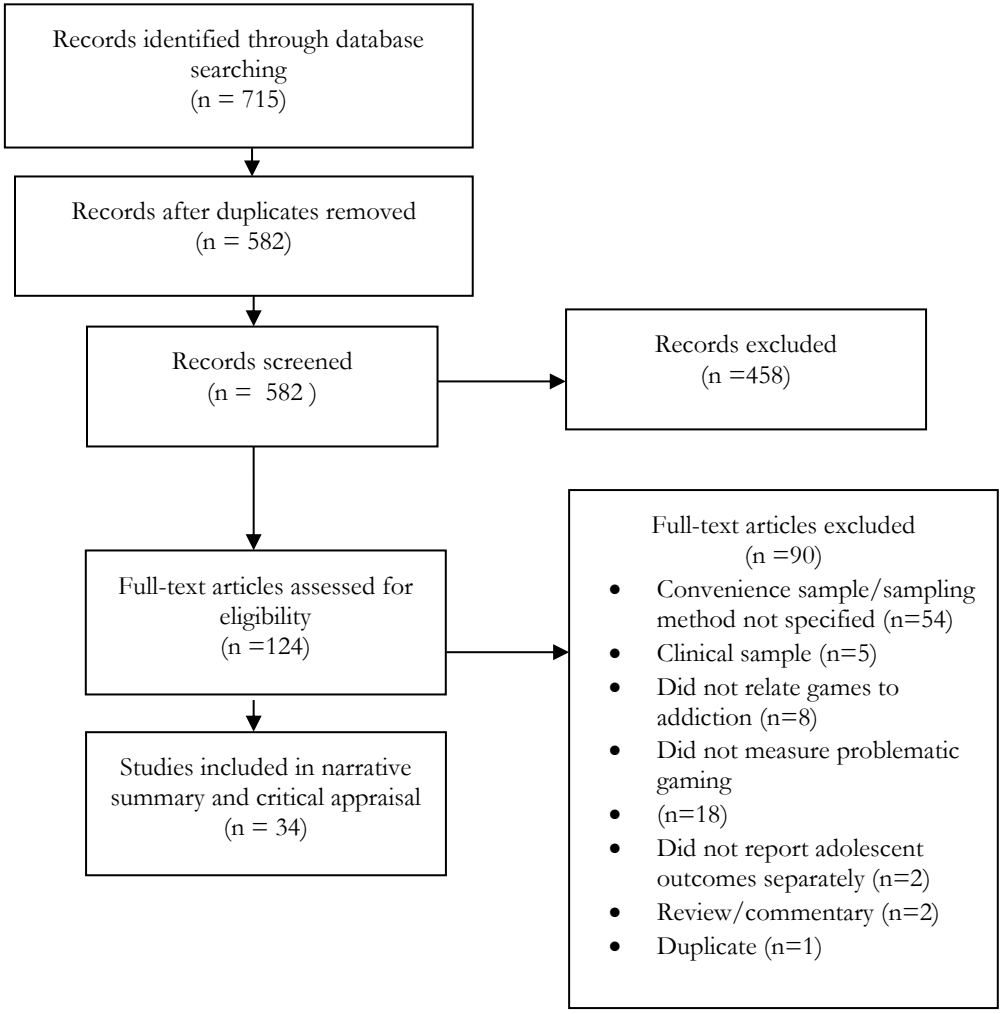


Table 2.1: Characteristics of included cross-sectional studies

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Abedini et al. (2012), Iran	Cross-sectional school-based survey of 500 secondary school students in a single city	Unpublished scale (Anuthawarn 2008)	Self-control Parenting styles	Path analysis	Mother's employment status, authoritarian, permissive and neglectful parenting are positively correlated with problematic gaming (PG), but authoritative parenting is negatively associated.	Computer PG does not directly effect educational progress or have a linking role between parenting style and educational progress.	Generalizability: Selection of secondary school students in a single city in Iran limits the ability to generalize.
Ahmadi et al. (2014), Iran	Cross-sectional school-based clinical interviews of 1020 high school students in a single city	Clinical interviews based on DSM-IV criteria for use/dependence/abuse of computer games or Internet	DSM-IV Generalized Anxiety Disorder (GAD) and Major Depressive Disorder (MDD)	Chi-square and Pearson regressions comparing those with various types of problematic technology use to adaptive users	Computer games abuse/dependence is associated with increased prevalence of GAD and MDD; PIU is associated with MDD.	PIU is not associated with GAD.	Analyses: No adjustment for confounding
Brunborg et al. (2013), Norway	Cross-sectional survey of 1320 8th-grade students across Norway	Game Addiction Scale: Endorsing 4 "core" criteria=PG, endorsing 2/3 "core" criteria=problem, endorsing 3 items "tapping engagement" but no core criteria=engaged	Time gaming Physical exercise Six health complaints/ symptoms	Hierarchical linear models of each health complaint/ symptom on PG groups, controlling for gender and exercise	PG and problem gamers have a higher risk of feeling low, irritability/bad mood, feeling nervous, having trouble sleeping, feeling tired and exhausted, or feeling afraid than the reference group.	Engaged gamers do not have a higher risk of feeling low, irritability/bad mood, feeling nervous, having trouble sleeping, feeling more tired and exhausted, or feeling more afraid than the reference group.	Idiosyncratic measurement of PG/engaged gaming

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Choo et al. (2010), Singapore	2998 primary and secondary school children from across Singapore	New scale (Gentile 2009)	Intelligence Somatic complaints Damages in functioning	Hierarchical linear models of outcome variable on PG, controlling for gender, race, SES and school; a second model regressed school performance on PG controlling for time spent gaming.	PG is associated with various physical health symptoms (e.g., hand pain, blurred vision), arguments/fights with parents about gaming, problems with sleep, school, and schoolwork related to gaming, and problems with friends related to gaming.	PG is not associated with intelligence or SES.	Measurement: New scale Reporting: All reported items statistically significant; may reflect selective outcome reporting
Chérif et al. (2014), Tunisia	Cross-sectional survey of 587 secondary-school students in a city	DSM-IV-JV scale (Fisher 1994) (4/9=PG)	Problematic Internet Use (PIU): YIAT	Chi-square analysis of PIU with PG	PG is significantly associated with PIU.	No other comparisons with PG	Analysis: Did not adjust for confounding Measurement: No information about psychometrics of translated scale

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Desai et al. (2010), U.S.	Cross-sectional survey of 4028 high school students in a US state (prevalence); 2064 gamers included in well-being analyses	New scale based assessing PG as an impulse control disorder-3 items based on the Minnesota Impulse Control Disorder Inventory (cite)-3/3 items=PG	Time gaming GPA, Extracurricular activities Smoking, alcohol, marijuana , caffeine and other drug use Depression: 1 item1 item Conduct problems: 2 items BMI	Multivariate logistic regression, controlling for race and gender	PG was associated with ever having smoked or used drugs, lower use of caffeine, more depression and conduct problems (serious fights, carrying a weapon to school).	PG was not associated with grades, extracurricular activities, cannabis use, marital status, or current or lifetime alcohol use.	Measurement: New scale with few psychometrics reported (alpha only)
Faulkner et al. (2015), Canada	Cross-sectional survey of 3338 high school students in a province in Canada	Problem Video Game Playing questionnaire (PVP)-4/9=PG; items used individually as latent class indicators in analysis	Time gaming Social dysfunction Anxiety/depression: Self-rated mental health: 1 item BMI Self-rated physical health : 1 item 3 Physical activity Grades	Latent class analysis and latent class regression with clustering, controlling for sex and SES	Three PG classes and one normative class were estimated. All non-normative classes were more likely to be male and overweight. High SES was less likely to be in Severe or High classes. Classes differed in time gaming except Severe and High PVP. The Severe PVP class had higher depression/ anxiety and social dysfunction and worse self-rated mental and	There was no difference in time gaming between the Severe and High PVP classes. The Severe class had same odds of poor grades and of meeting physical activity guidelines as other classes. The High PVP and Low PVP classes did not differ from each other or Normative class in depression/anxiety, social dysfunction,	Measurement: Adapted the PVP scale with one item from each dimension Missing data: 64% response rate (but no significant differences)

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
					physical health than other classes. (continued) The High PVP class had higher odds of physical activity but poorer self-rated mental health and worse academic performance than the Normative class.	or self-rated physical health.	
Festl et al. (2013), Germany	580 adolescent gamers analyzed as part of a larger sample including 3645 adults through computer-assisted telephone interviewing	Game Addiction Scale (GAS)-mean	Social competence: 2 items Social support: 4 items Self-efficacy: 5 items Physical aggression: 2 items Anger aggression: 2 items Life satisfaction: single question Time gaming, game genres	Structural equation modeling of psychological and gaming-related variables with mean GAS score. Factor loadings and personality traits constrained to be equal across age groups	PG is positively correlated with time gaming, online gaming, roleplaying game and shooter use, physical and anger aggression. PG is negatively correlated with self-efficacy, social support, social competence, and life satisfaction.	None reported	Analysis: assumed measurement invariance between adolescents and adults

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Fisher (1994), England	Virtually all (467/493) secondary school students from a single town in the UK	DSM-IV-JV scale (author): 4/9 items=PG	Frequency/duration of arcade game play (times/week, duration/event) Weekly expenditure on arcade game play Borrowing money/selling possessions to play Subjective awareness of excessive game play ("worried that they played video games too much")	Chi-squared analysis between PG group and non-PG gamers	Those with PG were more likely to be male, to play more frequently and for longer times, spend/borrow money to finance gaming, and have a higher subjective awareness of excess play than social players.	None reported	Analysis: Did not adjust for gender differences

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Gentile (2009), U.S.	Online cross-sectional survey of 8-18 year olds using stratified sampling (n=1178); analyses conducted on gamer subsample (88%)	New scale created by author, 6/11 items=PG	Gaming habits School performance Attention difficulties Involvement in physical fights Physical health	T-test and chi-squared analyses comparing PG to non-PG gamers; ANCOVA of school performance by PG status, controlling for sex, age and weekly amount of gaming	PG is associated with a being male, a longer history of gaming and more time gaming, more game rating symbols known, more trouble paying attention in school, lower grades, more hand, finger or wrist pain, and higher odds of ADHD, having "felt addicted" to video games, having friends who were "addicted" to video games, involvement in a physical fight in the last year, and having a video-game system in the bedroom. PG is a significant predictor of school performance when controlling for age, sex and time gaming, even when relevant criteria of the PG scale are excluded from analysis.	PG is not associated with neck pain, blurred vision, headaches, age, using the Internet to do homework, self-rating of being affected by violence in games, or having a TV in the bedroom.	Measurement: Adapted scales for covariates Sampling: Online sample limits generalizability to Internet users, erratum later issued re: representativeness of sample

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Holstein et al. (2014), Denmark	Cross-sectional survey of 2100 students from across Denmark	New: 3-item scales for both computer and console video games; 2/3=PG	Time gaming SES: Parent's occupational social class Migration status (parents born in Denmark vs. not) Family structure Grade level	Multivariate logistic regression with clustering controlling for grade in school, family occupational social class, migration status and family structure and stratified by gender	Time gaming on computer or console games is associated with computer-gaming PG in girls and boys and associated with console-gaming PG in boys. Moderate use (vs. low) of computer/console games is associated with PG with console gaming in boys.	Moderate use of computer/console games is not associated with computer- or console-gaming PG in girls. Moderate use of computer/console games is not associated with computer-gaming PG in boys.	Measurement: Levels of use categorized (high) differently for boys and girls, new scale
Jap et al. (2013), Indonesia	Cross-sectional survey of 1477 junior and senior high school students who play online games	New 7-item scale (Indonesian Online Game Addiction Questionnaire)	Time gaming Money spent on games Time spent on schoolwork	Correlation	PG is positively correlated with time gaming and gaming expenditures and is negatively correlated with time spent on schoolwork.	None reported	Measurement: New scale presented in this paper Prevalence reported in Discussion is based only on criteria of playing 4+ hours/day

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Jeong & Kim (2011), Korea	Cross-sectional survey of 600 middle and high school students in one city	Young Internet Addiction Test (YIAT) total score, adding the word "gaming" to Internet [i.e., Internet gaming], at-risk=50-79, PG=80-100	Social self-efficacy: online and offline Social activities with parents (frequency) Gaming activities with parents Social activities with friends/teachers Attitudes toward gaming (adolescent's own, parents', friends' and teachers')	ANOVA comparing variables between groups of non-PG at-risk and PG gaming students for variables significant in bivariate correlations	Compared to at-risk and non-PG students, PG students show less offline but more online social efficacy, and more positive attitudes toward gaming but lower grades and less positive parental attitudes, and were more likely to be male. Compared to non-PG students, at-risk students have less offline but more online social self-efficacy, less positive parental attitudes, more gaming time and fewer social activities with parents.	Social activities with parents and time gaming do not differ between PG and other groups Teachers' attitudes do not differ between groups	Measurement: New scale (added "gaming" to YIAT) Missing data: Not discussed
Johans-sen & Gotestam (2004), Norway	Cross-sectional phone and mail survey of 3237 adolescents across Norway	Young Diagnostic Questionnaire (YDQ), adapted, using "playing" instead of Internet-5/8=addicted, 3/8=at-risk; combined addicted+at-risk=PG	Time gaming and types of games played Demographic variables: sex, age, geography, school, work, domicile type	Forward regression of PG on covariates	PG is related to sex, age, time gaming, shooters, fighting games and strategy games.	None reported	Missing data: Low response rate (45.2%) Measurement: Two different survey forms combined Many changes made to validated scale used to measure

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
							PG
King et al. (2013), Australia	Cross-sectional school-based paper or online survey of 1214 students in one city	PTU (pathological technology use) Checklist (Sim et al. 2012, a version of Gentile's scale), 5+=PG/PIU	Anxiety/depression: Social anxiety Loneliness Social skills	T-test and chi-square analyses comparing PG to non-PG gamers, Internet users and both; ANOVA of comorbidity across PTU profiles	Students who had PVG without PIU had more negative social skills vs. non-PTU, but post-hoc analysis suggested that this might be due to having more males in the PVG group. Students with combined PVG and PIU had RCADS Panic Disorder and Separation Anxiety subscale scores in the clinical range, and more loneliness, depression, and overall anxiety than non-PTU students. Students who had only PIU had more loneliness, social anxiety, and other anxiety than those with no PTU and better social skills than those with PG.	Students with PG scored in the normal range on depression, panic disorder, separation anxiety, loneliness, social anxiety or overall anxiety. Students with PG showed no differences in positive social skills or other anxiety subscales than non-PTU students. Students with PIU do not differ from those without PTU on social skills.	Analyses: No adjustment for confounding

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Király et al. (2014), Hungary	Cross-sectional school-based survey of 4875 students secondary schools across Hungary; analyses conducted on 2073 current gamers	Problematic Online Gaming Questionnaire Short-Form (POGQ), 32+=POG	PIU: Problematic Internet Use Questionnaire Depression: Self-esteem: Demographics: sex, age Internet use and gaming habits Grades	Structural equation modeling on sample weighted for non-response	Both PG and PIU are associated with being male, using the Internet and online gaming for >5h /day, depressive symptoms, and lower self-esteem, but slightly higher grades. PG in gamers is associated with having PIU, information searching, sending emails and downloading, PIU in gamers is associated with being male but less strongly, with having PG, chat, and social networking.	PG is not associated with social networking or chatting. PIU is not associated with information searching, email or downloading.	Generalizability: Possible cohort effects due to low popularity of SNS in Hungary at time of study
Lee et al. (2014), Taiwan	Cross-sectional survey of 25,573 junior and senior high school students in Taiwan	Unpublished scale measuring Dys-controlled online gaming (DysOG)	PG: Self-perceived dys-controlled online gaming Internet addiction: Chen IA scale Internet expectancy (Beliefs about the benefits of the Internet) Attitude and	Structural equation modelling conducted separately for junior and senior high students	PG is associated with online gaming attitude and Internet addiction and lies on one of the pathways between Internet expectancy and Internet addiction for both junior and senior high students. Gender moderated magnitudes of path estimates.	None reported	Other mediators may exist

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
			preference toward online social interaction Attitude toward online games				
Linskiy et al. (2012), Ukraine	Cross-sectional survey of 1532 university, college and secondary school students in a city	10-item scale based on the WHO AUDIT	AUDIT and adapted scales to assess abuse/dependence of other substances/behaviors Sociodemographic information	Index of conjugation for computer games addiction in comparison to other substances/behaviors-no hypothesis testing	Computer games were found to be the most addictive of legal substances/behaviors (including work/study, tobacco, TV, reading, tea/coffee, shopping, food and Internet) and less addictive than taboo (alcohol, gambling, sex) and illegal substances (cannabinoids, sedatives, psychostimulants, volatile solvents, opioids and hallucinogens).	None reported	Measurement: New scale (sensitivity, specificity and reliability reported), new statistical analysis using rankings Analysis: No control for confounding

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Mentzoni et al. (2012), Norway	Cross-sectional mail or online survey of 816 individuals that included about 209 adolescents	Game Addiction Scale (GAS)-7/7=PG, 4/7=at-risk	Age, gender	Regression of at-risk (not PG) on gender and age	PG is associated with being male and with the lowest age group (16-21) only.	No other analyses separated findings by age group.	Missing data: Low response rate (34.0%) Analysis: LPG gamers excluded from analysis because of low prevalence
Müller et al. (2014), Europe	Cross-sectional survey of 12,938 10th graders across Europe	Scale for the Assessment of Internet and Computer Game Addiction- Gaming Module (AICA-S-gaming)-13.5+=PG, 7-13=at-risk	Youth Self Report (YSR): Social, academic performance and activities competence Internalizing and externalizing behaviors Game genre preference	Multiple regression of PG on age and four game genres, ANCOVAs of well-being and problem behaviors by PG status controlling for age, country and gender.	PG was associated with gender, migration background, parents' marital status, and mother's education; shooter, MMORPG and strategy games PG and at-risk are associated with lower academic performance and activities PG vs. at-risk male gamers have higher scores on the YSR clusters of Total Problems, externalizing and internalizing problems and across all subscales except Somatic Complaints, but females with IGD differ from those at	In unadjusted models, prevalence of PG did not differ by age In unadjusted models PG was not associated with father's employment At-risk gamers do not differ from non-problematic and non-gamers on YSR Somatic Complaints PG and at-risk gamers do not differ on Social competence, academic performance, or activities when gender, age and country are	Analyses: Comparison groups varied between analyses

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
					risk only on YSR subscales Gender, age and country have main effects in many comparisons, with girls with IGD showing more problems with well-being.	controlled for.	
Pápay et al. (2013), Hungary	Cross-sectional survey of 2774 9th- and 10th-graders across Hungary	Problematic Online Gaming Questionnaire Short-Form (POGQ) (continuous)	Time gaming, genre Self-esteem: Rosenberg Depressive mood: CES-D	Latent profile analysis of dimensions of PG based on confirmatory factor analysis in weighted sample with Wald test of equality across classes and clustering	PG and at-risk classes are associated with being male and playing for >5 hrs./day At-risk class has lower mean age PG class has lower GPA than at-risk/no risk PG class has lower self-esteem and more depressive symptoms than other classes	None reported	Measurement: Scale is specific to online gaming, making comparisons across studies difficult

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Rehbein et al. (2010), Germany	Cross-sectional survey of 15,168 9th graders in Germany (analyses varied in sample size)	Video Game Dependency Scale (KFN-CSAS) - 42+=PG, 35-41=at-risk. "Extensive" players have more time gaming but are not considered at-risk for PG	Suicidal thoughts Social competence Impulsiveness Acceptance of violence History of diagnosed depression, anxiety disorder or ADHD History of abuse by parents Truancy School performance Sleep disturbance Participation in activities Media use and habits Gaming as dysfunctional coping, Gaming as a source of self-efficacy	Multiple logistic regression of PG on predictors in regular gamers (boys and girls), t-test and chi-square comparing levels of PG/extensive gaming in boys	PG is predicted by gaming as dysfunctional coping, gaming as a source of self-efficacy, use of MMORPGs, no success in leisure activities besides gaming, school-related anxieties, previous repetition of a school year, social competence, impulsiveness, and acceptance of violence At-risk boys' grades in Sports do not differ from the non-PG group and they have equal amounts of sleep problems as the non-PG boys. "Extensive" players have lower grades in some classes than non-PG boys and equal levels of truancy; although when they are truant, they report it is more likely due to video gaming. They have more sleep problems	PG is not associated with strategy or shooter games, male gender, low parental or juvenile education, ADHD, depression, anxiety or physical abuse in childhood	Analyses: Some outcomes considered only for validation purposes and not included in logistic regression Sample: Some analyses in boys only Reporting: Some use of causal language in Discussion section ("seems to play a crucial part in developing VGD")

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
					and fewer activities than non-PG, but no more frequent thoughts of suicide.		
Rehbein et al. (2015), Germany	Cross-sectional survey of 11,003 German 9th graders	Video Game Addiction Scale (GAS) (KFN-CSAS) - PG=5/9 items	Time gaming Self-reported feeling "addicted" to video games Grades Sleep problems Truancy	T-test, Chi-square test for categorical variables comparing groups	Students with PG are more likely to be male, have foreign migration status, to be in lower education level, have more daily gaming time, sleep disturbances, worse GPA, feel more addicted to video games and have more truancy.	None reported	Measurement: Endorsement of criteria listed as "strongly agree" rather than "sometimes agree"
Turner et al. (2012), Canada	Cross-sectional survey of 2832 Ontario high school students	Problem Video Game Playing questionnaire (Tejeiro Salguero & Bersabe, 2002): 5/8=PG	Grades Amount of homework/ week Relationship with parents Suspension from school, truancy	Bivariate logistic regression of PG status on predictors, controlling for gender	PG is associated with being male, grades, amount of homework and parental relationship	PG is not associated with year in school (i.e., age) suspensions or truancy	Missing data: Response rate of 68% for in-school survey
Van Rooij et al. (2011), Nether-	Repeated cross-sectional survey of	Compulsive Internet Use Scale (CIUS) + time online gaming in a sample of online	Depressive mood: Loneliness: Self-esteem:	Latent class analysis of CIUS and time gaming with	A PG class is estimated that shows about 55 hours/week gaming and higher	PG is not associated with social anxiety PG is not associated with more	Analyses: No control for confounding by sex or age

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
lands	1572 students across the Netherlands who played online games; 467 had longitudinal measure-ments	gamers as latent class indicators	Social anxiety:	test of Wald test of equality of means and post-hoc tests of differences between PG classes and others cross - sectionally	CIUS scores; a high use class ("heavy gamers") is estimated that shows 46 hours/week gaming but average CIUS scores. Other classes show fewer hours/week gaming and lower CIUS scores. PG is associated with more loneliness and lower self-esteem at T1 and depression, loneliness and low self-esteem at T2 compared to other classes. PG gamers show more depressive symptoms than heavy gamers do at T2 Half of PG gamers at T1 are still PG at T2.	depression at T1. Gamers in the PG group do not differ from heavy gamers in depression, loneliness or self-esteem at T1 or in loneliness or self-esteem at T2.	

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Van Rooij et al. (2012), Nether-lands	Cross-sectional survey of 2894 students across the Netherlands	Video Game Addiction Test (VAT) (continuous)	IA: CIUS Time gaming: online, browser and offline games Depressive mood: Loneliness Self-esteem: Social anxiety:	Correlation	VAT is correlated with GAS, CIUS, depressive mood, low self-esteem, loneliness, social anxiety and time on each type of game	None reported	Analyses: Bivariate unadjusted analyses only as part of scale validation
Van Rooij et al. (2014), Nether-lands	Repeated cross-sectional survey of 8478 students in the Netherlands, of whom 5789 played video games and were used in the analyses	Video Game Addiction Test (VAT)-average endorsement of "often" to "very often"=PG	Time gaming: online, browser and offline games Use of alcohol, cigarettes or cannabis in last month Depressive mood: Loneliness Self-esteem: Social anxiety:	Chi-square with Fisher's exact test and t-tests comparing PG to non-PG gamers separately by sex	PG is associated with worse school performance and poorer well-being across all measures in boys and girls. PG is associated with online gaming, alcohol and cannabis use and smoking in boys. PG is associated with low education level, online and offline gaming, and alcohol and cannabis use in girls.	PG is not associated with year in school or browser game play. PG is not associated with low education or offline gaming in boys. PG is not associated with smoking in girls.	Analysis: Bivariate, unadjusted analyses (although stratified by gender) Measurement: Did not assess concurrent use of games, although most gamers played more than one type of game

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Walther et al. (2012), Germany	Cross-sectional survey of 2553 students in a state	Video Game Addiction Scale (GAS) (KFN-CSAS) - 20+-PG, 11-19=at-risk	Past month alcohol, tobacco and cannabis use Gambling Impulsivity: 4 items Social anxiety: 4 items ADHD: 4 items Depression: Sensation seeking: 4 items Irritability/aggression Extraversion: 4 items Loneliness: single item General and social self-efficacy Life satisfaction: single item Self-esteem: single item Parental monitoring	Correlation between forms of substance use and PG, multilevel mixed effects multivariate regression of PG on psychosocial predictors, controlling for age, gender, migration background, SES and parental monitoring	PG is correlated with problematic gambling and use of cannabis PG is associated with social anxiety, ADHD, impulsivity, irritability/aggression and lower self-esteem Relationships between substance use/problematic gambling and psychosocial predictors are the same for impulsivity PG is associated with more social anxiety, but problematic gambling and substance use are associated with less.	PG is not correlated with concurrent tobacco or alcohol use. PG (and problematic gambling) are not associated with depression, sensation seeking, extraversion, loneliness, general or social self-efficacy, or life satisfaction PG is associated with male gender, high socioeconomic status, low parental monitoring, and lower age.	Measurement: Substance use operationalized as frequency of use, not addiction

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Wang et al. (2014), China	Cross-sectional survey of 503 secondary school students in Hong Kong	Game Addiction Scale (GAS)-3 items endorsed at "often" or above=PG	IA: Internet Addiction Test Time gaming & game genre Spending money on games History of playing Internet games Number of close friends Single-item stress Single-item loneliness Academic performance, relationship with classmates, relationship with teachers Family harmony	Multiple logistic regression of PG on predictors found to be statistically significant in bivariate analyses	PG is related to male gender, lower grades, family disharmony, and *more* friends as well as time gaming and spending money on gaming.	PG is not related to grade level, parental marital or education status or economic status, relations with teachers or classmates, period of playing of online gaming, stress or loneliness, or ownership of a mobile device.	Measurement: Used a revised scoring approach to GAS (different cutoff)
Wang et al. (2015), China	Cross-sectional survey of 920 secondary school students in Hong Kong	Game Addiction Scale (GAS)-7/7 endorsed at "often" or above=PG; sum score also used	IA: Internet Addiction Test Social networking addiction Time spent gaming and in other Internet	Multivariate regression analysis of PG, IA and SNA on personality traits among those who game and use	PG is associated with male sex, less conscientiousness and less openness. IA is associated with male sex, less conscientiousness and more neuroticism.	PG is not associated with age, agreeableness, extraversion or neuroticism. IA is not associated with age, agreeableness,	Did not account for clustering

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
			activities Game genres and social networking sites used Personality traits: Short Big Five	SNS (n=830), controlling for age and sex	SNA is associated with more extraversion and neuroticism.	extraversion or openness. SNA is not associated with age, sex, agreeableness, conscientiousness, or openness.	

Table 2.2: Diagnostic features of psychometric instruments used to measure problematic gaming

Scale	Number of studies	Prevalence	Location	Preoccupation	Tolerance	Escape adverse moods	Withdrawal	Jeopardized/lost opportunity(Conflict)	Deceive/cover up	Continue despite problems	Give up other activities	Reduce/stop (Loss of control)	Relapse	Sleep	Financial consequences	overuse	Immersion	Compulsion	Behavior problems	Emotional changes	Functioning loss	Dysfunctional use	Chasing losses	Irrestistible urge	Urge relieved by playing
Internet Gaming Disorder	n/a	n/a	n/a	1	1	1	1	1	1	1	1	1	o	o	o	o	o	o	o	o	o	o	o	o	o
Assessment of Internet and Computer Game Addiction (AICA-S)	1	1.6	Europe	1	1	1	1	o	o	1	o	1	o	o	o	o	o	o	o	o	o	o	o	o	o
Clinical Interview	1	1.3	Iran	o	o	o	1	o	o	o	o	o	o	1	o	o	o	o	o	o	o	1	1	o	o
Compulsive Internet Use Scale	1	1.6	Netherlands	1	o	1	1	1	o	o	o	1	o	o	o	o	o	o	o	o	o	o	o	o	o
Game Addiction Scale	6	5.6	Norway, Germany, China	1	1	1	1	1	o	1	o	o	1	o	o	o	o	o	o	o	o	o	o	o	o
New (Desai et al.)	1	2.6	US	o	o	o	o	o	o	o	o	1	o	o	o	o	o	o	o	o	o	o	o	1	1
New (Fisher)	2	3.6	England, Tunisia	1	1	1	1	1	1	o	o	o	o	o	1	o	o	o	1	o	o	o	1	o	o
New (Holstein et al.)	1	9.8	Denmark	o	o	o	1	1	o	o	o	o	o	o	o	1	o	o	o	o	o	o	o	o	o
New (Jap et al.)	1	6.0	Indonesia	1	1	1	1	1	o	o	o	o	1	1	o	o	o	o	o	o	o	o	o	o	o
New (Linskiy et al.)	1	4.0	Ukraine	1	o	o	o	1	o	1	o	1	o	o	o	1	o	o	o	o	o	o	o	o	o
Problem Videogame Playing (PVP) Scale	2	5.7	Canada	1	1	1	1	1	1	1	o	1	1	o	o	o	o	o	o	o	o	o	o	o	o
Problematic online Gaming Questionnaire (POGQ)	2	8.2	Hungary	1	o	o	1	1	o	o	1	o	o	o	o	1	1	o	o	o	o	o	o	o	o
Unnamed scale (Gentile, 2009)	4	7.3	US, Singapore	1	1	1	1	1	o	o	o	o	1	o	o	o	o	o	o	o	o	o	o	o	o
Video Game Addiction Scale (KFN-CSAS)	4	2.0	Germany	1	o	o	1	1	o	o	o	1	o	o	o	o	o	o	o	o	o	o	o	o	o
Video Game Addiction Test	1	1.7	Netherlands	1	o	1	1	1	o	o	o	1	o	o	o	o	o	o	o	o	o	o	o	o	o
Young Diagnostic Questionnaire	1	2.7	Norway	1	1	1	1	1	1	o	o	1	1	o	o	o	o	o	o	o	o	o	o	o	o
Young Internet Addiction Test	1	2.2	Korea	1	o	o	o	o	o	o	o	o	o	o	o	o	o	1	1	1	1	o	o	o	o
Total	**30**			14	8	10	14	13	4	5	2	9	5	2	1	3	1	1	2	1	1	1	2	1	1

Table 2.3. Associations between problematic gaming and individual, media use, family and sociodemographic variables

Domain/subdomain	All studies	Adjusted models	Multivariate models
Comfort			
Emotional, including	14/17	12/13	6/7
ADHD/hyperactivity*	4/5	4/5	2/3
Anxiety*	6/9	4/5	2/3
Depression*	9/14	7/10	4/6
Hostility*	3/3	3/3	2/2
Negative stress	0/1	0/1	0/1
Physical, including	5/6	5/6	1/1
Single-item self-rated health	2/3	2/3	none
Sleep	4/4	4/4	1/1
Resilience			
Active coping, including	5/5	4/4	3/3
Impulsivity*	3/3	3/3	3/3
Social competence*	4/4	3/3	3/3
Community connectedness	1/1	1/1	none
Family connectedness	4/6	4/5	1/2
Peer connectedness, including	6/10	4/6	2/4
Loneliness	3/6	1/3	0/2
Social support	2/2	1/1	1/1
Personality factors	2/5	2/5	2/4
Teacher connectedness	0/1	0/1	0/1
Risk avoidance			
Aggression/bullying*	7/8	7/8	3/3
Drugs/alcohol/tobacco/	5/7	3/5	2/3

Domain/subdomain	All studies	Adjusted models	Multivariate models
other problematic behaviors, including			
Alcohol use	1/4	1/4	0/2
Smoking	2/3	2/3	1/2
Cannabis	2/3	2/3	1/2
PIU*	2/2	2/2	2/2
Peer hostility/bully victim	1/1	1/1	none
Subjective well-being			
Life satisfaction/perceived success*	2/4	2/3	2/3
Self-worth *	7/7	5/5	4/4
Achievement			
Academic achievement*	13/17	11/15	4/7
Academic performance			
School engagement, e.g.	3/5	3/5	1/2
Truancy	2/3	2/3	1/1
Media use factors			
Gaming-related attitudes, beliefs and knowledge, including	7/8	5/6	3/3
Attitude toward gaming	2/2	1/1	1/1
Gaming as dysfunctional coping*	2/2	2/2	2/2
Game use characteristics, including	15/17	12/13	5/6
Time gaming*	15/16	12/12	7/7
Roleplaying games*	4/4	4/4	3/3
Other genres	2/3	2/3	1/2
Offline video games	3/3	2/2	1/1
Internet use characteristics	1/2	1/2	1/1

Domain/subdomain	All studies	Adjusted models	Multivariate models
Internet-related attitudes, beliefs and knowledge	2/2	1/1	1/1
Parents' gaming-related attitudes	1/1	none	none
Peers' addiction to games	1/1	1/1	none
Teachers' gaming-related attitudes	0/1	none	none
Parent factors			
Mother's employment/education	2/2	2/2	1/1
Father's/both parents' employment/education*	0/3	0/3	0/2
Marital status*	1/3	1/3	0/2
Parenting style/monitoring*	2/2	2/2	2/2
Sociodemographic factors			
Age	4/11	3/10	3/6
Country	1/1	1/1	none
Education level	2/3	2/3	0/1
Ethnicity/migration status	3/4	3/4	1/2
Male *	20/21	17/18	11/12
SES	2/4	2/4	1/2

*Consistent results found in at least two multivariate models

Table 2.4: Characteristics of included longitudinal studies

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
Brunborg et al. (2014), Norway	Two-year longitudinal survey of 1928 junior and senior high students across Norway	Game Addiction Scale (GAS)-average of all items	Depression Heavy episodic drinking in past year Conduct problems: serious, aggressive or covert	Change in mental/behavioral health was regressed on change in GAS score (weighted for gender, age and academic achievement due to attrition).	Change in GAS score is associated with increased depression and conduct problems and lower grades.	Change in GAS score is not associated with increased drinking.	Potential confounding by time-variant variables; did not assess game genre
Gentile et al. (2011), Singapore	Longitudinal two-year study of 3034 primary and secondary students across Singapore	New scale (Gentile 2009)	Gaming habits Impulsiveness Social competence Emotional regulation Goal-setting Intelligence Aggressive cognitions Self-reported physical aggression Parent-child relationship ADHD Depression Anxiety Social phobia School performance Somatic complaints Damages in functioning	(1) Latent growth mixture model with ANCOVAs comparing students who became pathological gamers "starts" vs. "never" (2) Same in "stops" vs. "stays" (3) longitudinal growth curve model of risk factors for baseline problematic gaming (PG) score and outcomes of change in PG score between time 1 and time 3.	Risk factors for developing PG (starts vs. never) are impulsivity, social competence, emotional regulation, empathy, LAN center use and amount of weekly play. Outcomes of PG (starts vs. never) included parent-child relationship, violent game exposure, aggressive cognitions, aggressive behavior, online gaming, ADHD, anxiety, social phobia and depression. Potential protective factors for resolution/remission at T1 (stops vs. stays) are school	School performance at T3 is not associated with earlier PG. Hostility and relational aggression at T3 are not associated with stopping.	Reporting: Some outcomes reported in earlier paper by Choo et al. 2010. Generalizability: Cultural popularity of LAN centers may limit generalizability Analyses: Most outcomes measured in bivariate, adjusted models.

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
					performance, goal setting and level of PG symptoms (more symptoms=more likely to stop). Outcomes of stopping (stops vs. stays, measured at T3) are empathy, impulsivity, aggressive cognitions, physical aggression, anxiety, social phobia and depression. Time gaming and impulsivity predict T1 PG levels, while T1 social competence and impulsivity predict change in PG symptoms. Initial PG score is positively associated with depression, anxiety and social phobia at T3 and negatively associated with grades. Change in PG score is positively associated with change in depression, anxiety and social phobia and negatively associated		

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
					with change in grades.		
Mößle & Rehbein (2013), Germany	Two-year longitudinal study of 739 children in a state	Video Game Dependency Scale (KFN-CSAS-1 at T1 and KFN-CSAS-2 at T2). Items used in both scales were summed to create a PG score	Gaming as dysfunctional coping: single item Media use and ownership Academic self-concept: Peer problems Family violence Parental care ADHD symptoms Depressive symptoms: 5 items	Longitudinal path model of various covariates on PG including direct and indirect effect and correlation between predictors, controlling for T1 PG	T2 PG score is related to gaming as dysfunctional coping, low academic self-concept, male, peer problems, and MMOs. It is related to low parental care indirectly through low academic self-concept and through dysfunctional coping, also to hyperactivity indirectly through dysfunctional coping	T2 PG score is not related to earlier values of depression, hyperactivity (direct), shooters, family violence, low parental care (direct).	Measurement: Scale differed between years, Several measures are not established scales Sample: Younger sample than most studies
Scharkow et al. (2014), Germany	Two-year longitudinal study using computer-assisted telephone interviews of 112 adolescents, part of a larger sample that included 790 adults	Game Addiction Scale (GAS): 7/7 items=PG, 4/7=at risk, also used mean of items. At-risk and PG groups were combined for analysis.	Social support: 4 items Social capital: Single item Life satisfaction: Single item Perceived success vs. fellow students: Single item	Latent growth curve model and cross-lagged structural equation model of GAS on predictors, combining PG and at-risk groups	Adolescents' GAS scores decrease over time. Time 1 GAS is associated with lower values of life satisfaction and perceived social support cross-sectionally.	Perceived success and social capital are not associated with GAS cross-sectionally. T1 Life satisfaction, perceived success, social support and social capital do not predict later GAS. T1 GAS does not predict later life satisfaction, perceived success,	Measurement: PG and at-risk groups combined Analysis: Factor loadings constrained to be the same across age groups in SEM

Study, year, location	Participants and design	Problematic gaming measure	Relevant predictors, correlates and outcomes	Relevant analyses	Significant findings	Null findings	Limitations
						social support or social capital.	

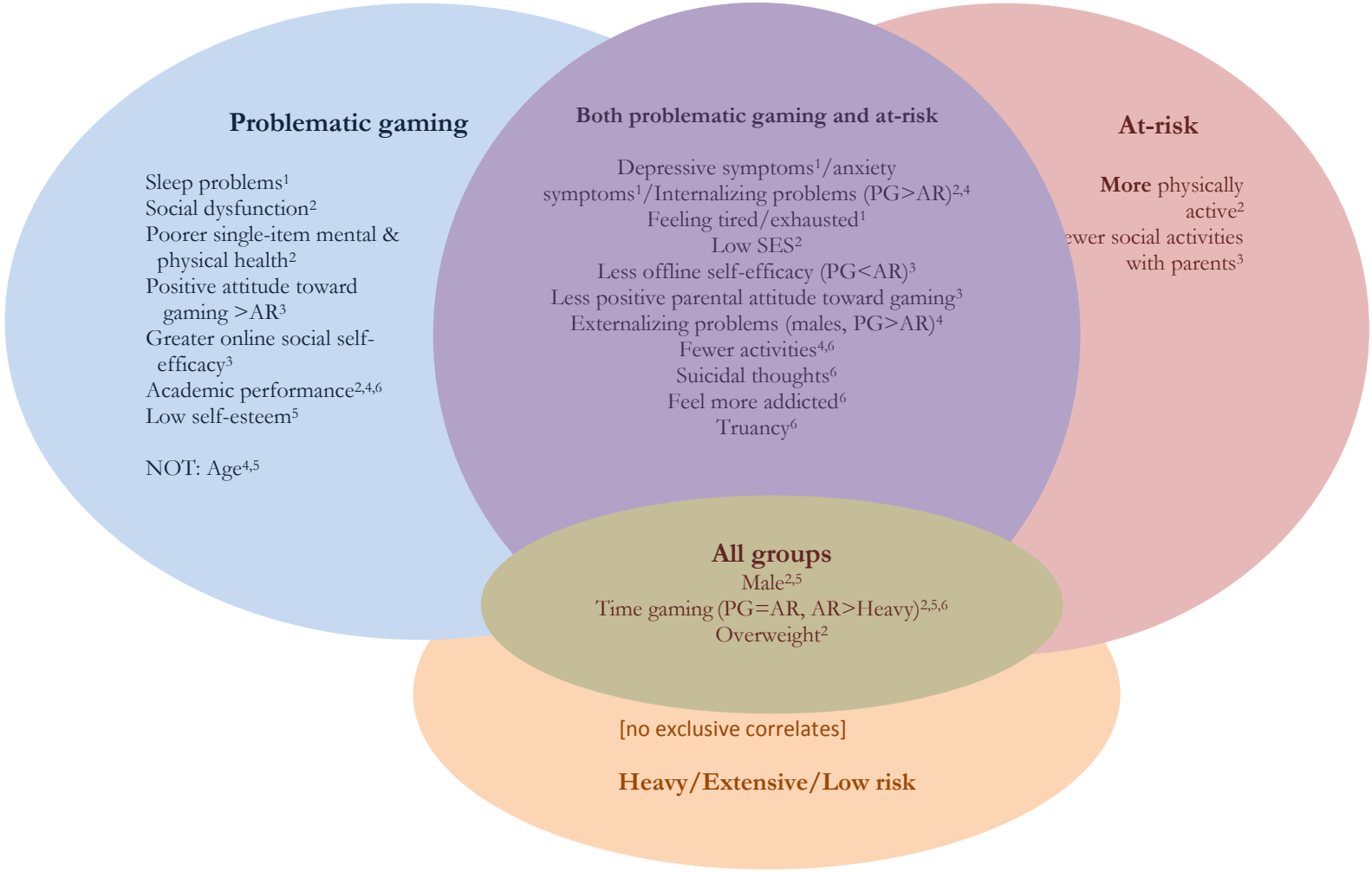
Table 2.5: Summary of longitudinal predictors, correlates and outcomes of problematic gaming scores and problematic gaming classification

	Predicts development of problematic gaming[1]	Predicts resolution (stopping) of problematic gaming [2]	Covaries with or predicts change in degree of problematic gaming[3,4,5,6]	Improves with stopping problematic gaming[2]	Outcome of starting problematic gaming[1]
Comfort/health					
Emotional comfort, including					
ADHD/hyperactivity			Indirect only		Y
Anxiety/social phobia			Y	Y	Y
Depression			N*	Y	Y
Hostility				Y	Y
Resilience					
Active coping, including					
Goal setting		Y (better)			N
Impulsivity/emotion regulation	Y		Y	Y	
Social competence/empathy	Y		Y	Y	
Family connectedness			Indirect only		Y (worse)
Peer connectedness			Y		
Subjective well-being					
Life satisfaction/perceived success			N		
Achievement					
School performance/academic self-concept	Y	Y (worse)	Y		N
Risk behaviors					
Physical aggression/conduct problems			Y	Y	Y
Relational aggression				N	Y
Victimization					Y
Past-year binge drinking			N		
Media					

	Predicts development of problematic gaming[1]	Predicts resolution (stopping) of problematic gaming [2]	Covaries with or predicts change in degree of problematic gaming[3,4,5,6]	Improves with stopping problematic gaming[2]	Outcome of starting problematic gaming[1]
Game-related beliefs, including					
Gaming as dysfunctional coping			Y		
Identification with game character	N				
Game use characteristics, including					
LAN center use	Y				
Roleplaying games			Y		
Shooters			N		
Time gaming	Y	Y	N		Y
Violent game exposure				N	Y
Problematic gaming score	Y	Y (worse)			N

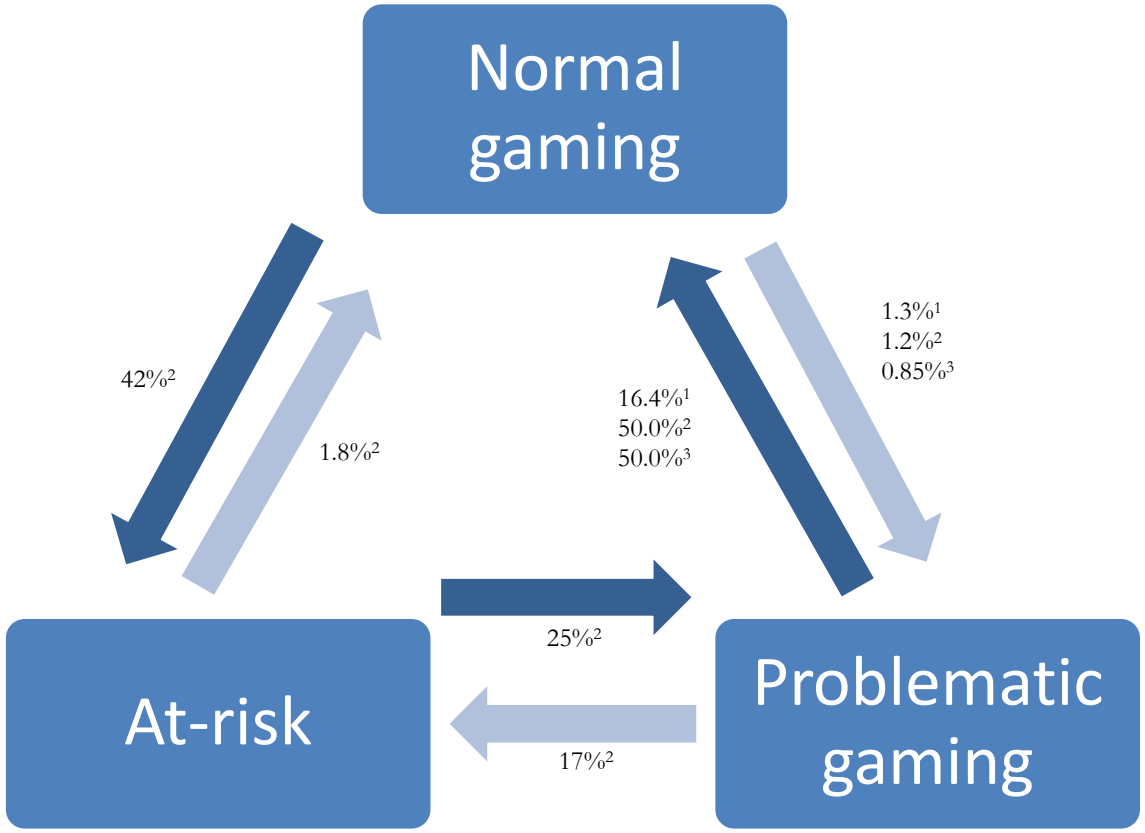
NOTE: Longitudinal outcomes measured at two years. Items in italics are associated in one multivariate longitudinal model. No outcomes were measured in two separate multivariate models. *Associated in 1/2 multivariate models. (1) Gentile et al. 2011, ANCOVAs comparing "starts" vs "never" problematic gaming groups, adjusting for race and gender (2) Gentile et al. 2011, ANCOVAs comparing "stops" vs "stays" problematic gaming groups, adjusting for race and gender, (3) Gentile et al. 2011, multivariate longitudinal growth model, (4) Brunborg et al., 2014, (5) Mößle & Rehbein, 2013 (6) Scharkow et al., 2014.

Figure 2.4: Comparisons to non-problematic gamers and between levels of problematic gaming



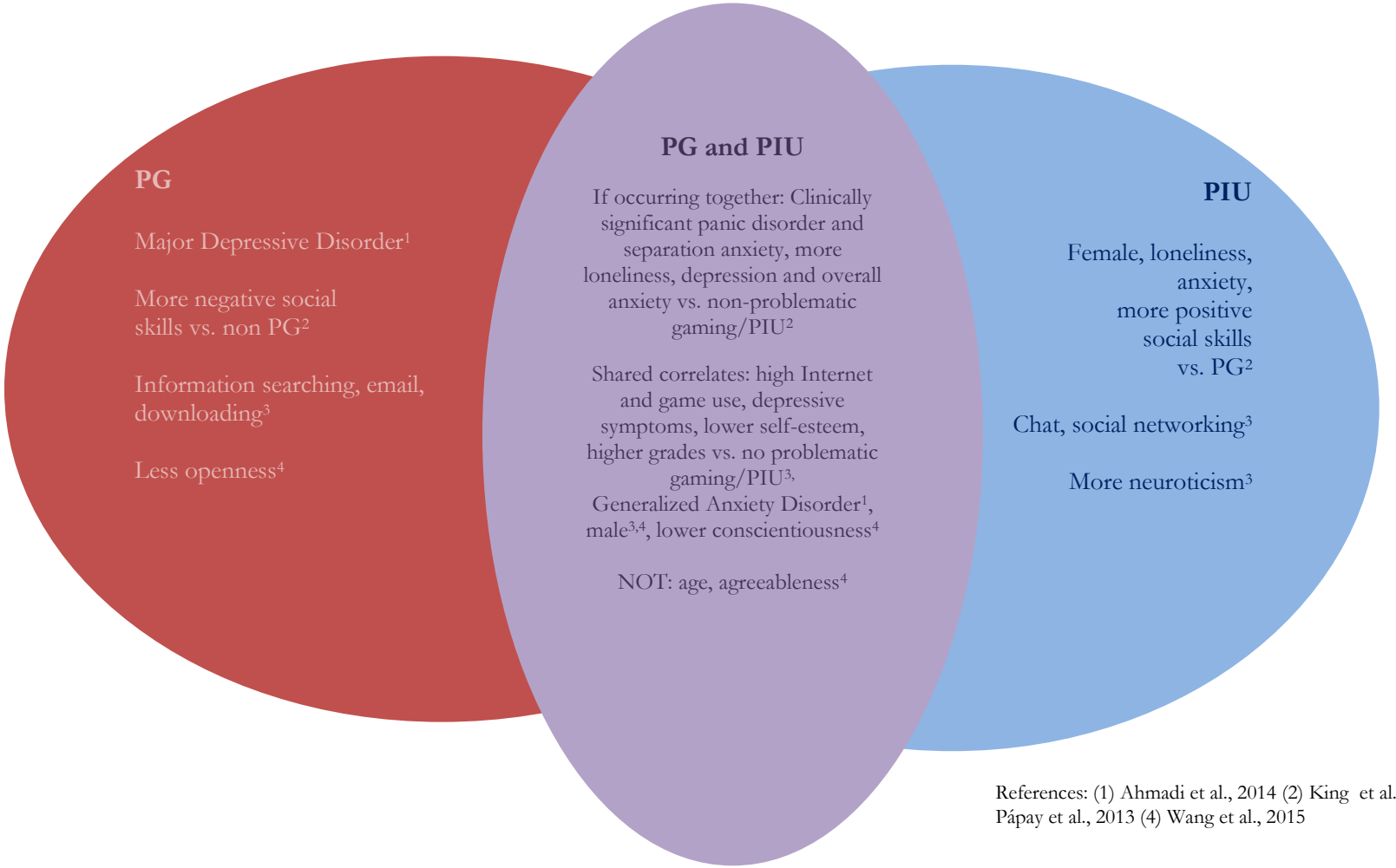
Note: No multivariate models compared problematic gaming to at-risk groups. (1) Brunborg et al. 2013, (2) Faulkner et al. 2014 (3) Jeong & Kim, 2011 (4) Müller et al., 2014(5) Pápay et al., 2013 (6) Rehbein et al. 2010 [results of unadjusted analyses reported here to illustrate comparison; adjusted analyses reported in Table 2.1].

Figure 2.5: Movement between problematic gaming, at-risk and non-problematic gaming states from longitudinal studies



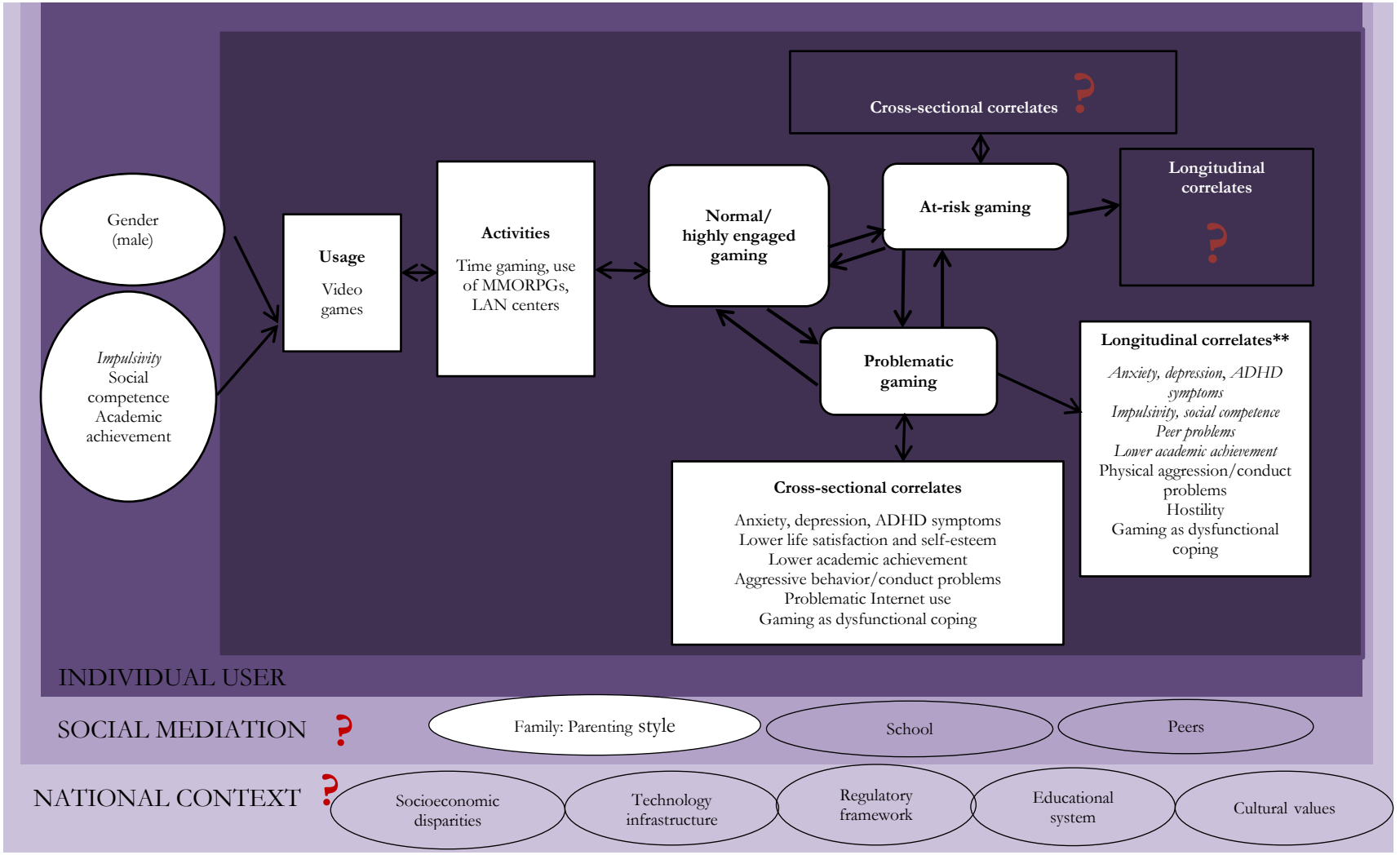
Note: Levels of at-risk as described in (1) Gentile et al. 2011 and (2) Mossle & Rehbein 2012; (3) van Rooij et al., 2011

Figure 2.6: Comparisons between problematic gaming and PIU and measured correlates



References: (1) Ahmadi et al., 2014 (2) King et al., 2013(3) Pápay et al., 2013 (4) Wang et al., 2015

Figure 2.7: Hypothesized sequence of factors related to problematic gaming



NOTE: Figure adapted from Livingstone et al. 2011, *Risks and safety on the internet: The perspective of European children*[1]. Cross-sectional correlates associated in at least two multivariate models. Longitudinal correlates associated in at least 2 bivariate, controlled models. Italicized longitudinal covariates associated in one multivariate model.

Chapter 3 Gaming in a Hyperconnected World

Abstract

Objective: Social interactions are crucial in video gaming, but their association with problems related to video gaming is ill-understood. This study evaluated whether subgroups of gamers can be identified based on patterns of online social interaction, video game play, and self-reported problematic gaming.

Methods: We estimated latent classes in a cross-sectional sample of 9733 Dutch adolescents from the Monitor Internet and Youth study based on measures of game play, social Internet use and self-reported problematic gaming.

Results: For both boys and girls, we identified several classes with varying levels of problematic gameplay, characterized by presence or absence of high online social interaction. Classes with more online social interaction were characterized by fewer symptoms of problematic gaming at the same levels of gaming.

Conclusions: Online social interactions seemed to make a difference in self-reported problematic game play. Those who were more socially active online reported lower distress related to gaming, even if they spent many hours gaming. This effect held for both boys and girls. Patterns of online social interaction may help distinguish healthy from unhealthy video game use.

Introduction

Youth in the United States are part of a "hyperconnected" world where constant digital multitasking leads to a new type of social environment that has benefits but also detractions (Anderson, Janna & Rainie, n.d.). Almost all adolescents in the United States and other developed countries play video games (D. Gentile, 2009; Lenhart, Amanda et al., 2008),and while low to moderate levels of gaming may be beneficial for some adolescents (Hofferth & Moon, 2012; Przybylski, 2014), excessive video game play may lead to problems for some. This concern has led to the inclusion of Internet Gaming Disorder (IGD) in Section III: Emerging Measures and Models of the *Diagnostic and Statistical Manual for Mental Disorders-5* (American Psychiatric Association, 2013) Although the primary focus of the proposed diagnosis is online gaming, other forms of video gaming may also contribute to problematic (addictive) play(D. L. King & Delfabbro, 2013; van Rooij, Schoenmakers, van den Eijnden, Vermulst, & van de Mheen, 2012b). In fact, many online behaviors have been associated with addiction-like problems, and possibly due to the fact that multiple behaviors can occur at once, it is unclear which behaviors are associated with problematic use (Carli et al., 2013; D J Kuss et al., 2013). Despite decades of research, questions remain about how best to distinguish "engaged" (positive and non-pathological heavy gaming, Charlton & Danforth, 2007) from problematic gaming, which has been conceptualized as a loss of control over gaming associated with problems and the potential for clinically significant harm (van Rooij, 2011). Debate continues over which criteria are important for distinguishing pathological, problematic or addictive gaming from engaged gaming (M. Griffiths et al., 2015). While the proposed diagnosis emphasizes the neurological similarities to substance use disorders, the "significant aspect of social interactions during play" was also mentioned (American Psychiatric Association, 2013).

Video game play in social settings

Video games may be played alone, in a physically co-located environment, or a shared online environment; these varying settings may be associated with different levels of well-being. Many gamers play alongside someone else (Entertainment Software Association, 2015), making co-located video gaming a social activity in and of itself. In addition, about 40% of adolescents play multiplayer online games (van Rooij et al., 2011), which may incorporate online social communication into video game play. Those who game together are sharing experiences that may help develop connections and friendships, contribute to skills development in areas such as teamwork, and provide benefits to well-being (Desjarlais & Willoughby, 2010; Johnson et al., 2013; Trepte et al., 2012).

While online communication can take place entirely within games using game-based text features or voice chat, gamers may also use other forms of online communication and connection, such as instant messaging and social networking sites, for discussion, planning, and community development (Amanda Lenhart, n.d.). This "extra" communication may be related to gameplay, such as coordinating team plans, or may be related to keeping in touch and strengthening bonds with existing friends or looking for new friends. Playing video games with others is associated with fewer symptoms of problematic play; mixed methods research suggests that friends who game together help one another maintain a healthy balance between game play and other life activities (Snodgrass, Lacy, Francois Dengah II, & Fagan, 2011a).

Normative vs. "risky" patterns of media use

While the suggested total screen time for children in the U.S. is one to two hours per day, the average screen exposure for US children is over 7 hours, with 16% of that time including multitasking (Rideout et al., 2010).

Gender differences in social Internet use and video game play patterns are clear (Daria J Kuss & Griffiths, 2011; Lemmens et al., 2009), and previous research in problematic gaming suggests that negative consequences may differ by gender as well, with lower degrees of problematic gaming in girls being associated with more severe psychosocial problems (D. L. King, Delfabbro, et al., 2013; Rehbein & Mößle, 2013). In a study of college students, Chen and Tzeng (2010) found that grouping students by time spent in preferred activities such as online games, information searching, and "making friends and chatting" produced clusters that linked patterns of play with well-being differently by sex. Female heavy users were most likely to search for information and chat/make friends. Females whose heavy use patterns included more than seven hours per week of online game play had the highest levels of loneliness, physical illness and depression and the lowest grades of all clusters, while males in a heavy use cluster that played games heavily but almost exclusively had lower grades but no differences in psychosocial well-being compared to male non-heavy users. Together these considerations imply that for some, heavy gaming may not be associated with negative consequences or psychosocial problems, and that outcomes may vary by gender normative patterns of use. Most prior research on problematic gaming has focused on using scales to measure problematic gaming, assuming that the problematic gaming construct is adequately explained by the addiction-related criteria used in problematic gaming scales, and that problematic gamers are a homogeneous population. However, if concurrent patterns of social interaction influence the consequences of heavy gaming, it may be that the patterns of use of games and online social interactions are a more realistic way to examine problematic gaming.

Current study

Social interaction is a unique and central characteristic of newer, online games. Moreover, adolescents create their own social environments, communication and communities when they play games with others online. Consequently, we believe it is both timely and important to study the role of social interactions within problematic video game play. The interactions between levels of perceived problematic gaming symptoms, video game play and online social interaction are likely to indicate non-linear relationships between these factors that are best conceptualized as latent constructs, which allow for person-level differences in patterns of media use and self-reported symptoms. In order to take a person-centered approach, the current study used latent variable modeling to test the hypothesis that including information about online social interactions along with video game play and problematic gaming symptoms would be better able to identify subgroups of adolescents at risk for distress related to gaming, as well as subgroups for whom even heavy video game use may be benign or even protective.

Methods

Dataset and participants*:* *The Monitor Internet and Youth (MIY)* study is an ongoing yearly survey of schoolchildren in the Netherlands designed to study trends in Internet and video game use (Meerkerk et al., 2006). The study, which is coordinated by IVO Addiction Research Institute and was first administered in 2006, collects information on demographics, time and activities on the Internet, video games and mobile phones as well as several different measures of mental and behavioral health and well-being. The survey is not approved by an institutional review board (IRB) in the Netherlands because this is not necessary under Dutch law (van Rooij, 2013). The Johns Hopkins Bloomberg School of

Public Health IRB has designated the proposed study as "Not Human Subjects Research" because the data do not contain identifiers.

Participating schools were selected for the MIY study to ensure diverse representation by region, urbanicity and education level within the Netherlands. In the Dutch education system, children finish elementary school at age 12 and begin one of three tracks of high school (Ministerie van Onderwijs, 2011). Children who attend the lower level *voorbereidend middelbaar beroepsonderwijs (vmbo)* finish at age 16 and usually go on to further vocational or middle management training. Those who attend one of the two upper-level tracks, *hoger algemeen voortgezet onderwijs* (*havo)* or *voorbereidend wetenschappelijk onderwijs (vwo)*, finish at age 17 or 18 and go on to college or university. As in the US, the majority of youth are Caucasian, and while the racial and ethnic distribution of minority youth differs between the Dutch students of the MIY and children in the U.S., the vast majority of youth in both countries use the Internet and video games (Meerkerk et al., 2006; Rideout et al., 2010).

Table 3.1 provides additional information about the students in the 2009-2012 waves that made up our study sample. Since this is a trend study (i.e., it samples the population of schoolchildren on a regular basis rather than following individual schoolchildren), longitudinal persistence was not a design feature. However, a smaller sample of students provided measurements at more than one time due to retention of their schools in the original sample over multiple years. Data were aggregated from students who participated during the 2009-12 study years and had complete information on well-being measures to permit longitudinal analyses (which will be reported elsewhere), but the current study was designed to determine cross-sectional patterns. The mean age is 14.4 in both the original and study samples. The final sample contained 439 classes from thirty schools. Non-response

was mainly at the classroom level. Average response rates per class were 93% (2009), 93% (2010), 92% (2011) and 86.5% (2012).

Measures: This study included measures of self-reported problematic video game use, video game, and social Internet use. The *Video game Addiction Test (*VAT) assessed self-reported frequency of symptoms of problematic use of both online and offline video games based on several of the domains of behavioral addictions as suggested by Griffiths (M. Griffiths, 2005), i.e. loss of control, conflict, preoccupation/salience, coping/mood modification, and withdrawal symptoms(van Rooij et al., 2012a). Responses to questions were measured on a 5-point scale: (1) Never, (2) Seldom, (3) Sometimes, (4) Often, and (5) Very Often. Students were asked about potential problems such as "How often do you find it difficult to stop gaming?"; see Table 3.2 for complete list of questions. The VAT demonstrated a single factor structure with factor loadings ranging from .62 to .78 and excellent reliability (Cronbach's alpha=0.93) in a previous study using the MIY sample(van Rooij et al., 2012a). Youth were also asked how many days per week and hours per day they used instant messaging (e.g., Google chat), social networking (e.g., Facebook) and three types of games: multiplayer online games (e.g., World of Warcraft, Call of Duty), browser games (e.g., Farmville), and offline games played on a console such as PlayStation or Wii (e.g. Grand Theft Auto). We dichotomized use into high (four or more hours per day for six or seven days per week) or low (any other use, including no use) to more precisely identify those whose gaming may be problematic or an indication of addiction (Jap et al., 2013; Romer et al., 2013).

Demographics. Gender was assessed with a binary self-report variable. *Year* refers to the year the survey was administered (2009-2012). *Education level* was coded dichotomously as high (pre-university/college) or low (pre-vocational school or trade). Self-reported *age* was

measured in years. *Ethnicity* was coded as Dutch (both parents born in the Netherlands) or other.

Statistical analysis. We first excluded responses that were likely to be invalid (e.g., most analysis variables answered at the most extreme values). For students who had repeated observations due to being in multiple waves of the sample, we used the first observation only to allow for clustering. We evaluated patterns of missing data, explored sample means and distributions and tested for differences by gender in media use and self-reported problematic gaming symptoms. We used latent class analysis with the indicators above, accounting for clustering at the class level. Model fit was evaluated using various measures including entropy and Bayesian Information Criterion (BIC), and the optimal number of classes was decided based on models that had the lowest values of BIC and lowest bivariate residuals with classes that appeared meaningful and distinct. Missing data for observed indicators in latent class analysis was addressed with full information maximum likelihood, which adjusts for ignorable missing data mechanisms such as missing at random(L. K. Muthén & Muthén, 2012). All analyses were performed in Mplus (B. O. Muthén & Muthén, 1998).

Results

Study sample. Of the 12,348 students in our sample from 2009-2012, 10,804 had values for gender and classroom, our grouping variables, and had valid data on consistency checks. However, an additional 9.9% of that subsample had missing data on one or more covariates to be used in further studies. This smaller subsample differed from the full sample on education level, year, age, and multiplayer online game use, but a sensitivity analysis with this smaller sample did not change class sizes or structure appreciably, so the smaller subsample (n=9733) was used in all analyses to allow this same sample to be used for future

analyses with covariates. Of this sample, 48.8% were male and 82.1% were of Dutch background, and the average age was 14.1 with a range of 13 to 16. Use of most video games and social internet applications differed significantly by gender, as did most psychosocial covariates as shown in Table 3.1.

Latent class analysis. Males. We fit between two and seven classes for males. While BIC decreased throughout and entropy was acceptable in all models, only the six-class model had acceptably low residual correlations. Aside from a large class considered Average (52.5%, estimated VAT 1.31), the remaining five classes split into two different overall subtypes of heavy gamers based on social interaction (Figure 3.1). In accordance with previous studies of excessive or problematic gaming that characterized levels of excess based on average item endorsement (Rehbein, Kleimann, & Mößle, 2010), we opted to describe classes as problematic if the estimated VAT items were, on average, endorsed at roughly the level of Often or above (i.e., around 4), and at-risk if the items were, on average, not rejected (e.g., average greater than Seldom, which we extended to 2.5). Thus, we labeled the classes as (presented in order of VAT): Problematic gamers (1.3%), At-Risk Gamers (11.6%), Social At-Risk Gamers (2.0%), Extensive Gamers (27.3%), and Social Engaged Gamers (5.3%). The Problematic Gamers class had an estimated VAT of 4.13 (corresponding to an average of "Often" for each VAT item) and used online games at the highest levels. The At-Risk Gamers class had slightly less online game use and a VAT of 2.94 (corresponding to endorsing "Sometimes" for each VAT item). The At-Risk Social Gamers class had similar probabilities of online gaming but higher probabilities of offline gaming as Problematic Gamers, but very high instant messaging and social networking use and a lower estimated VAT of 2.67 (corresponding to an average between "Seldom" and "Sometimes"). The last class with elevated VAT was Extensive Gamers (27.3%), which had a VAT of 2.04

(corresponding to an average of "Seldom"). Finally, the Social Engaged Gamers (5.3%) had equal or higher gaming as the At-Risk Gamers, but very high social Internet use and a VAT of 1.36, which was similar to that of the Average class. Visual examination of patterns also showed some general differences: Compared to non-social classes, social classes had higher probabilities of browser gaming and more similar levels of online and offline gaming. Also, in the non-social classes (Problematic Gamers, At-risk and Extensive), high instant messaging use was much more likely than high social networking use.

Females. For females, the best-fitting model had three classes (Figure 3.2): Average (83.2%), At-risk Gamers (5.8%) and Social Engaged Gamers (10.9%). Compared to the Average class (estimated VAT 1.23), which had little chance of any high media use, females estimated to be in the At-Risk Gamers class had higher online and offline game use and about equal probabilities of instant messaging and social networking use, with an estimated mean VAT of 2.84. The Social Engaged Gamers class was estimated to contain girls who had an even higher probability instant messaging and social networking and slightly less elevated probabilities of heavy gaming. The pattern of game platform was inverted for this class, with high browser game play being more likely than online or offline play. The average VAT for this group was 1.24, similar to the Average class.

Discussion

Using a data-driven, person-centered approach, we found support for our hypothesis that information about online social interaction provides a meaningful way to distinguish subgroups of gamers into those reporting more or fewer problems. Using this approach, gamers could be clearly separated into social and non-social classes, with social classes reporting fewer or no feelings of problematic use at equivalent levels of play. In males, the two groups with the highest—and nearly equal—levels of multiplayer online gaming

demonstrated stark differences in online social interaction and a 35% difference in average VAT. The same pattern was found for females, although the overall magnitude of game use and distress was much lower in females than males, and fewer classes were distinguished, suggesting that problems related to heavy gaming differ for males and females, and males spend much more time playing video games than females. These findings are consistent with prior research showing that boys find gaming to be an important social activity both in the opportunity to make new friends online and in the ability to participate in typical face-to-face conversation with male peers (Olson et al., 2008). We also saw that social gaming groups had higher levels of browser and offline game play. Browser games in this study included games based in social media, so it may be that the social networking leads to more browser game play. Online game play is seen as more likely to be addictive than other forms of play (see Chapter 2), so the higher levels of offline play may not have had much influence on feelings of addiction.

Prior latent variable research in game addiction has supported the idea of an "engaged" or low-risk subgroup that plays extensively or endorses some symptoms of problematic gaming, yet experiences fewer psychosocial problems than an "addicted" group (Faulkner et al., 2014; van Rooij et al., 2011). While previous theories about engaged gaming have suggested that this level of gaming may be a step on the path toward addiction (Seok & DaCosta, 2014), findings of the current study indicate that the "engaged gamer" who experiences few symptoms of problematic use at high levels of play is one who has an active online social life. Among adolescents, therefore, engaged gamers may represent a group whose heavy gaming may be a part of their active participation in a digital community. Our study shows that this social environment may be protective against feelings of being "addicted" to games. High use of instant messaging (as seen in our social classes) is linked

with interaction with existing friends; if communication and gaming happen as multitasking (Valkenburg & Peter, 2011), friends may help one another maintain perspective about competing offline demands as has been shown to occur when friends game together (Snodgrass, Lacy, Francois Dengah II, et al., 2011a). Newer approaches to understanding the effects of media have assessed the uses and gratifications of media use (as opposed to media effects models focusing only on exposure), however; as Internet users communicate and game (supposedly together), they co-create a new social environment with emergent cultural and other norms where aspects of development are played out (Greenfield & Yan, 2006). Future longitudinal research should ascertain whether this social interaction translates into better relationships and other factors that are protective of mental health and well-being.

While our study was able to detect significant effects and interactions between well-being and problematic gaming in a large, school-based sample, it did have some limitations. Our use of cross-sectional data means that we were unable to draw conclusions about causal relationships between gaming and psychosocial well-being. Future longitudinal research to determine direction of effects will be useful for developing interventions to promote healthy use of games and social Internet applications. In addition, because our data were self-reported, they may reflect social desirability or recall biases. Previous research on the validity of self-reported media use is inconsistent (Burke, Marlow, & Lento, 2010; Schmitz et al., 2004); further studies of patterns of media and game use may be facilitated by automated collection of usage data. Another concern is that adolescents may underreport problems associated with highly engaged use. Tzavela et al. (2015) describe a "no harm" discourse wherein adolescents normalize or underplay the interference associated with their intense behavior and suggest that this may be related to decreased sensitivity to aversive stimuli during adolescence (e.g., Spear, 2013). If this is the case, it may be that social gamers lack

awareness of the problems resulting from their gaming. To assess this possibility, future research would benefit from additional input by other raters, such as parents, or by use of more objective indication of harms that result directly from gaming (e.g., longitudinal multivariate studies that assess academic achievement as an outcome while controlling for earlier levels of achievement).

By examining patterns of media behavior together with self-reported problematic gaming, our analysis allowed us to tease out nuanced relationships between classes of heavy gaming and subjective distress. This supports prior research suggesting that online socializing may be an effective way to make friends, maintain existing friendships, and improve well-being. These findings have important implications for potential diagnostic criteria, prevention and policy making, as it may be inappropriate to evaluate the risk of problematic gaming without concurrently considering the possible benefits adolescents might gain from online social interaction.

Table 3.1: Descriptive statistics by sex in analysis sample

	Males (n=4753) No. , % or Mean (SD)		Females (n=4980) No. , % or Mean (SD)		χ^2/t^a
Latent class indicators					
High use (4+ hours/ day, 6+ days/week)					
Any high use of games	521	11.0%	79	1.6%	369.5**
Instant messaging	345	7.4%	603	12.2%	64.1**
Social networking	247	5.3%	482	9.8%	69.4**
Multiplayer online games	406	8.7%	32	0.6%	357.9**
Browser games	30	0.6%	20	0.4%	2.6
Offline games	170	3.7%	37	0.8%	95.8**
Problematic gaming[b]	1.77	(0.69)	1.33	(0.51)	32.0**

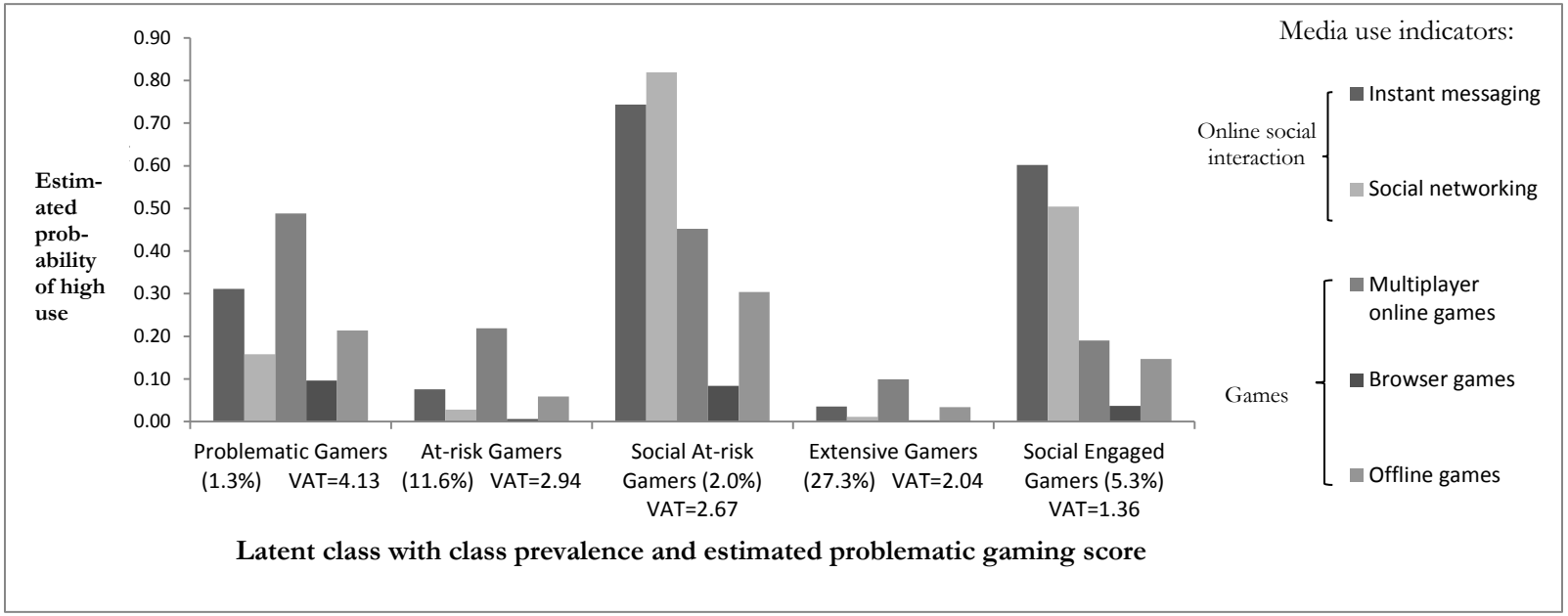
Note: (a)P-value for continuous variables is for two-tailed t-test with unequal variances using Satterthwaite's d.f.; *=p<.05, **=p<.01 (b) by Videogame Addiction Test

Table 3.2: Videogame Addiction Test (van Rooij et al., 2012)

How often…

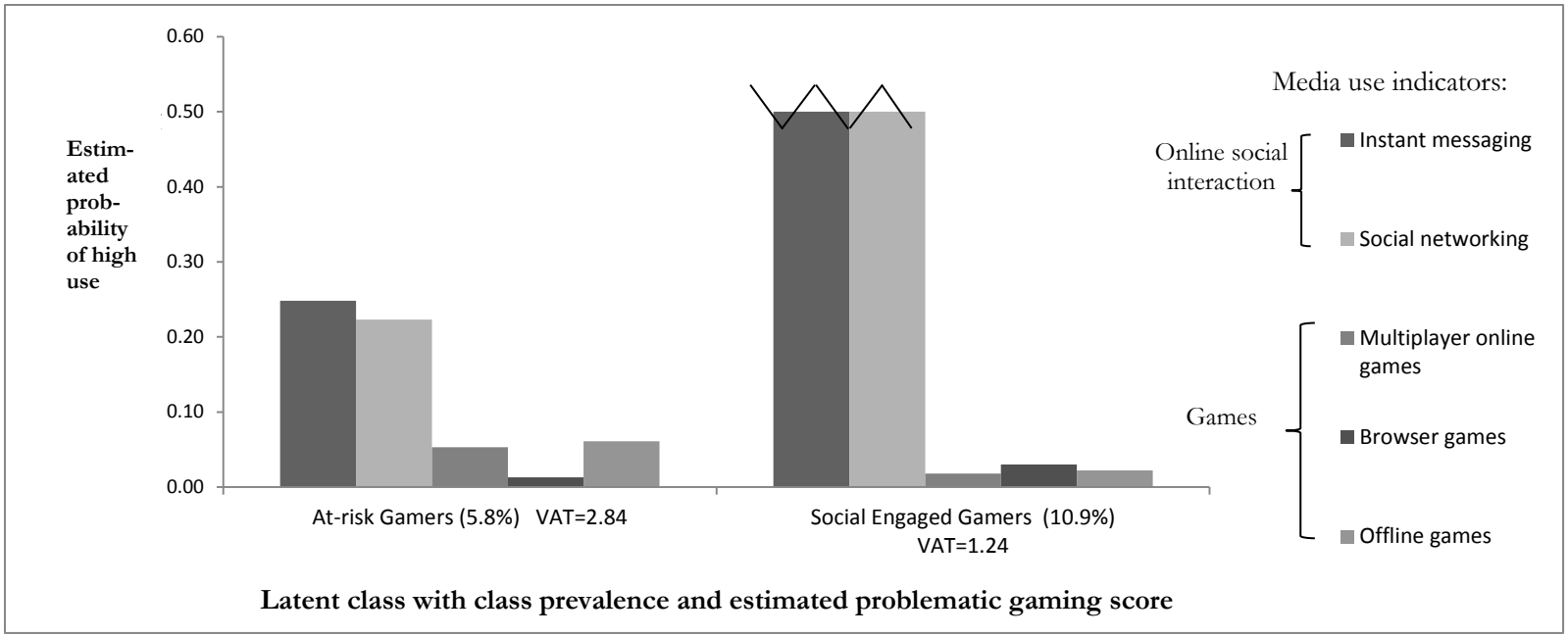
1. ...do you find it difficult to stop gaming?
2 ....do you continue to use the games, despite your intention to stop?
3 ....do others (e.g., parents or friends) say you should spend less time on games?
4 ....do you prefer to game instead of spending time with others (e.g., friends or parents)?
5 ....do you not get enough sleep because of gaming?
6 ....do you think about gaming, even when you're not online?
7 ....do you look forward to the next time you can game?
8 ....do you think you should be gaming less often?
9 ....have you unsuccessfully tried to spend less time on gaming?
10 ....do you feel restless, frustrated, or irritated when you cannot game?
11 ....do you rush through your homework to play games?
12 ....do you neglect to do your homework because you prefer to game?
13 ....do you game because you are feeling down?
14 ....do you game to forget about problems?

Figure 3.1: Estimated probabilities of high use[a] by latent class[b], males



Notes: (a) High use is defined as 6/7 days per week for 4+ hours per day (b) Average class (52.3%, not shown) had <3% probability of any high media use and an estimated VAT of 1.31. VAT=Videogame Addiction Test; sample mean (SD) is 1.77(.69).

Figure 3.2. : Estimated probabilities of high use[a] by latent class,[b] females



Note: (a) High use is defined as 6/7 days per week for 4+ hours per day. (b) Average class (83.2%, not shown) had <3% probability of high use of any latent class indicator. (c) Probability estimates for instant messaging (0.81) and social networking (0.73) are truncated in the Social Engaged Gamers class to better illustrate the distribution of indicators in the At-risk Gamers class.

Chapter 4 Associations between Problematic Gaming, Psychosocial Well-being and Friendship Quality

Abstract

Objective: Despite research supporting the social aspects of video game play, relationships between problematic gaming and psychosocial well-being are often studied in bivariate models that do not account for other potentially influential factors. This study examines both online and offline friendship quality and their effects on the associations between problematic video game play and psychosocial well-being.

Methods: In a prior study, we estimated latent classes in a sample of 9733 Dutch adolescents based on game play, social Internet use and self-reported problematic gaming. In this study, we used multivariate latent class regression to evaluate associations of class membership with well-being, friendship quality and selected interactions across these constructs.

Results. As previously reported, classes with various levels of problematic gameplay split into two types, characterized by presence or absence of high online social interaction. In main effects models in this study, classes with higher self-reported problematic gaming were associated with more negative self-esteem and more social anxiety, whereas a class identified as engaged gamers had less loneliness and social anxiety. All classes with high levels of gaming also reported more depressive symptoms. However, these associations changed for some subgroups when interactions with online and offline friendship quality were considered. Specifically, among girls identified as Social Engaged Gamers, those who had good online friendships but poor real-life friendships did not show greater depression than average. In addition, social anxiety was only associated with problematic gaming among boys with high-quality online friendships, and among girls who had high-quality online and real-life friendships**.**

Conclusions: Socially active gamers were found to have lower self-reported psychosocial problems in spite of gaming extensively. High-quality online friendships

strengthened associations between problematic gaming and social anxiety for both sexes, and weakened associations between Social Engaged Gamers and depression for girls. Online social interaction, especially when it is associated with high-quality online friendships, may have positive implications for some heavy gamers but may be associated with more negative well-being in others.

Introduction

For adolescents, video gaming is a normal part of daily life (Floros & Siomos, 2012; D. Gentile, 2009; D. A. Gentile et al., 2011; Holstein et al., 2014; Jeong & Kim, 2011; D. L. King, Delfabbro, et al., 2013) that can occur in a variety of social settings and provides opportunities for shared experiences and for making and strengthening friendships (Southwell & Doyle, 2004). Patterns of media use that include heavy video gaming have been differentially associated with well-being in youth (S.-Y. Chen & Tzeng, 2010; Romer et al., 2013), suggesting that aspects other than amount of play are important in determining subgroups of adolescents who may be at risk of harm related to gaming. Problematic gaming has been associated with a variety of psychosocial problems, but for some heavy gamers the benefits of extensive amounts of gaming seem to outweigh any significant distress associated with heavy use (Chapter 3). While previous research has concentrated on single-variable associations between problematic gaming and mental and behavioral health (Ferguson et al., 2011), the inherently social nature of gaming and interactions between social processes and individual factors are important to consider when evaluating which populations may be at risk and which may benefit from video game play.

Adolescents who interact online, whether through games or social communication and networking applications, are part of a virtual community that may expand opportunities for friendship and its protective effects on development (Greenfield & Yan, 2006). Online gaming, for example, may help shy adolescents expand their sources of social support (Domahidi, Festl, & Quandt, 2014) and can also provide an important way to keep up with existing friendships (Valkenburg & Peter, 2007)and make new friends and social connections (Lenhart, Smith, Anderson, Duggan, & Perrin, 2015). Uses and gratifications approaches to media effects suggest that even excessive use of online media

may serve to meet various needs. According to the *social compensation hypothesis,* online media users who have difficulty with real-life social interactions may use online relationships to meet their social needs (McKenna & Bargh, 2000). In contrast, the *augmentation hypothesis* (Kraut et al., 2002) suggests that those who successfully use the Internet for social support are extraverts who apply their friend-making skills to this online arena. These hypotheses, in conjunction with themes generated from qualitative research on adaptive and maladaptive patterns of Internet use (Tzavela et al., 2015), suggest potential mechanisms for the development and maintenance of problematic use as compared to use that may be benign or even protective.

Social relationships are an essential part of adolescent life, and good relationships help prevent mental, emotional and behavioral disorders (O'Connell, M & the National Research Council, 2009). High quality friendships help prevent depression (La Greca & Harrison, 2005), and they enhance other aspects of psychosocial well-being such as self-esteem, life satisfaction, peer connectedness, and emotional comfort, which all support positive adolescent health outcomes (Bevans et al., 2010). While some research shows that video game use or levels of problematic gaming may be associated with lower quality real-life friendships (Padilla-Walker, Nelson, Carroll, & Jensen, 2010; Van Rooij et al., 2013), other studies show that online video game play is associated with mental health benefits such as relief of negative psychological symptoms, higher self-esteem, lower stress, and enjoyment, as well as the possibility of developing leadership and problem solving skills along with social support (Longman, O'Connor, & Obst, 2009; Snodgrass, Lacy, Dengah, Fagan, & Most, 2011; Steinkuehler & Williams, 2006; Trepte et al., 2012). High-quality friendships in a virtual social environment lessen associations between loneliness and problematic gaming just as real-life friendships do, but may not be significant enough to reduce the other forms of

distress associated with problematic gaming (van Rooij et al., 2013). Overall, computer- and online mediated social interaction has been associated with higher quality friendships and better psychological well-being for some (S.-K. Chen, 2012; Desjarlais & Willoughby, 2010), and online gamers who play for social reasons are more likely to bring new gaming-related friendships into offline settings (Domahidi et al., 2014). Since peer acceptance and connectedness are vital to positive developmental outcomes for adolescence (O'Connell, M & the National Research Council, 2009; Valdez et al., 2011), the opportunities for communication and interaction through games and online settings—potential benefits for those who are less facile in face-to-face interactions—may both lead to difficulties (excessive or problematic gaming) but also benefits (more and better friends) for vulnerable adolescents.

Research into adolescent media use is best conducted by evaluating interactions between the individual, media use, and social environments (McHale et al., 2009). Most research in PG and associated risk factors, correlates and outcomes involves bivariate models (see Chapter 2) using self-reported data, potentially overlooking the contribution of interrelationships between psychological and demographic factors, motivations for play and inherently dyadic or polyadic social factors like friendship quality and contact with friends (Billieux et al., 2015; Desjarlais & Willoughby, 2010; Elson et al., 2014; Kardefelt Winther, 2014b). Studies have found that gender(Kaess et al., 2014), age(Scharkow et al., 2014), and education level (Rehbein, Kliem, Baier, Mößle, et al., 2015), as well as self-reported social factors such as friendship quality (van Rooij et al., 2013) and relationships with parents (Mößle & Rehbein, 2013) modify relationships between problematic gaming and well-being in representative samples. The many potential patterns across dimensions of problematic gaming, well-being and potential moderators suggest that latent variable methods may be

useful for identifying underlying subgroups of individuals based on combinations of characteristics. Previous latent class analysis shows that assessing problematic gaming along with patterns of game use and online social interactions can distinguish between patterns of heavy gaming that are associated with higher or lower levels of problematic gaming symptoms (Chapter 3). The aim of this study is to use this approach to examine relationships between these classes and psychosocial wellbeing. Using the dual pathways framework described in Chapter 1, this research will address three questions: 1) How are the previously identified classes of gamers (estimated based on patterns of gaming, self-reported problematic gaming symptoms and online social interactions) associated with psychosocial well-being? 2) How are these classes associated with friendship quality? and 3) Does friendship quality moderate associations between gaming classes and psychosocial well-being? We will also explore potential gender differences with these patterns.

Methods

Dataset and participants*:* *The Monitor Internet and Youth (MIY)* study is an ongoing yearly survey of schoolchildren in the Netherlands designed to study trends in Internet and video game use (Meerkerk et al., 2006). The study, which is coordinated by IVO Addiction Research Institute and was launched in 2006, collects information on demographics, time and activities on the Internet, video games and mobile phones and mental and behavioral health and well-being. Further details can be found in Chapter 3.

This study used the same sample used in Chapter 3, i.e., data from students who participated during the 2009-12 study years and had complete information on well-being measures. The mean age was 14.4 in both the entire 2009-12 sample and subsample for the present project. The final subsample contained 439 classes from thirty schools. Non-

response was mainly at the classroom level. Average response rates per class were 93% (2009), 93% (2010), 92% (2011) and 86.5% (2012).

Measures: Measures of self-reported problematic video gaming symptoms, video game use, and social Internet use were used to identify unique groups of individuals using latent class analysis. The *Video game Addiction Test* (VAT) assesses self-reported frequency of symptoms of problematic use of both online and offline video games on a 5-point interval scale from "Never" (1) to "Very Often" (5) with questions such as "How often do you find it difficult to stop gaming?" The VAT demonstrated a single factor structure with factor loadings ranging from .62 to .78 and excellent reliability (Cronbach's alpha=0.93) in a previous study using the MIY sample (van Rooij et al., 2012a). We also asked youth how many days per week and hours per day they used instant messaging (e.g., Google chat), social networking (e.g., Facebook) and three types of games: multiplayer online games (e.g., World of Warcraft, Call of Duty), browser games (e.g., Farmville), and offline games played on a console such as PlayStation or Wii (e.g. Grand Theft Auto). We dichotomized use into high (four or more hours per day for six or seven days per week) or low (any other use, including no use) to more precisely identify those whose gaming may be problematic or an indication of addiction (Jap et al., 2013; Romer et al., 2013).

For each measurement of psychosocial well-being, items were averaged to form a scale. *Depressive symptoms* were assessed with the Depressive Mood List (Kandel & Davies, 1982). This six-item scale asks about the frequency of depressive symptoms in the past year, with five responses ranging from "Never" to "Always". An initial validation study showed good classification ability when comparing clinical to community samples (Kandel & Davies, 1982). These scales have been translated into Dutch and used previously in Dutch youth

(Engels, Finkenauer, Meeus, & Deković, 2001). The scale showed good reliability in the MIY sample (Cronbach's α >.80, van Rooij et al., 2011).

Loneliness was measured with the 10-item UCLA Loneliness Scale (Russell, Peplau, & Cutrona, 1980) which contains items such as "I am feeling alone" and "There are people who really understand me". Responses were scored along a 4-point scale ranging from "Never" to "Always" and negative items were reverse-coded. The internal consistency of the scale has been high in previous Dutch samples (Cronbach's alpha >.85, van Rooij et al., 2011).

Social anxiety was measured with the Social Anxiety Scale Revised, a 10-item scale that captures domains of social avoidance and distress associated with social situations (La Greca & Lopez, 1998). Adolescents are asked "How strongly do the following statements apply to you?" and answer using a 5-point scale ranging from "Not at all" to "Very much". A sample question is "I get nervous when I meet new kids". This scale demonstrated good reliability in a previous sample of MIY (Cronbach's alpha >0.80, van Rooij et al., 2011).

Self-esteem was assessed with Rosenberg's Self-Esteem Scale (Rosenberg, 1989); negatively worded items were reverse-coded such that a high score indicates good self-esteem. We investigated transformations to better approximate normal distributions; all scales of psychosocial well-being were log-transformed and standardized in analyses.

Friendship quality was assessed by using the average of all nine questions of the Network of Relationships Inventory (Furman & Buhrmester, 1985), which asks questions such as "How often do you turn to this person for support with personal problems?" As in previous studies, we split the scale into online (OLF) and "real-life" (RLF) versions (van Rooij, 2011). Students were told to skip the question about online friendship quality if they had no friends that they spoke to only on the Internet. The rate of missingness on this scale

was high (>33%), which likely results from the intentional skip pattern. Because of this, we imputed missing values as Never and included a missing indicator in analyses. We categorized the continuous scale into Low (average below 4, corresponding to Never, Almost Never or Sometimes), or High (average above 4, Often to Very often) and created a composite variable with four categories representing the possible combinations of dichotomized OLF and RLF as shown in Table 4.1.

Demographics. Gender was assessed with a binary self-report variable. *Year* refers to the year the survey was administered (2009-2012). *Education level* was coded dichotomously as high (pre-university) or low. *Age* in this sample ranges from 13 to 16. *Ethnicity* was coded as Dutch (both parents born in the Netherlands) or non-Dutch.

Statistical analysis. Please refer to Chapter 3 for detail on the estimation of latent classes. We explored our research questions using latent class regression with a 3-step approach (Asparouhov & Muthén, 2014), first estimating the latent class model, then assigning individuals to the most-likely latent class, and finally estimating a latent class regression model where indicators of latent class are fixed at their posterior probabilities to account for measurement error in the estimated class assignment (auxiliary variable modeling using R3STEP in Mplus, B. O. Muthén & Muthén, 1998). We used a series of models to compare changes in associations from less (e.g., main effects of psychosocial covariates) to more saturated models (main effects of psychosocial covariates and friendship quality and important interactions). To evaluate interactions between friendship quality and psychosocial well-being variables, we performed backwards stepwise selection, retaining all demographic and control variables, all psychosocial well-being indicators, and interactions that had a p-value of <.15. We used robust estimators for standard errors and allowed for clustering at the class level. Our final model included the four psychosocial covariates, friendship quality,

and interactions between psychosocial covariates and friendship quality that had a p-value of <.15. Exploratory analyses and interaction modeling using stepwise regression were conducted using Stata 13 (StataCorp., 2013); latent class analyses and the final auxiliary regression model including interaction terms were estimated using Mplus v. 7.3 (B. O. Muthén & Muthén, 1998).

Results

Study sample. Please see Chapter 3 for descriptive statistics of the sample as well as descriptions of latent classes. For males, all demographic and control variables—education, ethnicity, age and study year—showed some significant associations with class membership throughout all models (Model A; see Appendix 2). Problematic gamers, At-risk gamers, Social At-risk gamers and Social Engaged gamers were more likely to be on a lower-level education track than higher, while Extensive gamers were more likely to be on a higher-level education track. Problematic and Social Engaged classes were also more likely to be ethnic minorities (i.e., non-Dutch). Social Engaged gamers were more likely to be older, and membership in all heavy use classes increased with year of study. For females, all control variables showed significant associations with latent class (Model A; Appendix 3). Both At-risk and Social Engaged Gamer classes were more likely to be in the lower education track and to be ethnic minorities. Likelihood of membership in the Social Engaged Gamers class increased with age, and cohort effects were seen for later years in both non-average classes.

Associations between latent classes and psychosocial well-being predictors. *Males.* Adding psychosocial indicators to our model removed effects of education level on the At-risk group and strengthened cohort effects for 2011 in the Extensive gamers group to significance. Depression was significantly associated with membership in all non-average classes in all models, with strength of effect closely following VAT (Model 1; see Table 4.2).

Higher values of loneliness were associated with membership in the At-Risk Gamers and Extensive Gamers classes, but negatively associated with the Social Engaged Gamers class. Lower self-esteem was associated with membership in the Problematic Gamers and At-Risk Gamers classes. Higher social anxiety was associated with the At-Risk Gamers and Extensive Gamers classes, but lower social anxiety was found in the Social Engaged Gamers class.

Females. When psychosocial indicators were added, depression was a significant predictor of both non-average classes in all models (Model 1; Table 4.3). Lower self-esteem was associated with the At-risk Gamers class, but also with Social Engaged Gamers class membership; however, Social Engaged Gamers were found to have less social anxiety and loneliness.

Associations between latent classes and friendship quality. *Males.* For all classes, adding friendship quality to the model with covariates (Model 2; Table 4.2) produced no qualitative (and little quantitative) change in effects. Compared to the most common group (i.e., the reference group of those high in real-life friendship quality but low in online friendship quality), having good quality online friendships was more likely for almost all heavy use gamer classes. Having both good online *and* real-life friendships was significantly associated with membership in the Social Engaged Gamers, At-Risk Gamers and At-Risk Social Gamers classes. Social Engaged gamers were also significantly more likely to have high-quality online friendships but *low* quality real-life friendships, as were Problematic Gamers. In other words, for the Social Engaged Gamers class, high levels of online friendship quality were more strongly associated regardless of quality of real-life friendships. Extensive Gamers were less likely to rate themselves as having both low quality online and offline friendships. Interestingly, the increased likelihood of loneliness for the At-risk class persisted despite their high self-reported online and offline friendship quality.

Females. As with males, adding friendship quality to the model had no effect on psychosocial covariates (Model 2, Table 4.3). At-risk and Social Engaged Gamers were equally likely to have high quality friendships on- and offline as compared to the Average class. In addition, At-risk Gamers were much more likely to have high online but low offline friendship quality.

Moderation of associations by friendship quality—males

*Social anxiety***.** Most striking was the qualitative change in association between problematic gaming and social anxiety (Model 3, Table 4.2). While prior models showed a trend toward higher social anxiety in the Problematic Gamers class as a whole, in this set of models social anxiety was only associated with problematic gaming among boys with high-quality online friendships. This effect was over three times as strong among boys who had high online but low real-life friendships, supporting both the social compensation and augmentation hypotheses.

*Self-esteem***.** When interactions with friendship quality were taken into account, the previous trend toward low self-esteem in the At-Risk Social Gamers class became strong and positive for those high in both online and real-life friendship quality. In other words, boys who had good friendships both on- and offline were more likely to have high self-esteem if they were estimated to be At-Risk Social Gamers, supporting the augmentation hypothesis for this subgroup.

Moderation of associations by friendship quality—females

Depression. While previous associations between depression and membership in either the At-risk Gamers or Social Engaged Gamers classes were positive, for girls with good

online friendships but poor real-life friendships the relationship between depression and the Social Engaged Gamers class was negative, suggesting that girls low in real-life friendships may have been able to successfully relieve their depressive symptoms by developing online friendships (Model 3, Table 4.3).

Social anxiety. Girls in the At-risk Gamers class showed a similar interaction between social anxiety and online friendships as boys, where higher values of social anxiety were seen to be associated with a certain subgroup. This time, however, the subgroup was composed of girls high in online *and* real-life friendships. A similar pattern was found for Social Engaged Gamers. While earlier models indicated lower social anxiety in this class, interactions with friendship quality showed that those with high quality online and real-life friendships were more likely to be in this class as values of social anxiety increased.

Self-esteem. While prior models showed a negative association between self-esteem and the Social Engaged Gamers class, when friendship quality was taken into account, self-esteem was positively associated with class membership for girls with high levels of both online and offline friendship quality.

Discussion

In this study of social interactions and gaming, we found differences in well-being across subgroups of problematic, social and non-problematic gamers, distinct patterns of interaction with both online and offline friendship quality, and significant differences by gender. When moderation by friendship quality was assessed, problematic gamers with high levels of online friendship quality looked significantly different from those with low levels, suggesting a social compensation mechanism may be involved. Specifically, even though the most problematic gaming class in boys had less extreme amounts of online social interaction than the At-Risk Social Gamers, they were able to develop online friendships that they

perceived as beneficial in the setting of higher levels of social anxiety, suggesting that their patterns of heavy game use and moderate social interaction may be a successful way to compensate for social anxiety. The strongest associations were seen in the most problematic class in boys, reinforcing the idea that this is a qualitatively different group of heavy gamers. This contrasts with previous findings by van Rooij and colleagues (van Rooij et al., 2013) that described moderation between social anxiety and continuous levels of VAT by real-life friendship quality, but not online friendship quality among online gamers. This may be due to our person-centered latent variable approach. By estimating classes that included both gaming and social interaction, it is likely that we identified a group of people (the Problematic Gamers class) where most people had social anxiety *and* few people had low online friendship quality. In models where these two conditions were not accounted for (i.e., models with no interaction), associations were small, but once interactions were accounted for, the strong relationships with social anxiety in this class for those with high online friendship quality emerged.

These findings are consistent with findings by DesJarlais & Willoughby (2010) and others supporting the social compensation hypothesis. In that study, DesJarlais & Willoughby found that socially anxious boys who used the computer with friends more often had higher friendship quality than those with social anxiety who used computers with friends less often. Computer-mediated communication may make it easier for boys to connect with peers and develop better friendships (Desjarlais & Willoughby, 2010; Kowert, Domahidi, & Quandt, 2014), and many boys find video games to be a good way to keep in touch with even their closest friends (Lenhart et al., 2015). Interestingly, for both boys and girls this effect was also seen among those who had high quality real-life and online friendships. This suggests that more socially anxious problematic gamers, both boys and girls, might be

practicing social skills they learned online "in real life", using them to successfully develop high-quality real-world friendships (Borca, Bina, Keller, Gilbert, & Begotti, 2015; Kowert, Domahidi, & Quandt, 2014; Tzavela et al., 2015). These findings also, however, highlight the need to consider that boys with social anxiety who game heavily may be at the greatest risk of problems with gaming, regardless of their real-life friendship quality. Whether their combination of gaming and social interaction truly does compensate for their social anxiety, it does seem to be accompanied by significant symptoms of problematic gaming.

On the other hand, differences in the otherwise robust association between depression and highly engaged gaming classes were seen only in Social Engaged Gamer girls whose online friendships may be making up for poor real-life friendships, suggesting that if girls were engaging in high levels of gaming and online social interaction to combat depressive symptoms, this approach was not effective for all. While it is possible that heavy media use leads to depression, heavy use may also reflect the apathy and withdrawal from social functioning associated with depressive symptoms (Romer, Jamieson, & Pasek, 2009). Although some studies suggest that depression increases with problematic gaming or PIU (D. A. Gentile et al., 2011; Lam & Peng, 2010; van den Eijnden et al., 2008), other multivariate models do not support associations between earlier depression and later problematic gaming (Mößle & Rehbein, 2013) or demonstrate that associations relate more to time spent in media use, consistent with the concept of media use as a result of withdrawing from previously-valued or pleasing activities and relationships (Primack, Swanier, Georgiopoulos, Land, & Fine, 2009; Romer et al., 2013). In our study, heavy game use with or without heavy social interaction (4+ hours/day for 6-7 days/week) was associated with depression among almost all subgroups of boys and girls, an effect that persisted though all modeling steps. However, for girls with poor real-life friendships and

very high levels of online social interaction, having high-quality online friendships reversed the association between depression and membership in the Social Engaged Gamers class. This is consistent with the social compensation hypothesis and findings by Selfhout and colleagues (Selfhout et al., 2009) which show that more time spent instant messaging is associated with less depression only for those with low friendship quality, suggesting a potential benefit of high levels of computer-mediated communication for this group. Support seeking is a common coping mechanism for girls with depressive symptoms (Khurana & Romer, 2012), and for this group of girls, it may be that the social support gained through good online friendships as a result of their high levels of online interactions may have aided in relieving depressive symptoms. Overall, however, the finding of depression in all of these high-use classes suggests that highly engaged media use may be driven by and/or may cause depressive symptoms. Additional research using longitudinal multivariate models that include depression as a longitudinal predictor would help clarify the direction of effects.

The fact that we see less loneliness in the Social Engaged Gamer classes suggests that these gamers are successfully facilitating their existing relationships with highly engaged gaming and online social interactions, consistent with the augmentation hypothesis. Both boys and girls in this class had less loneliness than the average class. Their high levels of online communication combined with gaming may help lessen loneliness. This contradicts the findings of Caplan et al. (S. Caplan et al., 2009), who suggested that gamers whose motivation to play was more social would be less lonely, but more likely to have problematic use. Our results may have differed because we incorporated social networking and instant messaging into our latent variable model rather than assessing a scale score of problematic gaming, or it may be that they also accounted for voice chat as well as game motivations in

their analysis. An alternative hypothesis is that Social Engaged Gamers are just more outgoing people. Social Engaged girls and boys had less social anxiety that the average class, although this effect disappeared for boys when friendship quality interactions were accounted for and was reversed for some girls. Online communication increases the opportunities for extraverted adolescents to make friends, which may account for reports of less loneliness (Peter, Valkenburg, & Schouten, 2005). Among adolescents with highly engaged gaming, those who are more extraverted are less likely to develop problematic gaming (Daria J. Kuss, 2013). Social Engaged Gamers were also more likely to be older adolescents who have had more time to develop social skills and the executive inhibitory control (Carlson, Eldreth, Chuang, & Eaton, 2012) to balance highly engaged game use and active participation in an online social life with competing real-life demands.

Results for self-esteem in social gamers seem to point more toward augmentation or facilitation of good existing relationships through highly engaged gaming: The most social gaming classes in boys and girls (At-risk Social boys and Social Engaged Gamer girls) who have high online *and* offline friendship quality have positive associations with self-esteem. Real life friendships contribute to self-esteem (La Greca & Harrison, 2005), so adolescents who effectively use their high engagement to maintain existing friendships and are successfully able to make new friends may receive self-esteem benefits. Another possibility is that adolescents with low self-esteem may be using online role-playing and social media to make an idealized self to socialize with (Billieux et al., 2015; Selfhout et al., 2009). Adolescents feel compelled to project an idealized self in social media as well (Lenhart et al., 2015), seeking "likes" on Facebook that boost self-esteem (Tzavela et al., 2015). These boys and girls could also be part of a tight-knit online gaming community such as a guild, where organized gaming allows clear opportunities for advancement in the setting of frequent

social interaction (Trepte et al., 2012) and associated social support (Longman et al., 2009; Steinkuehler & Williams, 2006).

However, when high engagement in games is associated with low self-esteem but not affected by friendship quality, as seen in the most problematic non-social classes in boys (Problematic and At-risk Gamers), this may indicate a desire to escape poor subjective well-being through intense gaming (Kardefelt Winther, 2014a) and may be, therefore, a sign of non-social compensatory use. High engagement, when associated with positive feedback, e.g. "dominating" fellow players (Tzavela et al., 2015), may be empowering for adolescents, and playing with the goal of achievement is linked with greater likelihood of problematic use (Billieux et al., 2015; Yee, 2006). The reinforcing properties of games for these individuals may lie more in the ability to achieve in-game goals, which are provided through a variety of carefully planned mechanisms(D. King, Delfabbro, & Griffiths, 2010). It may be that these less social players are motivated to achieve as a way to boost self-esteem, but are frustrated in their efforts to do so, resulting in problematic play and no boost to self-esteem. For these gamers, treatment and prevention efforts may focus on developing other sources of self-esteem or more adaptive coping methods. Their lower self-esteem could also derive from recognizing that game play creates distress in their lives (e.g., family conflicts, lower grades) but feeling unable to control their play (Tzavela et al., 2015).

Other findings in this study support a non-social pathway to problematic gaming as well. Extensive and At-risk male gamers were lonelier than the average class and Extensive Gamers were found to have more social anxiety, yet these classes did not have high engagement with instant messaging and social networking. These adolescents could be introverted and turn to games as a way to ease social interactions (Kardefelt Winther, 2014a), without particularly seeking to expand friendship networks or social support. This pathway

may involve impulsivity, as discussed in Chapter 2. The earliest theories of excessive technology use focused on problems with self-regulation and impulsivity (S. E. Caplan, 2002; Davis, 2001; Young, 1998), which has also been found in other addictions (Walther et al., 2012) and pathological gambling (Billieux et al., 2012). In fact, pathological gambling has been said to consist of two subtypes of individuals: Emotionally vulnerable and Impulsive/antisocial (Milosevic & Ledgerwood, 2010). Excessive gamers have been found to be higher in impulsivity in self-reported, behavioral and electrophysiological domains (Littel et al., 2012). In this case, the excessive time spent on gaming may displace real-world social interactions, increasing social anxiety and loneliness in a downward spiral.

The changes in association of control and demographic variables are also worth noting. In both male and female At-risk Gamers, whose gaming is less associated with social interaction, we found that lower education level and class membership were no longer related when psychosocial covariates and friendship quality were accounted for. In addition, cohort effects seem to be masked by psychosocial well-being factors; when the variance of these is accounted for, we see each year of study is significantly related to the Extensive class in males. The comparative strength of demographic and control variables relative to individual and social factors for these groups supports the potential for different mechanisms in the development and/or maintenance of maladaptive gaming.

This study has several limitations. Our use of cross-sectional data means that we cannot draw conclusions about causal relationships between gaming and psychosocial well-being. In addition, because our data are self-report, they may reflect social desirability or recall biases. Finally, since our sample was gathered from schools in the Netherlands, we cannot assume that findings are generalizable to other cultures where gaming and social interaction patterns may differ.

This study identified nuanced relationships between gaming classes and psychosocial well-being and explored moderating effects of friendship quality in a way that accounted for differences in these factors by gender. Our findings support the possibility of distinct social and non-social pathways toward the development of adaptive or maladaptive patterns of gaming (Figure 4.1). We see that socializing online may be an effective way to make friends and improve well-being, but that ultimately these additional friendships do not help avert all psychosocial problems. However, an alternative hypothesis is that both heavy media use and psychosocial problems are driven by difficulty regulating moods and behavior; further studies could examine whether differences in regulatory capacity such as those occurring as a part of normal maturation affect both the intensity of media use and self-reported psychosocial difficulties. These findings have important implications for potential diagnostic criteria, prevention and policy making, as it may be inappropriate to evaluate the risk of problematic gaming without concurrently considering the possible benefits adolescents might gain from online social interaction. Future longitudinal research to determine direction of effects will be useful for developing interventions to promote healthy use of games and social Internet applications.

Table 4.1: Descriptive statistics

	Males (n=4753) No. , % or Mean (SD)		Females (n=4980) No. , % or Mean (SD)		χ^2/t^a
Latent class indicators					
High use (4+ hours/ day, 6+ days/week)					
Any high use of games	521	11.0%	79	1.6%	369.5**
Instant messaging	345	7.4%	603	12.2%	64.1**
Social networking	247	5.3%	482	9.8%	69.4**
Multiplayer online games	406	8.7%	32	0.6%	357.9**
Browser games	30	0.6%	20	0.4%	2.6
Offline games	170	3.7%	37	0.8%	95.8**
Problematic gaming[b]	1.77	(0.69)	1.33	(0.51)	32.0**
Psychosocial covariates					
Loneliness	1.64	(0.49)	1.60	(0.51)	4.17**
Depression	2.06	(0.67)	2.33	(0.73)	-19.4**
SA	1.98	(0.67)	2.13	(0.70)	-10.6**
SE	3.36	(0.51)	3.17	(0.58)	17.0**
Friendship quality					
Low OLF/High RLF (reference group)	2,554	53.7%	3,043	61.1%	485.7**
High OLF/High RLF	1,326	27.9%	1,707	34.3%	
Low OLF/Low RLF	744	15.7%	155	9.2%	
High OLF/Low RLF	129	2.7%	75	1.5%	

Note: (a)P-value for continuous variables is for two-tailed t-test with unequal variances using Satterthwaite's d.f.; *=p<.05, **=p<.01 (b) by Videogame Addiction Test

Table 4.2: Latent class regression on psychosocial covariates and friendship quality in males

	Latent Class[a]														
	Problematic Gamers (1.3%)			At-Risk Social Gamers (1.8%)			At-Risk Gamers (10.3%)			Social Engaged Gamers (5.1%)			Extensive Gamers (26.3%)		
	b	SE	p-value[b]	b	SE	p-value	b	SE	p-value	b	SE	p-value	b	SE	p-value
Model 1:Main effects of psychosocial covariates[c]															
Loneliness (Lon)	0.17	0.21	0.40	0.06	0.20	0.78	**0.40**	**0.08**	**0.00**	*-0.36*	*0.13*	*0.01*	*0.17*	*0.08*	*0.02*
Depression (Dep)	**1.21**	**0.30**	**0.00**	**0.85**	**0.17**	**0.00**	**0.81**	**0.08**	**0.00**	**0.40**	**0.12**	**0.00**	**0.55**	**0.06**	**0.00**
SA (SA)	0.24	0.22	0.28	-0.11	0.15	0.46	*0.20*	*0.07*	*0.01*	*-0.21*	*0.11*	*0.04*	**0.40**	**0.06**	**0.00**
SE (SE)	*-0.44*	*0.17*	*0.01*	-0.17	0.18	0.33	*-0.24*	*0.09*	*0.01*	-0.26	0.17	0.12	-0.08	0.10	0.43
Model 2: Main effects of psychosocial covariates and friendship quality (friendship quality)[d]															
Loneliness (Lon)	0.13	0.22	0.54	0.13	0.21	0.55	**0.45**	**0.09**	**0.00**	*-0.27*	*0.13*	*0.04*	*0.22*	*0.08*	*0.01*
Depression (Dep)	**1.17**	**0.31**	**0.00**	**0.82**	**0.17**	**0.00**	**0.78**	**0.08**	**0.00**	*0.35*	*0.12*	*0.01*	**0.54**	**0.06**	**0.00**
SA (SA)	0.24	0.21	0.26	-0.10	0.15	0.53	*0.22*	*0.08*	*0.00*	*-0.23*	*0.11*	*0.03*	**0.40**	**0.06**	**0.00**
SE (SE)	*-0.42*	*0.17*	*0.01*	-0.14	0.19	0.46	-0.25	0.09	0.01	-0.30	0.17	0.08	-0.09	0.10	0.37
Low OLF/High RLF							Reference								
Low OLF/Low RLF	-0.35	0.47	0.46	-0.10	0.52	0.85	-0.13	0.18	0.49	-0.55	0.35	0.11	*-0.37*	*0.16*	*0.02*
High OLF/Low RLF	**1.81**	**0.58**	**0.00**	1.42	0.73	0.05	0.66	0.38	0.08	*1.29*	*0.51*	*0.01*	0.02	0.47	0.96
High OLF/High RLF	0.64	0.40	0.11	*0.93*	*0.40*	*0.02*	**0.58**	**0.15**	**0.00**	*0.62*	*0.23*	*0.01*	0.13	0.14	0.36
Model 3: Interaction effects[e]															
Lon	0.09	0.21	0.67	0.18	0.23	0.43	**0.45**	**0.09**	**0.00**	*-0.30*	*0.14*	*0.03*	0.22	0.08	0.01
Dep	**1.14**	**0.25**	**0.00**	**0.86**	**0.18**	**0.00**	**0.79**	**0.08**	**0.00**	*0.33*	*0.13*	*0.01*	**0.54**	**0.06**	**0.00**

	Latent Class[a]														
	Problematic Gamers (1.3%)			At-Risk Social Gamers (1.8%)			At-Risk Gamers (10.3%)			Social Engaged Gamers (5.1%)			Extensive Gamers (26.3%)		
	b	SE	p-value[b]	b	SE	p-value	b	SE	p-value	b	SE	p-value	b	SE	p-value
SA	-0.44	0.29	0.12	-0.14	0.25	0.57	0.19	0.10	0.06	-0.24	0.14	0.09	**0.37**	**0.07**	**0.00**
SE	*-0.72*	*0.25*	*0.00*	*-0.56*	*0.21*	*0.01*	*-0.28*	*0.10*	*0.00*	-0.25	0.23	0.28	-0.10	0.11	0.34
Low OLF/High RLF	Reference														
Low OLF/Low RLF	-0.32	0.51	0.54	-0.27	0.52	0.60	-0.13	0.19	0.47	-0.52	0.34	0.13	*-0.37*	*0.16*	*0.02*
High OLF/Low RLF	-2.25	2.68	0.40	1.20	1.66	0.47	0.75	0.43	0.08	0.89	0.66	0.17	0.01	0.54	0.98
High OLF/High RLF	0.65	0.42	0.12	*0.94*	*0.44*	*0.03*	**0.57**	**0.16**	**0.00**	*0.60*	*0.29*	*0.04*	0.13	0.16	0.43
SAxHiOLF/LoRLF	*3.73*	*1.60*	*0.02*	-0.91	1.21	0.45	-0.30	0.48	0.53	-0.09	0.46	0.85	0.07	0.40	0.86
SAxHiOLF/HiRLF	*1.02*	*0.40*	*0.01*	0.25	0.33	0.44	0.18	0.15	0.22	0.11	0.23	0.63	0.15	0.14	0.30
SExHiOLF/LoRLF	0.53	0.52	0.30	0.71	0.79	0.37	-0.19	0.42	0.66	-0.87	0.54	0.11	-0.07	0.43	0.86
SExHiOLF/HiRLF	0.49	0.35	0.16	*0.95*	*0.33*	*0.00*	0.14	0.18	0.43	0.11	0.28	0.69	0.05	0.19	0.78

Notes: (a) Multinomial latent class regressions using most likely class assignment, comparing class to average class (52.3%). (b) Italics indicates statistical significance at p<.05; bold indicates significance at Bonferroni-adjusted p-value for that model (varies by model): Model 1: p<.004, Models 2-3: p< .003. (c) All models adjusted for control variables. (d) Models 2&3 friendship quality logistic regression coefficients are compared to reference category of Low OLF/High RLF. (e) Model 3 includes all covariates from main effects models and interactions with p<0.15. OLF=Online friendship quality, RLF=Real-life friendship quality.

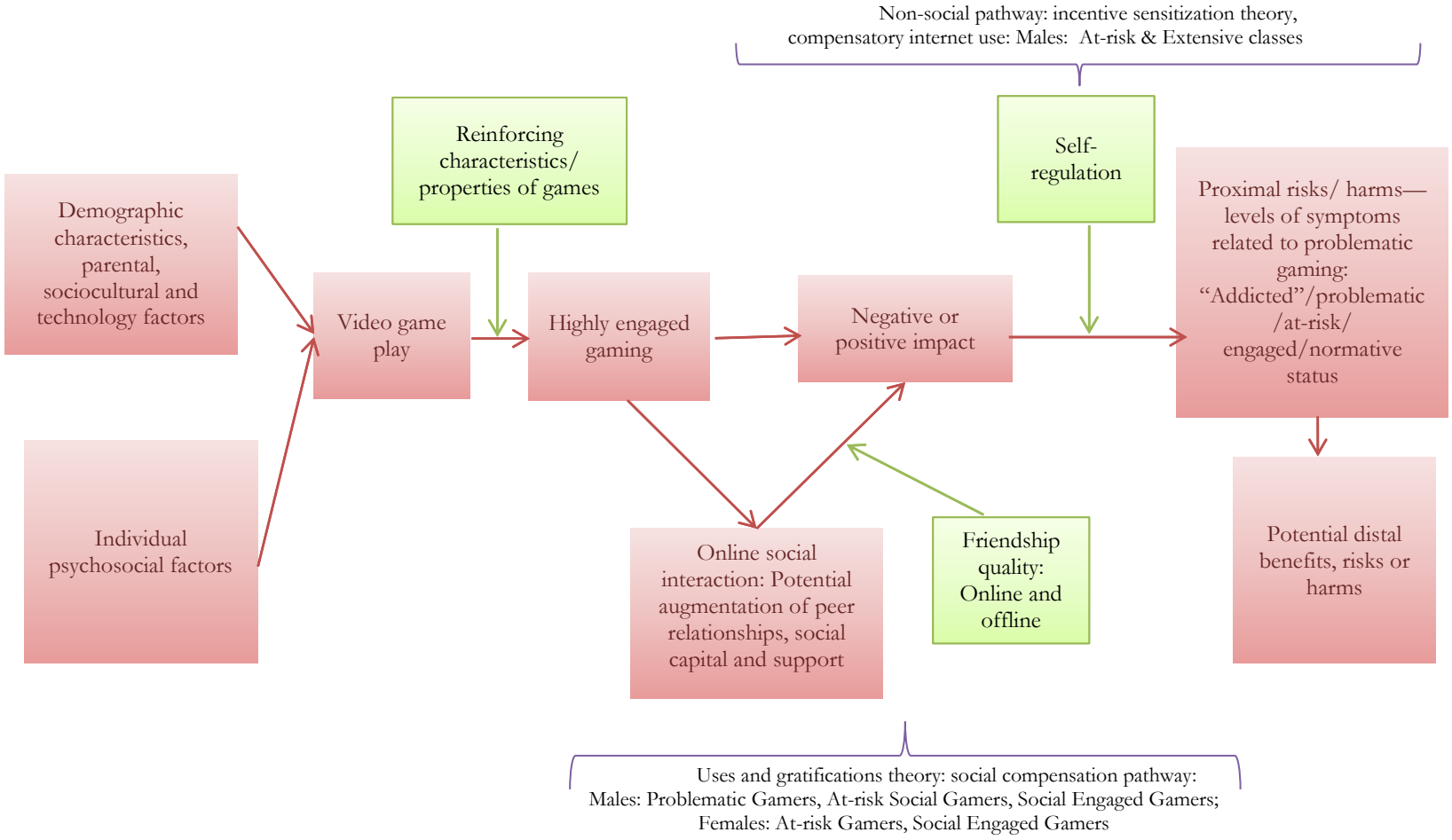
Table 4.3: Latent class regression on psychosocial covariates and friendship quality in females

	Latent class[a]					
	At-Risk Gamers			Social Engaged Gamers		
	b	SE	p-value[b]	b	SE	p-value
Model 1: Psychosocial covariates[c]						
Loneliness (Lon)	0.07	0.10	0.50	**-0.37**	**0.07**	**0.00**
Depression (Dep)	**0.79**	**0.15**	**0.00**	**0.56**	**0.09**	**0.00**
SA (SA)	0.17	0.10	0.10	**-0.26**	**0.07**	**0.00**
SE (SE)	*-0.19*	*0.08*	*0.02*	**-0.29**	**0.06**	**0.00**
Model 2: Psychosocial covariates and friendship quality (friendship quality)[d]						
Lon	0.04	0.10	0.67	**-0.34**	**0.07**	**0.00**
Dep	**0.74**	**0.15**	**0.00**	**0.53**	**0.09**	**0.00**
SA	0.17	0.10	0.08	**-0.26**	**0.07**	**0.00**
SE	-0.15	0.08	0.07	**-0.28**	**0.06**	**0.00**
Low OLF/Low RLF	0.45	0.42	0.28	-0.34	0.44	0.44
High OLF/Low RLF	*1.07*	*0.46*	*0.02*	0.12	0.48	0.80
High OLF/High RLF	*0.64*	*0.22*	*0.00*	*0.64*	*0.17*	*0.00*
Model 3: Psychosocial covariates, friendship quality and selected interactions[e]						
Lon	0.05	0.10	0.66	**-0.35**	**0.07**	**0.00**
Dep	**0.80**	**0.14**	**0.00**	**0.55**	**0.09**	**0.00**
SA	-0.01	0.14	0.96	**-0.42**	**0.10**	**0.00**
SE	-0.13	0.11	0.21	**-0.41**	**0.08**	**0.00**
Low OLF/Low RLF	*0.94*	*0.39*	*0.02*	-0.91	0.78	0.25
High OLF/Low RLF	1.58	0.85	0.06	0.60	0.60	0.32
High OLF/High RLF	0.43	0.25	0.09	**0.76**	**0.19**	**0.00**
DepxLoOLF/LoRLF	-0.50	0.37	0.17	0.57	0.54	0.30

	Latent class[a]					
	At-Risk Gamers			Social Engaged Gamers		
	b	SE	p-value[b]	b	SE	p-value
DepxHiOLF/LoRLF	-0.44	0.67	0.51	*-0.65*	*0.31*	*0.04*
SAxHiOLF/HiRLF	*0.36*	*0.18*	*0.05*	*0.34*	*0.14*	*0.01*
SExHiOLF/HiRLF	0.01	0.14	0.93	*0.27*	*0.11*	*0.01*

Notes: (a) Multinomial latent class regressions using most likely class assignment, comparing class to average class (82.3%). (b) Italics indicates statistical significance at p<.05; bold indicates significance at Bonferroni-adjusted p-value for that model (varies by model): Model 1: p<.004, Models 2-3: p< .003. (c) All models adjusted for control variables. (d) Models 2&3 friendship quality logistic regression coefficients are compared to reference category of Low OLF/High RLF. (e) Model 3 includes all covariates from main effects models and interactions with p<0.15. OLF=Online friendship quality, RLF=Real-life friendship quality

Figure 4.1: Online social interaction and dual pathways to problematic gaming



Chapter 5 Discussion

Video games and the Internet—as new, overlapping and virtually ubiquitous forms of mass media—present unique challenges for public health researchers. Not only are they used daily by adolescents in areas of the world that have access to them (Floros & Siomos, 2012; D. A. Gentile et al., 2011; Holstein et al., 2014; Jeong & Kim, 2011; D. L. King, Delfabbro, et al., 2013), they overlap explicitly in the form of online games and implicitly in characteristics and attributes, complicating efforts to classify and measure them. Online video games are played with others and involve social interactions as part of gameplay, making them inherently social media (Cole & Griffiths, 2007), while social media can include games (e.g., Farmville), game-like mechanisms ("gamification") to encourage use, or "push" notifications from online games that make friends in one's social network aware of a game's use (e.g., an automated post to Facebook after using a game that says "Michelle completed Mission 7: ran 2.85 miles in Zombies, Run!"). Since online games and social media have both been associated with problematic technology use, this is especially concerning. Although the American Psychiatric Association has proposed a new diagnosis, Internet Gaming Disorder, to promote research into online games as a potential behavioral addiction (American Psychiatric Association, 2013), there is still a lack of consistency in measurement and methods as well as a lack of consensus on how to define problems related to high engagement with video games (see Chapter 2). However, people who struggle to control video game use despite problems are presenting themselves for treatment at greater rates (Müller, Beutel, & Wölfling, 2014; Tao, 2010), making it clear that interventions, treatment and policy advancements are needed now. The empirical research in this thesis draws on naturally occurring patterns within a sample of adolescents, avoiding the complications associated with relying solely on self-reported symptoms of problematic gaming in a scale score. Using a person-centered approach has clarified the importance of placing heavy

gaming and symptoms of problematic gaming in adolescents in the context of socially-mediated efforts to meet developmental needs.

This chapter reviews findings of this thesis and discusses them in light of existing literature and theory. First, I will review and discuss findings from the thesis aims:

- Aim 1: Review and synthesize evidence specific to problematic gaming (as opposed to problematic Internet use [PIU]) and psychosocial well-being;
- Aim 2: Identify subgroups of adolescents that are at risk for self-reported problematic gaming, as well as those for whom even high levels of video game use are benign or even protective;
- Aim 3: Investigate associations between problematic gaming and potential correlates of psychosocial well-being in the context of both online and offline friendship quality.

Following that, I will discuss the strengths and limitations of the thesis as a whole, then suggest some implications for policy, intervention development, and treatment. Finally, I will propose directions for future research.

Summary of findings

Aim 1: Review and synthesize epidemiologic research on problematic gaming and psychosocial well-being in adolescents.

This systematic review aimed to synthesize evidence related specifically to problematic gaming (as distinct from PIU) and associations with psychosocial well-being. Results show that problematic gaming is prevalent in about 5% of adolescents (range 0.6% to 15.6%), seems to be a time-limited state with varying levels of distress, and is associated with a variety of negative psychosocial correlates in both cross-sectional and longitudinal studies. Problematic gaming was distinguishable from engaged gaming (those with very high levels of gaming who do not meet criteria for problematic gaming but may endorse

peripheral criteria such as preoccupation and mood modification) and from PIU. Greater internalizing and externalizing symptoms, problems with academic achievement and Internet use and lower levels of subjective well-being were found to coexist with problematic gaming, and problematic gaming was predicted by impulsivity, lower social competence and less academic achievement. A recent meta-analysis of problematic gaming suggested that academic problems are a consistent effect regardless of measurement approach, but that associations with mental health and social indicators vary by measurement method (Ferguson et al., 2011). That study suggested that measurement instruments based on pathological gambling criteria (as opposed to impulse control disorders, negative life consequences or interference with functioning) are likely to misclassify highly engaged gamers as problematic. If highly engaged gamers, who by definition do not suffer negative consequences related to gaming, are indeed misclassified as having problematic gaming in studies using those criteria and the condition of problematic gaming is associated with harm, we would expect the effect sizes observed in systematic reviews to be attenuated from true effects, as the population of those identified as problematic gamers would be a mixture of highly engaged gamers who do not experience harm and those whose gaming is truly associated with harm. Most instruments, including the current IGD criteria, have their roots in pathological gambling criteria and so ultimately depend on symptoms associated with addiction rather than negative consequences or interference with life and functioning. This means that person-centered approaches may take on a more important role should these criteria remain unchanged, a topic that is currently under debate (M. Griffiths et al., 2015; Kardefelt Winther, 2015; Rehbein, Kliem, Baier, Mößle, & Petry, 2015).

That being said, the review supports a dual pathway model of the development of problematic gaming that distinguishes between a pathway with a social component that may

be more associated with internalizing symptoms such as anxiety and depression, and a pathway where symptoms may depend on aspects of impulsivity that may be associated with externalizing symptoms such as aggression and hostility. The intrinsically reinforcing properties of video games encourage high engagement, and for adolescents with ADHD or problems with impulsivity, problematic use may result (Carli et al., 2013; D. A. Gentile et al., 2011). This may also be a compensatory mechanism; academic achievement was found to precede problematic gaming as well as follow it, so gaming may be used as a form of dysfunctional or maladaptive coping with difficulty functioning in role demands (Kardefelt Winther, 2014a; Mößle & Rehbein, 2013). As cognitive control is still developing in adolescence, self-regulation may be lacking and this maladaptive coping may lead to distress and harms. Dysfunctional coping may also be associated with problems with social functioning, a consistent finding across studies reviewed here that is also supported in studies of online gaming in general (S. E. Caplan, 2007; Kowert & Oldmeadow, 2013). While it is straightforward to imagine how gaming in a virtual world may help compensate for or complement the real-world social environment, it is less clear how this may apply to other types of games, and robust effects for other forms of gameplay were not clear here.

A shortcoming of the current evidence for problematic gaming is the lack of studies at social, national and cultural levels. Even the most vital social factors related to peer and family connectedness were not often studied in multivariate analyses. Parental mediation in the form of low monitoring, authoritarian, permissive and neglectful parenting were the only factors outside of the individual level that were studied often enough in multivariate models to show consistent links to problematic gaming. Various aspects of parenting behaviors including talking about Internet and game use, limit-setting and parents' own Internet and game use have been linked to more or fewer problems with gaming (Tzavela et al., 2015; van

den Eijnden, Spijkerman, Vermulst, van Rooij, & Engels, 2010). Parents may feel unsure about how to encourage healthy media behaviors ("EU Kids Online," 2014), and new digital media represent a form of ever-changing sociotechnological culture that requires a new set of skills for parents, educators, and clinicians to learn in order to support optimal adolescent development (Borzekowski, 2007; Greenfield & Yan, 2006; Livingstone, 2013). Although regular video game play represents a common activity for adolescents, problematic use may reflect a form of maladaptive coping that, when combined with poor self-regulation, leads to problems regulating video game play that result in negative life consequences.

Aim 2: Identify adolescents by patterns of video game play, online social interaction and self-reported problematic gaming to distinguish adaptive from maladaptive patterns of use.

Chapter 3 described a person-centered modeling approach to group adolescents by their patterns of game use, social Internet applications and problematic gaming symptoms. Findings indicated that incorporating online social interaction as one component of latent class analyses helped identify classes of adolescent gamers who had adaptive and maladaptive patterns with regard to problematic gaming symptoms. In this analysis, 47% of boys and 17% of girls were estimated to be in classes with heavy use of video games. Some of these classes--the ones designated as "social"--had much higher levels of instant messaging and social networking, and similar levels of gaming. Of the social classes, one class each for boys and girls had average levels of self-reported problematic gaming symptoms despite high engagement in both video games and online social applications. The most problematic class in boys (Problematic Gamers) reported more symptoms than the most problematic class in girls (At-risk Gamers), but patterns of play differed by sex and social vs. non-social class designation. Boys in the non-social classes were much more likely to play online games than offline games, while social boys showed less of a difference and girls were equally likely to

play online and offline games. Browser game play was unlikely for boys with low online social interaction and was the most likely form of gameplay for social girls.

These findings support the idea that both social and nonsocial mechanisms may contribute to the development of problematic gaming. Overall, high levels of online social interaction seem to be associated with fewer problematic gaming symptoms in highly engaged gamers. Both boys and girls seek social support through online friendships (Lenhart et al., 2015; Tzavela et al., 2015), and most boys and girls in the U.S. play games with friends (Lenhart et al., 2015). For adolescents, gaming is a natural part of daily life, and in fact those who do not game are often less well-adjusted than those who game moderately (Hofferth & Moon, 2012; Przybylski, 2014). While the social benefits of play seem clear in this analysis, when gameplay and online social interactions are driven by feelings of inadequacy in real-world social settings, this may lead to perceptions of the Internet (or online games) as necessary for daily life and interfere with the ability to modulate excessive play in the face of negative consequences (S. E. Caplan, 2005; Tzavela et al., 2015). It may be that this is what was observed in the Problematic Gamers class in males—although they had moderately high levels of social interaction, they had even higher levels of game use; in this case, the social benefits may not have outweighed the distress and conflict associated with highly engaged gaming. Alternatively, their extensive levels of gaming could be indicative of impulsivity and associated problems with self-regulation that undermine a well-rounded online and gameplay experience. A final possibility is that our social gaming classes underreport harms. Adolescents may ascribe fewer harms to rewarding activities (Spear, 2013), and as social networking and instant messaging are now among the primary ways for teens to keep in touch with friends (Lenhart et al., 2015), it may be easier to brush off associated problems as normative. Findings from the person-centered approach in this study suggest that online

social interaction may be a key factor distinguishing highly engaged gaming from problematic gaming among adolescents who game heavily.

Aim 3: Associations between problematic gaming, psychosocial well-being and friendship quality.

Chapter 4 examined the impact of problematic gaming patterns on further indicators of well-being, first alone and then with a more naturalistic accounting for perceived online and offline friendship quality. Association of gaming classes with well-being varied based on whether or not the gaming class was categorized as "social." Friendship quality was also found to moderate some, but not all, associations.

First, we found that highly social gamers expressed higher well-being overall than less social gamers. Social gaming groups, which had the highest levels of online social interaction, were more likely to have had high quality online and offline friendships. Levels of depressive symptoms were lower for social gaming classes than their less social counterparts, and Social Engaged Gamers also indicated less loneliness. Moderation of associations by friendship quality produced evidence for social compensation and augmentation through use of online social applications: although Social At-risk Gamer boys on average showed lower self-esteem, this was not seen in those with high quality online and offline friendships. Before looking at interactions, it seemed that Social Engaged Gamer girls also reported lower self-esteem. However, once interactions were taken into account, this was reversed for girls high in both online and offline friendship quality, who had higher self-esteem. For these groups, highly engaged gaming may have been part of a more adaptive pattern of media use that placed high value on social interaction (Tzavela et al., 2015) and seemed to effectively gain social support from online networks (Longman et al., 2009). These classes were more likely to include ethnic minorities compared to the Average class, so their digital inclusion in a social community may be an effort to overcome social

exclusion. Cohort effects indicating stronger relationships between class membership and later years were strongest for these classes too, which parallels the increasing popularity of social networking ("Social Networking Fact Sheet," n.d.). Social Engaged gamers were also likely to be older, and as older adolescents are more likely to "hang out" online (Lenhart et al., 2015), gaming and social interaction are likely to be part of an autonomous space where adolescents can pass time, develop relationships, and participate in many aspects of adolescent life to their advantage (Kowert, Domahidi, & Quandt, 2014).

A striking finding was that all non-average classes indicated higher depressive symptoms than the Average classes, although this effect was reversed in girls whose only high-quality friendships were online. One previous longitudinal study from our review found depression to be a longitudinal correlate of problematic gaming in a multivariate model (D. A. Gentile et al., 2011), but another study did not (Mößle & Rehbein, 2013). While it is possible that highly engaged use of video games leads to depression, cognitive psychological theory suggests that individuals with depressive symptoms may choose less cognitively demanding tasks such as media use over the more cognitively demanding task of social interaction, especially when choice of media is consistent with existing negative biases (Romer et al., 2009). This has been supported in studies of adolescent media use (Romer et al., 2013, 2009) but represents an important area for further study. Other studies suggest that depression increases with more use of instant messaging (van den Eijnden et al., 2008) or social networking(Steers, Wickham, & Acitelli, 2014); this may be another factor, either alone or in conjunction with other media use, that contributes to greater depressive symptoms. Finally, it is possible that the elevated depressive symptoms seen here were, in fact, mostly due to endorsement of the two items related to sleep. Sleep is commonly disturbed in depression, so inclusion of items related to sleep in a depression scale may make it seem as if

depression exists when it may be that what is actually being endorsed is sleep problems (W. W. Eaton, Dryman, Sorenson, & McCutcheon, 1989; Roane et al., 2013). Since media use in adolescents does interfere with sleep (Carli et al., 2013; Primack et al., 2009; Rehbein & Mößle, 2013; Smyth, 2007), further studies should consider excluding sleep-related items of depression scales after first assessing psychometric support for doing so.

We also found evidence for social compensation through highly engaged gaming in some, but not all, of our classes. Boys and girls estimated to be in the most problematic classes may have successfully compensated for higher levels of social anxiety by making online friends. Boys and girls seek social support online, and about a third of boys use online games as one of their main forms of communication with close friends (Lenhart et al., 2015). For girls, this picture was slightly different—only girls high in both online and offline friendship quality had positive associations between social anxiety and heavy game use classes. While this could be a sign of social compensation by girls who are socially anxious yet have good existing friendships, it makes more sense to consider that socially anxious girls may be learning additional social skills through their online friendships and transferring them to real-life relationships. As one adolescent said in a paper on high online engagement (Tzavela et al., 2015, p.40):

> *"Although I was introvert, I found out that through the internet I can improve the way I communicate with others. In a good way I became more open. Anyway after a long period of using the Internet. It became easier to talk to someone, online and in real life. And this has many advantages for me."*

The picture for non-social gamers is more complicated. Even when friendship quality was rated as high both on- and offline, some non-social gamers still reported

significantly higher level of loneliness and social anxiety as well as low self-esteem. It might be that the perception of friendship quality was different for boys estimated to be in non-social classes. Adolescents differ in their subjective experiences of friendship quality (Zurko, 2011), so these groups may be reporting friendships as high quality that other groups might consider low quality. Alternatively, their lower levels of online social interaction may reflect an overall decrease in the importance of social relationships that corresponds with their heavy involvement in video games. In an online study using a convenience sample of gamers, interest in offline social goals was found to be inversely related to degree of game involvement (Kowert, 2014), suggesting that game play may lead to displacement of time spent with real-world social contacts. As studied here, relationships are cross-sectional, so the direction of effect cannot be inferred from these results. In any case, these groups may represent gamers whose problems associated with high levels of gaming are neither driven by social compensation (i.e., a desire for high levels of online interaction) nor affected by socially-mediated factors like friendship quality—they may represent a non-social pathway toward the development of problematic gaming. Adolescents whose patterns of media use lead to better online friendship quality may be effectively using games and online social interaction to gain social support, but those who game heavily without extensive online socializing have more indicators of poor psychosocial well-being.

Strengths and limitations

While this thesis provides a novel approach to understanding problematic gaming, it has several limitations. Because these empirical studies use cross-sectional data, no conclusions can be drawn about the directionality of relationships between problematic gaming and psychosocial well-being. In addition, the validity of self-reported data on social networking use has been questioned (Burke et al., 2010), although adolescents are able to

self-report some forms of media use accurately (Schmitz et al., 2004). Social desirability and recall biases may affect reporting of well-being symptoms; clinical interviews could help clarify assessment of emotional functioning. Adolescents may also minimize problems associated with highly engaged use (Tzavela et al., 2015); future studies would benefit from recording more objective criteria or using multiple raters such as friends, parents or teachers. Although the assessment of friendship quality here has been validated in our sample, the fact remains that it is an inherently dyadic (or polyadic) construct that is being measured on an individual level. Finally, since our sample was gathered from schools in the Netherlands, we cannot assume that findings are generalizable to other cultures where gaming and social interaction patterns may differ.

However, the approach and findings herein have several strengths. First, the systematic review is the first to focus exclusively on scales that assess problematic gaming. This is an important contribution to the literature, as prior reviews have included scales that do not specifically assess gaming (Ferguson et al., 2011; D. L. King, Haagsma, et al., 2013; Daria Joanna Kuss & Griffiths, 2012). This thesis is the first to examine how use of two of the most popular forms of online social interaction, instant messaging and social networking, is associated with highly engaged gaming and problematic gaming symptoms using a latent variable approach. This person-centered approach allowed for the distinction of naturally-occurring patterns that provide a clearer portrait of what it means to be an engaged gamer, and how patterns of social and non-social gaming differ for boys and girls. Also, in examining social factors such as friendship quality and online social interactions, this thesis recognizes that highly engaged gaming is part of a bigger picture of media use as it occurs in an individual's social environment. Finally, by examining these relationships in a multivariate model that also controls for potential confounders, this analysis provides additional

assurance that the observed effects are due to the included variables rather than other potential determinants or unmeasured confounders.

Implications

This empirical approach to assessing problematic gaming along with Internet activity and friendship quality points to the importance of studying potential benefits and harms related to video game play in a more holistic context. The results of moderation by friendship quality as presented here provide evidence that social environment plays a crucial role in the outcomes of highly engaged gaming for some adolescents. As has been suggested previously, the inherently social nature of video game play has the potential to be protective and useful for adolescents (Domahidi et al., 2014; Kowert, Domahidi, & Quandt, 2014; Lenhart et al., 2015; Tzavela et al., 2015), and if this potential is not taken into account, any attempt to understand how highly engaged gaming—the norm for some adolescents and some types of games—is related to psychosocial well-being will be misleading. These results also suggest that a non-social pathway to problematic gaming may exist, i.e. a pathway that does not seem to be affected by social interaction either on- or offline. Self-regulation has been heavily implicated in behavioral addictions (LaRose, Eastin, & Gregg, 2001; Milosevic & Ledgerwood, 2010; Young, 1998), and impulsivity particularly has been associated with problematic gaming (Ko et al., 2013; Littel et al., 2012). Although this thesis did not specifically analyze variables related to impulsivity, impulsivity was identified as a longitudinal precursor of problematic gaming in the systematic review (Chapter 2) and is supported by recent qualitative research (Tzavela et al., 2015). The fact that we found groups of adolescents for whom social interactions did not seem to matter in relation to associations between problematic gaming and psychosocial well-being implies a non-social causal pathway to problematic gaming. It is possible that the problematic gaming of these groups

resulted from maladaptive attempts to cope with low self-esteem (Kardefelt Winther, 2014c), but we did not find significant effects for associations with self-esteem in all non-social groups. Self-regulation is proposed to play a large role in the degree of problems associated with high engagement with games, as adolescents who experience problems and have good self-regulation are motivated and able to change their behavior (Tzavela et al., 2015). This thesis proposes that further research consider both social and non-social mechanisms for the development of problematic gaming.

Using a variety of activities as indicators of behavioral risk offers the possibility of developing interventions that could incorporate passively observed information about behavior (e.g., captured through an individual's interaction with the computer or with game consoles) to assess risk in an ongoing fashion. Future studies of gaming and online interaction could be improved by logging data through interaction with specific applications (i.e., computer-based passive surveillance), a practice which occurs already in many online games and social networking applications and is, in fact, used by marketing analytics firms to discover ways to enhance game engagement (Ninja Metrics, n.d.). This thesis also has successfully identified groups of highly engaged video gamers who have less loneliness. Whether their high online and game engagement is a sign of pre-existing extraversion or the result of successfully using games and the Internet to develop friendships and connectedness will need to be clarified by future research.

Treatment programs for problematic Internet use and problematic gaming are increasing worldwide (Fackler, 2007; Parr, 2009; "Virtual Worlds - Internet Addiction | Digital Nation | FRONTLINE | PBS," 2010), and as more adolescents (or their parents) seek treatment, it will be important for clinicians to have a thorough understanding of highly engaged game play in a developmental context. Rather than treating problematic gaming as

another form of "problem behavior" indicative of the potential for delinquency, substance abuse and other antisocial behaviors (Chang et al., 2014; Mößle & Rehbein, 2013), clinicians should first attempt to identify the role of highly engaged gaming in the adolescent's life. This thesis has shown that the online social interactions matter when evaluating which adolescents may be at greater risk of problems related to gaming. For some adolescents, a highly engaged online social life may seem excessive but ultimately be useful, especially if online friendships are of high quality. In this case, high engagement may be driven by low psychosocial well-being, including depression, but problems with well-being may be relieved by successful development of online friendships. Cognitive behavioral therapy may help address depressive symptoms in these adolescents, and motivational interviewing may be useful to give adolescents the push needed to change maladaptive behaviors (van Rooij, 2011). Adolescents who spurn online social interactions, on the other hand, may have lower emotional functioning in more domains. In this case, it will be especially important for clinicians to determine the nature and extent of underlying problems in order to direct treatment. This research also has implications for learning self-management skills: problematic gamers who are interested in self-managing their gaming as part of continuing treatment or self-care may benefit from computer-based interventions that monitor online behavior to identify high-risk patterns, such as less online social interaction, and remind users to be mindful about their use.

Concern about problematic gaming has led to regulations limiting amount of time spent on online games in China (Xing, 2007), proposed regulations on online gaming in Korea (Hawkins, 2012) and consideration of an addiction rating for all types of games (similar to an objectionable content rating) in Germany (Egan, 2009). The findings here clarify that it may not be appropriate to target online games as the sole focus of those

efforts. While online games were more clearly associated with problematic gaming in the literature review (Chapter 2), for girls, the empirical studies presented here show that offline game use was more strongly associated with problematic gaming. An approach that would be useful to parents especially (who are likely to buy games for their children) would be a revised rating system that takes into account game characteristics that are associated with greater reinforcement potential, such as appointment mechanics (Hopson, 2001). While an addiction rating may not be easy to quantify, the presence or emphasis on game elements that are associated with more highly engaged play or have the potential to cause more real-world conflict (e.g., paid upgrades to freemium games, purchasable downloadable content) would help provide objective indication up front of games that might more likely to lead to problems.

In addition, countries such as the Netherlands have implemented school-based universal prevention programs to promote healthy Internet behavior and media use (de Haan, 2009). Several findings here support healthier ways to game. While it is difficult to translate the probability of a response in an estimated latent class to a quantity of a behavior in a real-world setting, in general, more moderate amounts of gaming in the setting of higher online socializing were better than higher amounts of gaming with less online socializing. Thus, adolescents could be made aware that if they find themselves gaming alone, or feeling consistently or more socially anxious when highly engaged with a gaming habit, it might be time to seek help. Parents do not yet understand how to help children moderate their use of new media (Kutner et al., 2008; Livingstone, 2013); this is an important area of future research. In addition, it may be especially fruitful for intervention developers to work with the game industry itself to develop socially responsible game-based interventions. Game developers are in the unique position of being able to control not only the especially

reinforcing properties of their games, but also to capture data about use and design mechanics that might inform research on problematic gaming (van Rooij, 2011). As this would be a very direct way to capture data effortlessly, develop new statistical models for analyzing these "big data", and develop novel commercial-media based interventions, this might be the most important area for future public health research.

Conclusion

As online games and other media continue to evolve, the reach of online media will expand (Durkin & Blades, 2009) and new technologies may bring even more attractive opportunities and greater inherent risks. Newer mobile games such as Ingress use augmented reality to overlay game aspects into real-world settings. Games such as this may foster physical movement and real-world participation, but may also be hard to stop using (play can occur everywhere, all the time) and could lead to risky interactions with unknown fellow players that could add to real-life difficulties. Mobile phones are used for Internet access by many people in developing countries (Pew Research Center, 2014) , and mobile phone games have already been identified as having especially strong reinforcing qualities ("Why is candy crush so addictive?," n.d.). As access to cheaper hardware and Internet penetrates into developing countries, it will be important to monitor the risks and benefits associated with these changes in games and Internet use so as to maximize benefits and minimize risks for users.

Appendices

Appendix 1: Videogame Addiction Test

How often…

1. ...do you find it difficult to stop gaming?

2 ....do you continue to use the games, despite your intention to stop?

3 ....do others (e.g., parents or friends) say you should spend less time on games?

4 ....do you prefer to game instead of spending time with others (e.g., friends or parents)?

5 ....do you not get enough sleep because of gaming?

6 ....do you think about gaming, even when you're not online?

7 ....do you look forward to the next time you can game?

8 ....do you think you should be gaming less often?

9 ....have you unsuccessfully tried to spend less time on gaming?

10 ....do you feel restless, frustrated, or irritated when you cannot game?

11 ....do you rush through your homework to play games?

12 ....do you neglect to do your homework because you prefer to game?

13 ....do you game because you are feeling down?

14 ....do you game to forget about problems?

Appendix 2: Latent class regression on control variables, psychosocial covariates and friendship quality in males

	Latent Class[a]													
	Problematic (1.3%)			Social At-risk (1.8%)			At-risk (10.3%)			Social Engaged (5.1%)			Extensive (26.3%)		
	b	SE	p-value	b	SE	p-value	b	SE	p-value	b	SE	p-value	b	SE	p-value
Model A: Demographic and control variables															
Education	-1.72	0.50	0.00	-0.83	0.31	0.01	-0.36	0.13	0.01	-1.14	0.23	0.00	0.21	0.12	0.07
Ethnicity	0.83	0.32	0.01	0.53	0.30	0.08	0.10	0.15	0.51	0.78	0.20	0.00	-0.04	0.13	0.75
Age 14	0.19	0.34	0.57	0.50	0.34	0.14	0.10	0.14	0.48	0.97	0.28	0.00	0.20	0.13	0.12
Age 15	0.04	0.43	0.93	0.35	0.38	0.36	0.16	0.17	0.34	1.13	0.31	0.00	0.03	0.14	0.86
Age 16	0.62	0.48	0.20	0.50	0.56	0.37	0.48	0.22	0.03	1.44	0.40	0.00	0.21	0.18	0.24
2010	-0.60	0.61	0.33	-0.25	0.66	0.70	0.42	0.18	0.02	0.40	0.37	0.28	0.39	0.13	0.00
2011	-0.02	0.48	0.97	1.11	0.35	0.00	0.40	0.19	0.03	1.23	0.27	0.00	0.15	0.15	0.34
2012	0.79	0.34	0.02	1.07	0.32	0.00	0.64	0.17	0.00	1.48	0.24	0.00	0.34	0.13	0.01
Model 1: Psychosocial covariates[b]															
Education	-1.55	0.50	0.00	-0.83	0.30	0.01	-0.23	0.15	0.12	-1.12	0.22	0.00	0.22	0.13	0.08
Ethnicity	0.82	0.31	0.01	0.51	0.30	0.09	0.12	0.16	0.44	0.77	0.20	0.00	-0.05	0.14	0.73
Age 14	0.15	0.37	0.69	0.51	0.34	0.14	0.12	0.15	0.41	0.96	0.28	0.00	0.21	0.14	0.13
Age 15	0.15	0.45	0.74	0.46	0.38	0.22	0.24	0.18	0.17	1.16	0.31	0.00	0.06	0.15	0.69
Age 16	0.49	0.53	0.36	0.47	0.59	0.43	0.47	0.24	0.05	1.36	0.39	0.00	0.18	0.19	0.35
2010	-0.21	0.59	0.72	-0.09	0.63	0.89	0.69	0.19	0.00	0.29	0.37	0.43	0.60	0.14	0.00
2011	0.19	0.49	0.69	1.31	0.35	0.00	0.66	0.20	0.00	1.25	0.27	0.00	0.43	0.16	0.01
2012	1.03	0.35	0.00	1.25	0.33	0.00	0.84	0.19	0.00	1.48	0.24	0.00	0.55	0.14	0.00
Loneliness	0.17	0.21	0.40	0.06	0.20	0.78	0.40	0.08	0.00	-0.36	0.13	0.01	0.17	0.08	0.02
Depression	1.21	0.30	0.00	0.85	0.17	0.00	0.81	0.08	0.00	0.40	0.12	0.00	0.55	0.06	0.00
Social anxiety	0.24	0.22	0.28	-0.11	0.15	0.46	0.20	0.07	0.01	-0.21	0.11	0.04	0.40	0.06	0.00
Self-esteem	-0.44	0.17	0.01	-0.17	0.18	0.33	-0.24	0.09	0.01	-0.26	0.17	0.12	-0.08	0.10	0.43
Model 2: Psychosocial covariates and friendship quality															
Education	-1.40	0.50	0.01	-0.72	0.32	0.03	-0.14	0.16	0.39	-1.04	0.22	0.00	0.25	0.13	0.05
Ethnicity	0.73	0.33	0.02	0.52	0.31	0.10	0.11	0.16	0.47	0.76	0.20	0.00	-0.04	0.14	0.79
Age 14	0.16	0.37	0.66	0.47	0.35	0.17	0.08	0.15	0.60	0.99	0.29	0.00	0.19	0.14	0.17
Age 15	0.11	0.49	0.83	0.41	0.39	0.30	0.19	0.18	0.29	1.17	0.32	0.00	0.04	0.15	0.81
Age 16	0.63	0.55	0.25	0.55	0.61	0.37	0.48	0.24	0.05	1.47	0.41	0.00	0.17	0.19	0.36
2010	-0.22	0.58	0.71	-0.14	0.67	0.83	0.69	0.19	0.00	0.28	0.38	0.45	0.62	0.14	0.00
2011	0.22	0.49	0.66	1.32	0.35	0.00	0.65	0.20	0.00	1.24	0.27	0.00	0.41	0.17	0.01
2012	0.99	0.37	0.01	1.22	0.33	0.00	0.80	0.20	0.00	1.46	0.25	0.00	0.51	0.15	0.00
Loneliness	0.13	0.22	0.54	0.13	0.21	0.55	0.45	0.09	0.00	-0.27	0.13	0.04	0.22	0.08	0.01

	Latent Class[a]														
	Problematic (1.3%)			**Social At-risk (1.8%)**			**At-risk (10.3%)**			**Social Engaged (5.1%)**			**Extensive (26.3%)**		
	b	**SE**	**p-value**	**b**	**SE**	**p-value**	**b**	**SE**	**p-value**	**b**	**SE**	**p-value**	**b**	**SE**	**p-value**
Depression	1.17	0.31	0.00	0.82	0.17	0.00	0.78	0.08	0.00	0.35	0.12	0.01	0.54	0.06	0.00
Social anxiety	0.24	0.21	0.26	-0.10	0.15	0.53	0.22	0.08	0.00	-0.23	0.11	0.03	0.40	0.06	0.00
Self-esteem	-0.42	0.17	0.01	-0.14	0.19	0.46	-0.25	0.09	0.01	-0.30	0.17	0.08	-0.09	0.10	0.37
Missing OLF	-0.89	0.56	0.11	-0.67	0.56	0.23	-0.55	0.17	0.00	-0.25	0.25	0.32	-0.45	0.13	0.00
LoOLF/ LoRLF	-0.35	0.47	0.46	-0.10	0.52	0.85	-0.13	0.18	0.49	-0.55	0.35	0.11	-0.37	0.16	0.02
HiOLF/ LoRLF	1.81	0.58	0.00	1.42	0.73	0.05	0.66	0.38	0.08	1.29	0.51	0.01	0.02	0.47	0.96
HiOLF /HiRLF	0.64	0.40	0.11	0.93	0.40	0.02	0.58	0.15	0.00	0.62	0.23	0.01	0.13	0.14	0.36
Model 3: Interaction effects[c]															
Education	-1.36	0.48	0.00	-0.68	0.32	0.04	-0.14	0.16	0.39	-1.06	0.22	0.00	0.26	0.13	0.05
Ethnicity	0.76	0.36	0.04	0.59	0.32	0.07	0.12	0.16	0.46	0.78	0.20	0.00	-0.04	0.14	0.79
Age 14	-0.02	0.37	0.96	0.48	0.38	0.21	0.08	0.15	0.62	1.01	0.29	0.00	0.18	0.14	0.18
Age 15	-0.09	0.56	0.88	0.38	0.41	0.36	0.19	0.18	0.29	1.18	0.32	0.00	0.04	0.15	0.81
Age 16	0.51	0.54	0.35	0.60	0.63	0.34	0.48	0.25	0.05	1.46	0.41	0.00	0.17	0.19	0.37
2010	-0.26	0.60	0.67	-0.16	0.80	0.84	0.70	0.19	0.00	0.30	0.38	0.43	0.62	0.14	0.00
2011	0.17	0.50	0.74	1.43	0.38	0.00	0.64	0.20	0.00	1.24	0.27	0.00	0.42	0.17	0.01
2012	0.93	0.42	0.03	1.32	0.36	0.00	0.79	0.20	0.00	1.44	0.25	0.00	0.51	0.15	0.00
Loneliness	0.09	0.21	0.67	0.18	0.23	0.43	0.45	0.09	0.00	-0.30	0.14	0.03	0.22	0.08	0.01
Depression	1.14	0.25	0.00	0.86	0.18	0.00	0.79	0.08	0.00	0.33	0.13	0.01	0.54	0.06	0.00
Social anxiety	-0.44	0.29	0.12	-0.14	0.25	0.57	0.19	0.10	0.06	-0.24	0.14	0.09	0.37	0.07	0.00
Self-esteem	-0.72	0.25	0.00	-0.56	0.21	0.01	-0.28	0.10	0.00	-0.25	0.23	0.28	-0.10	0.11	0.34
Missing OLF	-0.98	0.60	0.10	-0.72	0.59	0.22	-0.53	0.17	0.00	-0.25	0.25	0.31	-0.45	0.13	0.00
LoOLF/ LoRLF	-0.32	0.51	0.54	-0.27	0.52	0.60	-0.13	0.19	0.47	-0.52	0.34	0.13	-0.37	0.16	0.02
HiOLF/ LoRLF	-2.25	2.68	0.40	1.20	1.66	0.47	0.75	0.43	0.08	0.89	0.66	0.17	0.01	0.54	0.98
HiOLF/ HiRLF	0.65	0.42	0.12	0.94	0.44	0.03	0.57	0.16	0.00	0.60	0.29	0.04	0.13	0.16	0.43
SAxHiOLF/LoRLF	3.73	1.60	0.02	-0.91	1.21	0.45	-0.30	0.48	0.53	-0.09	0.46	0.85	0.07	0.40	0.86
SAxHiOLF/HiRLF	1.02	0.40	0.01	0.25	0.33	0.44	0.18	0.15	0.22	0.11	0.23	0.63	0.15	0.14	0.30
SExHiOLF/LoRLF	0.53	0.52	0.30	0.71	0.79	0.37	-0.19	0.42	0.66	-0.87	0.54	0.11	-0.07	0.43	0.86
SExHiOLF/HiRLF	0.49	0.35	0.16	0.95	0.33	0.00	0.14	0.18	0.43	0.11	0.28	0.69	0.05	0.19	0.78

Notes: (a) Multinomial latent class regressions using most likely class assignment, comparing class to average class (52.3%). (b) All models adjusted for control variables. (d) Models 2&3 friendship quality logistic regression coefficients are compared to reference category of Low OLF/High RLF. (c) Model 3 includes all covariates from main effects models and interactions with $p<0.15$. OLF=Online friendship quality, RLF=Real-life friendship quality.

Appendix 3: Latent class regression on control variables, psychosocial covariates and friendship quality in females

	Latent Class[a]					
	At-risk (4.2%)			Social Engaged (13.4%)		
	b	SE	p-value	b	SE	p-value
Model A: Demographic and control variables						
Education	-0.57	0.15	0.00	-1.51	0.16	0.00
Ethnicity	0.54	0.18	0.00	0.76	0.14	0.00
Age 14	0.06	0.18	0.73	0.45	0.15	0.00
Age 15	0.16	0.22	0.47	0.76	0.19	0.00
Age 16	-0.32	0.39	0.41	1.09	0.22	0.00
2010	0.06	0.23	0.78	-0.12	0.22	0.59
2011	0.71	0.20	0.00	1.20	0.17	0.00
2012	0.29	0.21	0.18	0.78	0.17	0.00
Model 1: Main effects of psychosocial covariates[b]						
Education	-0.46	0.16	0.01	-1.41	0.15	0.00
Ethnicity	0.50	0.18	0.01	0.78	0.15	0.00
Age 14	-0.02	0.19	0.93	0.45	0.15	0.00
Age 15	0.07	0.23	0.76	0.73	0.19	0.00
Age 16	-0.56	0.42	0.18	0.99	0.24	0.00
2010	0.28	0.24	0.24	-0.06	0.22	0.80
2011	1.02	0.21	0.00	1.35	0.18	0.00
2012	0.43	0.22	0.05	0.96	0.17	0.00
Loneliness	0.07	0.10	0.50	-0.37	0.07	0.00
Depression	0.79	0.15	0.00	0.56	0.09	0.00
Social anxiety	0.17	0.10	0.10	-0.26	0.07	0.00
Self-esteem	-0.19	0.08	0.02	-0.29	0.06	0.00
Model 2: Main effects of psychosocial covariates and friendship quality						
Education	-0.26	0.17	0.12	-1.30	0.15	0.00
Ethnicity	0.46	0.19	0.02	0.77	0.15	0.00
Age 14	-0.04	0.19	0.82	0.42	0.15	0.01
Age 15	0.10	0.24	0.69	0.72	0.19	0.00
Age 16	-0.43	0.42	0.31	1.03	0.24	0.00
2010	0.32	0.24	0.18	-0.03	0.22	0.88
2011	1.06	0.22	0.00	1.34	0.18	0.00
2012	0.46	0.23	0.05	0.97	0.17	0.00
Loneliness	0.04	0.10	0.67	-0.34	0.07	0.00
Depression	0.74	0.15	0.00	0.53	0.09	0.00
Social anxiety	0.17	0.10	0.08	-0.26	0.07	0.00
Self-esteem	-0.15	0.08	0.07	-0.28	0.06	0.00
Missing OLF	-0.72	0.26	0.01	-0.07	0.19	0.72
LoOLF/LoRLF	0.45	0.42	0.28	-0.34	0.44	0.44
HiOLF/LoRLF	1.07	0.46	0.02	0.12	0.48	0.80
HiOLF/HiRLF	0.64	0.22	0.00	0.64	0.17	0.00
Model 3: Interaction effects						
Education	-0.25	0.17	0.13	-1.27	0.15	0.00
Ethnicity	0.43	0.19	0.02	0.78	0.15	0.00
Age 14	-0.05	0.19	0.80	0.43	0.15	0.01
Age 15	0.09	0.24	0.69	0.72	0.19	0.00
Age 16	-0.42	0.42	0.31	1.00	0.24	0.00
2010	0.31	0.24	0.19	-0.02	0.22	0.91
2011	1.07	0.22	0.00	1.36	0.18	0.00
2012	0.45	0.23	0.05	0.98	0.17	0.00
Loneliness	0.05	0.10	0.66	-0.35	0.07	0.00

	Latent Class[a]					
	At-risk (4.2%)			Social Engaged (13.4%)		
	b	SE	p-value	b	SE	p-value
Depression	0.80	0.14	0.00	0.55	0.09	0.00
Social anxiety	-0.01	0.14	0.96	-0.42	0.10	0.00
Self-esteem	-0.13	0.11	0.21	-0.41	0.08	0.00
Missing OLF	-0.74	0.26	0.00	-0.04	0.19	0.85
LoOLF/LoRLF	0.94	0.39	0.02	-0.91	0.78	0.25
HiOLF/LoRLF	1.58	0.85	0.06	0.60	0.60	0.32
HiOLF/HiRLF	0.43	0.25	0.09	0.76	0.19	0.00
DepxLoOLF/LoRLF	-0.50	0.37	0.17	0.57	0.54	0.30
DepxHiOLF/LoRLF	-0.44	0.67	0.51	-0.65	0.31	0.04
SAxHiOLF/HiRLF	0.36	0.18	0.05	0.34	0.14	0.01
SExHiOLF/HiRLF	0.01	0.14	0.93	0.27	0.11	0.01

Notes: (a) Multinomial latent class regressions using most likely class assignment, comparing class to average class (82.3%). (b) All models adjusted for control variables. (d) Models 2&3 friendship quality logistic regression coefficients are compared to reference category of Low OLF/High RLF. (e) Model 3 includes all covariates from main effects models and interactions with $p<0.15$. OLF=Online friendship quality, RLF=Real-life friendship quality

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Zurko, M. (2011). Friendship during adolescence: The necessity for qualitative research of close relationships. *Polish Journal of Applied Psychology*, *9*(1), 21–38.

Curriculum Vitae

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EDUCATIONAL BACKGROUND

Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland
PhD candidate, Mental Health
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Johns Hopkins University, Baltimore Maryland.
Bachelor of Arts in Psychology, 1987

RESEARCH INTERESTS

Methodological issues in video game research, including latent variable modeling of problematic video gaming and its association with mental and behavioral health outcomes
Development and evaluation of Internet-based interventions, video games and mobile technologies to foster recovery from mental illness and promote mental health
Fostering engagement of and collaboration with multiple stakeholders, disciplines and institutions in mental health research, translation and dissemination.

AWARDS AND RECOGNITION

NIDA Drug Dependence Epidemiology Training Fellow, 2013-2015.

NIMH Child Mental Health Services and Service Systems Training Fellow, 2011-2013.

Individual Leadership Award, Howard County Commission on Disability Issues, 2009.

PUBLICATIONS

Carras, M. C., Mojtabai, R., Furr-Holden, C. D., Eaton, W., & Cullen, B. A. M. (2014). Use of mobile phones, computers and internet among clients of an inner-city community psychiatric clinic. *Journal of Psychiatric Practice*, *20*(2), 94–103.
Claassen, C. A., Pearson, J. L., Khodyakov, D., Satow, P. M., Gebbia, R., Berman, A. L., … Insel, T. R. (2014). Reducing the burden of suicide in the u.s.: the aspirational research goals of the national action alliance for suicide prevention research prioritization task force. *American Journal of Preventive Medicine*, *47*(3), 309–314.
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PRESENTATIONS

Colder Carras, M. (2011). *Electronic Patient-Reported Outcomes: Characteristics, Questions and Quandaries*. Johns Hopkins University Bloomberg School of Public Health.
Colder Carras, M. (2012a). *Comparing disability websites*. Johns Hopkins University Diversity Leadership Council.
Colder Carras, M. (2012b, May). *Psychiatry 2.0: Improving prevention, treatment, decision support and knowledge through e-Mental health*. the Johns Hopkins Bloomberg School of Public Health.
Colder Carras, M., Noorani, T., & Carras, M. (2014, May). *Games, drugs and the user experience: Comparing use, misuse and self-regulation in a social and political context*. Presented at the International Communications Association Preconferece: Beyond the pixels, Seattle, WA.
Labrique, A. B., Agarwal, S., & Lucea, M. (2012, December). *Working Papers on mHealth Classification, Evaluation, Indicators and Evidence Grading. Presentation by coauthors Alain Labrique and Smisha Agarwal to the WHO mTAG Consultative Meeting*. Montreaux, Switzerland.

AD-HOC REVIEWER

Psychiatry Research
Global Mental Health
International Communications Association
The Cochrane Collaboration
Journal of Dual Diagnosis

TEACHING EXPERIENCE

Winter 2015. Teaching Assistant, Psychiatric Epidemiology (online version)
Johns Hopkins Bloomberg School of Public Health, Department of Mental Health
Instructor: William Eaton

Fall 2013. Teaching Assistant, Psychiatric Epidemiology
Johns Hopkins Bloomberg School of Public Health, Department of Mental Health
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PROFESSIONAL MEMBERSHIPS

International Society for Research on Internet Interventions
International Communication Association
American Public Health Association
American Psychological Association
Mental Health America
On Our Own of Maryland

MENTAL HEALTH ADVOCACY EXPERIENCE

Member, Public Policy Committee, Mental Health America, 2015-present. Provide input on policy statements for a national mental health advocacy organization, work with other organizations and policymakers to promote organizational priorities and positions.

Intern, Mental Health America, 2013-2015. Represent Mental Health America at the Clinical Trials Transformation Initiative, a public-private partnership between the FDA, academic institutions, industry and other organizations designed to transform clinical trials.

Patient representative, Food and Drug Administration, 2010-present. Serve on ad-hoc advisory panels to provide advice on regulation of drugs and neurological devices, including electroconvulsive therapy devices.

Guest speaker for The Kennedy Forum media project, 2013. Worked with former Congressman Patrick Kennedy and other consumers to create a video that addressed aspects of the lived experience of mental illness, research needs and challenges that was aired during the Kennedy Forum in October 2013.

Member, Diversity Leadership Council, The Johns Hopkins University, 2011-2013. Served on an advisory council to the president and senior leadership of the university to assist in recommending and promoting policies, programs and other initiatives to attract and retain a diverse mix of faculty, staff, and students.

Faculty Liaison, Mental Health Student Group, Johns Hopkins Bloomberg School of Public Health, September 2010-2011. Represented the students of the Mental Health Department at faculty meetings, facilitated communication of student concerns to faculty, and helped develop opportunities for student growth in the department.

Co-founder, Mindfulness for Mental Health Group, Johns Hopkins Bloomberg School of Public Health, 2013-2014. Under the supervision of faculty member Tamar Mendelson, PhD, worked with fellow PhD student Angela Lee-Win to host mindfulness meditation sessions for interested faculty, staff and students.