Causes and consequences of pathological gaming

Lemmens, J.S.

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Chapter 3

The Relation between Pathological Gaming, Attentional Bias, and Response Inhibition among Male Adolescents.

Jeroen S. Lemmens, Ruth J. van Holst, Patti M. Valkenburg, Jochen Peter,
Dick J. Veltman and Anna E. Goudriaan
University of Amsterdam

Abstract

The aim of this study was to examine whether behavioral tendencies commonly related to addictive behaviors are consistent with those related to pathological gaming. Specifically, we tested the relation between pathological use of computer and video games and two behavioral tendencies: attentional bias and impaired response inhibition. For this purpose, 92 male adolescents performed two tasks that measured attentional bias (addiction-Stroop, dot-probe) and one task that measured behavioral inhibition (go/no-go). Additionally, self-report measures of pathological gaming, self-control and time spent playing computer and video games were administered. Our results indicate that male adolescents with higher levels of self-reported pathological gaming did not show reaction time bias, but they did display signs of error-related attentional bias to game cues. Higher levels of pathological gaming were also related to lower self-control and impaired response inhibition when game cues were presented.

The Relation between Pathological Gaming, Attentional Bias, and Response Inhibition among Male Adolescents

Although pathological use of computer and video games, more commonly known as ‘game addiction’ or ‘pathological gaming’ is not recognized as a clinical disorder, recent studies have indicated that a small subset of players show symptoms of pathological behavior (Charlton & Danforth, 2007; Gentile, 2009; Grüsser, Thalemann, & Griffiths, 2007). Many researchers consider pathological gaming a type of behavioral addiction similar to pathological gambling, and have adapted the diagnostic criteria for pathological gambling from the DSM-IV (APA, 2000) to further explore and quantify this phenomenon (e.g., Griffiths, 2005; Lemmens, Valkenburg, & Peter, 2009). Similar to pathological gambling, pathological gaming generally refers to the inability to control gaming habits despite social and/or emotional problems that arise from excessive use. Considering the conceptual similarities between these two types of addictive behavior, the purpose of the present study is to investigate whether behavioral tendencies commonly associated with pathological gambling and other addictive behaviors are consistent with those observed in pathological gaming. Specifically, we focused on the relation between pathological use of games and two prominent characteristics of addictive behavior: attentional bias to addiction-related cues and impaired response inhibition.

It is generally accepted that all addictive disorders are characterized by biases in the attentional processing of addiction-related stimuli (Field & Cox, 2008). Increased attention to addiction-related cues leads to increased craving and vice versa (Ryan, 2002). Because addictive stimuli may result in conditioned responses that motivate indulging in the addictive behavior, biased attention to addiction-related cues seems to play an important role in maintaining addictions and can induce relapse after treatment (Robins & Ehrman, 2004). Using attentional bias tests such as the addiction-Stroop task (Cox Fadardi, & Pothos, 2006) or the dot-probe task (Ehrman et al., 2002), researchers have found empirical evidence of attentional bias for addiction-related stimuli in a variety of addicted populations, such as alcohol dependent patients (Lusher, Standler, & Ball, 2004), tobacco smokers (Munafo et al., 2003), and pathological gamblers (Boyer & Dickerson, 2003).

The extent to which pathological gamers show attentional bias for game-related stimuli has rarely been investigated. To date, only two studies on this subject were published. First, Thalemann, Wölfling, and Grüsser (2007) examined responsiveness to game-related cues in both excessive and occasional computer game players. Their EEG analyses indicated that excessive players were significantly more sensitive to game-related cues than casual players, concluding that excessive gaming is maintained through craving of game-related cues (Thalemann, Wölfling & Grüsser, 2007). The only other study on cue-reactivity and pathological gaming used fMRI scans to indicate that the neural substrate of cue-induced craving among subjects with online gaming addiction is similar to cue-induced craving in substance dependence (Ko, Liu, Hsiao, et al., 2009). Both of these studies used neuroimaging techniques to indicate attentional bias, whereas other addictive disorders, such as pathological gambling, have been associated with attentional bias using behavioral response tasks (e.g., Boyer & Dickerson, 2003). The current study is the first to investigate the relationship between pathological gaming and attentional bias for game-related material (i.e., pictures and words associated with games) using behavioral measures among male adolescent gamers.

A second behavioral tendency associated with addictive disorders is a deficiency in self-regulation, as manifested in an impaired ability to inhibit the urge to perform the desired behavior. The ability to suppress inappropriate and unwanted actions is often referred to as response inhibition. Using inhibition tasks, such as a go/no-go task (Simmonds et al.,

2007) or a stop signal task (Logan, Cowan, & Davis, 1984), diminished inhibition has been found among alcohol dependent patients (Noël et al., 2007), cocaine dependent patients (for a review see Garavan & Hester, 2007), nicotine dependents (Dawkins et al., 2009) and pathological gamblers (Goudriaan, Oosterlaan, de Beurs, & van den Brink, 2006). However, to our knowledge, studies examining whether impaired self-regulatory patterns are also a feature of pathological gaming have not been published. Therefore, the second aim of our study was to fill this gap in the current literature by examining whether players who show more signs of pathological gaming also show impaired response inhibition.

Closely related to self-regulatory behavior patters is the concept of self-control. Self-control is defined as the ability to resist an impulse, drive, or temptation to perform an action, or terminate behavior once initiated (e.g., Baumeister, 2003). Failure of self-control has been found to be centrally conducive to all sorts of addictive behavior, such as alcohol dependence (Lyvers, 2000), pathological gambling (Lakey et al., 2007), and more recently, addiction to online games (Kim, Namkoong, Ku, & Kim, 2008). Because of the conceptual similarities between self-control and response inhibition, we expected that players who show more signs of pathological gaming also show less self-control.

The overall purpose of the current study was to expand our knowledge of the relation between pathological gaming, attentional bias, and response inhibition. If these behavioral patterns commonly associated with addictive disorders are also found related to pathological gaming, this could provide further evidence that the underlying cognitive-emotional processes of this relatively new condition are similar to other, clinically recognized, addictive disorders. Based on previous studies, we included two common measurements for attentional bias: a dot-probe task and an addiction-Stroop task. To examine the relationship between pathological gaming and response inhibition, we included a go/no-go task, and a self-report measure of self-control. We investigated whether performance on these measures was associated with participants' level of pathological gaming, which was measured using a game addiction survey scale developed by Lemmens, Valkenburg, and Peter (2009).

Method

Participants

In May 2008, we conducted a survey among 573 Dutch adolescents, measuring their experiences with computer and video games and their levels of pathological gaming. At the end of that survey, all game-playing respondents could indicate whether they were willing to participate in the current game-related study. All male adolescents who volunteered were invited to participate in the current study. Participants were from six different schools and had all played computer or video games in the months prior to the study. Their age ranged from 12 to 17 years (M = 15.1 years, SD = 1.27). When we compared participants in the current study to the non-participating male adolescent gamers from the aforementioned survey, our sample of volunteers spent more time on computer or video games (t (349) = -6.09, p < .001), and showed higher levels of pathological gaming (t (349) = -7.64. p < .001). No significant differences in age were found. This indicates that our participants were generally heavier gamers who showed relatively more signs of pathological gaming when compared to other Dutch adolescent game-playing boys. Before participation, we obtained consent from participants, their parents, and their schools.

Procedure

In the last two months of 2008, during school hours, participants were taken in pairs to an empty classroom where they were each seated behind a laptop, facing away from each other. All participants were told that (1) they were participating in a reaction-time experiment, comparing different types of gamers; (2) they would be presented with three computerized reaction-tests of approximately five minutes each; (3) throughout the tests, they should try to respond as fast as possible. All tests were developed using the program E-Prime. The order of tests (dot-probe, go/no-go, and addiction-Stroop), was counterbalanced between pairs of participants. After 20 minutes, when both participants had completed all three tests, they were asked to fill out a paper-and-pencil questionnaire. This questionnaire contained a scale to measure pathological use of computer and video games, and items on the time participants had spent playing games in the six months prior to the study. After approximately 40 minutes, participants received a small box with refreshments as appreciation for their time and effort, and went back to their class.

Self-report Measures

Pathological gaming. To measure respondents' level of pathological gaming, we used a 21-item game addiction scale developed by Lemmens, Valkenburg, and Peter (2009), which is based on the DSM IV-criteria for pathological gambling previously adapted by Griffiths (2005). This scale included three items for each of the seven underlying criteria of pathological gaming: (1) *Salience*: e.g., "Did you spend all day thinking about a game?" (2) *Tolerance*: e.g., "Did you start spending increasing amounts of time on games?" (3) *Mood modification*: e.g., "Have you played games to forget about real life?" (4) *Relapse*: e.g., "Have others unsuccessfully tried to reduce your game use?" (5) *Withdrawal*: e.g., "Did you feel bad when you were unable to play?" (6) *Conflict*: e.g., "Did you have fights with others (e.g., family, friends) over your time spent on games?" (7) *Problems*: e.g., "Have you neglected other important activities (e.g., school or work) to play games?" Every item was preceded by the statement: 'During the last six months, how often…' Players rated all items on a 5-point scale: 1 (*never*), 2 (*rarely*), 3 (*sometimes*), 4 (*often*), 5 (*very often*). This 21-

item scale showed good reliability with a Cronbach's Alpha of .89.

Because it is increasingly believed that mental and behavioral disorders can best be understood as points along a continuum (e.g., Satcher, 2000), we conceptualized pathological gaming as a continuum, instead of using an arbitrary cut-off point to determine if someone is addicted or not. Therefore, contrary to some earlier studies (e.g., Charlton & Danforth, 2007; Gentile, 2009), we performed no dichotomous comparisons (i.e., game addicts versus non-addicts), but examined the correlation between individual mean scores on the 21-item game addiction scale and measures for attentional bias and response inhibition, described below. However, to be able to show and compare mean scores, we also created three groups based on the 33rd and 67th percentiles of the self-report game addiction scale: low pathological gaming scores (N = 31), medium pathological gaming scores (N = 31) and high pathological gaming scores (N = 30).

Time spent on games. Previous research has used time spent on games as an indicator of problematic gaming (e.g., Roe & Muijs, 1998). Although we believe time spent on games should not be used to determine pathological use, we expect participants who show more signs of pathological gaming to spend more time on games. Therefore, we also measured the weekly time spent on computer and videogames, by multiplying the number of days per week by the number of hours per day participants had spent on specific platforms (i.e., PCs, consoles, and handheld gaming devices).

Self-control. Respondent's level of self-control was measured using a short version of the self-control scale developed by Tangney et al. (2004). This 11-item self-control scale assesses people's ability to control their impulses, alter their emotions and thoughts, and to interrupt undesired behavioral tendencies and refrain from acting on them (Finkenauer, Engels, & Baumeister, 2005). Examples of items are: "I can easily resist temptations" and ''I have a hard time breaking bad habits.'' (Reverse scored). Response categories ranged from 1 (strongly disagree) to 5 (strongly agree). This scale showed acceptable reliability with a Cronbach's alpha of .70 (*M* = 3.05, *SD* = .52).

Attentional Bias Measures

Dot-probe task. In the dot-probe task, a target-related picture (in this study a game picture) and a matched neutral picture (in this study an animation picture) were simultaneously presented on a computer screen (Ehrman et al., 2002). Participants followed the on-screen instructions to focus on a fixation point ('+') in the middle of the screen. After ten neutral trial runs with feedback, they were presented with 50 pairs of pictures (one picture on each side of the fixation point). Pictures appeared for 500msec after which they disappeared, revealing a small rectangular probe behind one of the pictures for 200msec. If the probe appeared left, the participant was to press the Z key on the keyboard, and if the probe appeared right, the M key was to be pressed. The task contained 50 game pictures that were paired with 50 animation pictures. Each of the 50 pairs was shown twice, with each picture appearing once left and once right of the fixation point. The order in which the pairs were shown was randomized over participants.

The game pictures were all in-game screenshots from 18 console and computer games that were selected according to the most popular titles among adolescent boys as reported in the survey of a previous study (e.g., Call of Duty, Counter-Strike, World of Warcraft). Since we wanted the neutral pictures to have comparable salience to the game pictures, we opted for animated cartoon pictures from popular film and television characters, but only those that did not appear in computer and video games. All pictures were pre-tested for salience in a group of undergraduate students who had experience with video games, after which outliers in attraction or familiarity were removed. Attentional bias for game cues is reflected by faster responses to probes that followed game pictures than to those that followed (neutral) animation pictures. This bias in reaction time (RT-bias) was calculated by subtracting the reaction times to probes that followed game pictures from the reaction times to probes that followed animation pictures. A positive score would indicate participants' tendency to react more slowly to probes that follow animation pictures, and faster to probes that follow game pictures, when the two pictures are presented simultaneously, thereby inferring attentional bias.

Addiction-Stroop task. We used a modified version of the classic Stroop test, (Stroop, 1935), the addiction-Stroop (Cox et al., 2006). In this test, 34 English words were successively presented on screen. Participants were asked to indicate the font-color of the presented word. They pressed '1' for green, '2' for red, and '3' for blue. All 34 words were randomly presented three times, each time in a different font color. We used 17 game-related words and 17 movie-related words that were matched on word length and phonetic structure. For instance, we matched *Warcraft* with *Worldcup, Call of Duty* with *Call of the Wild,* and *Multiplayer* with *Mediaplayer*. After each font color selection, participants received feedback on their response correctness, total percentage of correct responses, and reaction time.

Attentional bias was inferred in two ways: (1) error-bias and (2) reaction time bias (RT-bias). Error-bias is the number of incorrect responses to game-related words minus the number of incorrect responses to movie-related words. A positive score indicates a participant's tendency to make more errors in color identification of game-related words than movie-related words. It is assumed that processing of the semantic content of game-related words results in higher error rates, which indicates preoccupation with addiction-related information (Cox et al., 2006). RT-bias is the reaction time to game-related words minus reaction time to movie-related words. A positive score on RT-bias would indicate slower response times to game-related words, compared movie-related words. Similar to error-bias, processing of the semantic content of the words would result in slower response times, thereby indicating attentional bias.

Response Inhibition Measure

Go/no-go task. In go/no-go tasks, participants are assigned to respond as rapidly as possible to 'go pictures' and refrain from responding to 'no-go pictures' (Simmonds et al., 2007). Our go/no-go task consisted of two conditions, a basic condition, measuring basic motor inhibition, and a game condition, measuring inhibition to game cues. In the basic condition, participants were presented with 104 pictures of animals and 40 pictures of humans. They were asked to press the spacebar as fast as possible only when presented with a picture of an animal. All pictures appeared for 800msec and were semi-randomized, in order to prevent two consecutive no-go pictures. In the game condition, they were presented with 120 pictures of cars and 40 pictures of popular games. Participants were instructed to press the spacebar as fast as possible when confronted with a picture displaying a car, and withhold a response when a picture of a game was displayed. No pictures of race games or other game-pictures displaying cars were used. For both basic and game condition, number of responses to no-go pictures was taken as measure of impaired inhibition.

Statistical Analysis

For the all three tasks, the first ten responses were considered practice trials, and removed. Further, any responses < 100msec were considered invalid and removed from further analysis. Individual scores larger than three standard deviations above or below the overall mean of a particular score were considered outliers and removed from further analysis (Bowerman & O'Connell, 1990). Individual mean reaction times were based solely on correct responses (Weltford, 1980). All analyses were performed using SPSS.

Results

Descriptive Results

The individual mean scores on the 21-item game addiction scale ranged from 1.00 through 3.43 (*M* = 2.12, *SD* = .56). Using the 33rd and 67th percentiles as the cut-off points, we divided participants into three groups: low pathological gamers (*Range M*: 1.00-1.86, *N* = 31), medium pathological gamers (*Range M*: 1.86-2.33, *N* = 31), and high pathological gamers (*Range M:* 2.33-3.43, *N* = 30). These groups and their means (*SDs*) on the game addiction scale are presented in the first two columns of Table 1. Participants' weekly time on computer and video games ranged from 10 minutes to 54 hours, *M* = 14.47 (*SD* = 12.72). Time spent on games was strongly correlated to scores on the game addiction scale ($r = .49$, $p <.001$). The mean time spent on games for each of the three pathological gaming groups is presented in the third column of Table 1.

Dot-Probe Results

Two participants were identified as outliers with 18 and 19 errors respectively (>3 SDs from the mean) and were subsequently deleted. Before analyzing participants' reaction time bias to game cues, we first examined their general reaction time to all probes (the animation and game probes aggregated). Their mean reaction time was 322msec (*SD* = 34.05), which is very low. As Table 1 shows, participants' general reaction time ranged from 330msec (*SD* = 40.67) among low pathological gamers to 314msec (*SD* = 24.41) among high pathological gamers. Although each consecutive pathological gaming group showed faster general reaction times, the correlation between pathological gaming and general reaction time was not significant ($r = -.17$, $p = .ns$). As discussed earlier, reaction time bias is not measured by faster responses in general, but to faster responses to game cues only. A positive RT-bias score would indicate attentional bias, because the reaction times to game cues would be faster than those to animation cues. Results indicated that participants' RT-bias was approximately 2.5 nanosecond (M = -.27msec, SD = 12.39), and the correlation between participants' game addiction scores and RT-bias was not significant (r = .03, p = *ns*).

Addiction-Stroop Results

One participant was removed from analysis due to a high number of errors resulting from color blindness. As the sixth column of Table 1 shows, participants' error-bias to game-related words ranged from -1.11 (SD = 2.98) among low pathological gamers to .37 (SD = 3.20) among high pathological gamers. Participants' game addiction scores were significantly correlated to an error-bias for game-related words (r = .22, $p < .05$). RT-bias ranged from -.80 (SD = 51.28) among low pathological gamers to 2.03 (SD = 45.27) among high pathological gamers. However, we found no correlation between participants' mean game addiction scores and their RT-bias (r = .00, p = *ns*).

Go/No-Go and Self-control Results

On the go/no-go task, one participant was removed as an outlier with 48 counts of failed inhibition (>3 SDs from the mean: 14.21, SD = 8.63). In the basic condition (go animals, no-go humans), participants' mean game addiction scores were not significantly correlated with the amount of failed no-go trials (r = .16, p = *ns*). However, in the game condition (go cars, no-go games), participants' game addiction scores were significantly correlated with the number of failed no-go trials (r = .27, $p < .01$). As the far-right column in Table 1 shows, high pathological gamers (M = 7.35, SD = 3.70) showed more disinhibition to game cues, compared to low pathological gamers (*M* = 5.74; *SD* = 3.24). Furthermore, mean game addiction scores were negatively correlated with mean scores on self-control ($r = -.32$, $p < .01$), thereby further underlining the relation between pathological gaming and a general inability to resist inhibitory behavior.

Table 1: Mean Differences in Time Spent on Games, Attentional Bias, and Response Inhibition.

		Pathological gaming	Time	Attentional Bias Tasks: Dot-Probe		Attentional Bias Tasks: Addiction-Stroop		Response Inhibition Task: Go/No-go	
Group		Game Addiction	Hrs/week Games	General RT msec	RT-bias [y] msec	Error-bias [x]	RT-bias [y] msec	Basic Disinhibition	Games Disinhibition
Low	*M*	1.38 [a]	7.25 [a]	330.41	-.84	-1.11 [a]	-.80	6.43	5.74 [a]
(*N* = 31)	*SD*	.27	7.19	40.67	12.31	2.98	51.28	4.52	3.24
Medium	*M*	2.04 [b]	14.22 [b]	321.72	.99	.17	-3.38	7.62	6.63
(*N* = 31)	*SD*	.15	8.58	32.39	14.05	3.55	39.89	4.76	3.97
High	*M*	2.71 [c]	22.17 [c]	313.91	-.99	.37 [b]	2.03	7.58	7.35 [b]
(*N* = 30)	*SD*	.28	16.15	26.41	10.87	3.20	45.27	4.69	3.70
Total	*M*	2.12	14.47	322.10	-.27	-.19	-.72	7.20	6.56
(*N* = 92)	*SD*	.56	12.72	34.05	12.39	3.29	45.33	4.69	3.67

Notes. Column means with different superscripts differ significantly at least at $p < .05$; [x] Error-bias indicates mean difference between incorrect responses to neutral cues and game cues; [y] RT-bias indicates mean difference in reaction times between neutral cues and game cues.

Discussion

The main aim of our study was to investigate whether attentional bias and diminished response inhibition were related to pathological gaming. For this purpose, we used two tasks to measure attentional bias (dot-probe and addiction-Stroop), and one task to measure response inhibition (go/no-go). Results from the two attentional bias tasks showed mixed results. The dot-probe and addiction-Stroop tasks showed no correlation between reaction time bias and self-reported levels of pathological gaming. However, the addiction-Stroop showed that gamers with higher self-reported levels of pathological gaming made significantly more errors in selecting the correct font-color when confronted with game-related words, but not when confronted with movie-related words. Errors in color identification of addiction-related words indicate preoccupation with addiction-related information, which compromises correct color naming, thereby indicating attentional bias (Cox et al., 2006).

Regarding response inhibition (go/no-go), we found that gamers with higher levels of pathological gaming had more difficulty inhibiting responses when confronted with pictures of games during a go/no-go task. However, they did not have trouble inhibiting their response to pictures of humans. Because basic motor inhibition was unaffected by levels of pathological gaming, impaired inhibition in response to game cues among participants with higher levels of pathological gaming indicates that only addiction-related cues affect response inhibition. Contrary to neutral images, pictures of games are perceived as 'wanted', thus eliciting approach behavior to these stimuli, resulting in impaired inhibitory responses when these cues are presented (Robinson & Berridge, 2001). Therefore, the relation between pathological gaming and impaired response inhibition was affected by biases in the processing of game cues.

Attentional bias has been linked to relapse in heroin dependence (Marissen et al., 2006), relapse in nicotine dependence (Waters et al., 2003), and to treatment outcome in alcohol and cocaine dependence (Cox et al., 2002; Carpenter et al., 2006). In the current study, the addiction-Stroop task showed that game-related information interfered with cognitive processes, resulting in more errors in identification of addiction-related words. This type of interference by addiction-related words is an indication of an individual's current level of preoccupation or attentional bias (Ehrman et al., 2002). In addition, the go/no-go task indicated that pathological gaming negatively influenced response inhibition, but only when confronted with game cues, which is also an indication of attentional bias to addiction-related cues. These findings imply that, due to their preoccupation with game-related cues, gamers with higher levels of pathological gaming may have more difficulty restraining from starting a game when they should be doing other things on their PC, or disengaging from a gaming session once started. They may also have more difficulty when trying to quit or control their excessive behavior despite efforts to do so.

Contrary to previous studies on attentional bias and pathological gaming (Ko, Liu, Hsiao, et al., 2009; Thalemann, Wölfling & Grüsser, 2007), we did not use neuroimaging techniques to examine this relation. Instead, we opted for computerized behavioral tasks, that have proven to be effective in determining attentional bias in other addictive behaviors, such as alcohol dependent patients (Lusher, Standler, & Ball, 2004), and pathological gamblers (Boyer & Dickerson, 2003). However, contrary to these addictive behaviors, reaction time bias to game cues showed no significant correlation with levels of pathological gaming. We suggest that these inconsistent findings regarding reaction time bias may be related to floor effects in the reaction speed of our sample of participants. All our behavioral tasks required actions that are strongly related to the skills used in computer and video games. Several studies have shown that computer games can improve players' abilities related to motor skills, perception, and selective attention (Castel, Pratt, & Drummond, 2005; Green & Bavelier, 2003). Our sample consisted mostly of moderate to heavy male adolescent gamers who showed very fast response times on the dot-probe task (M = 322msec), which are faster than response times reported in previous studies that have applied dot-probe tasks (e.g., Ehrman et al., 2002; Townshend & Duka, 2001). In fact, we did not find a single study that reported general reaction times on a dot-probe task that were faster than those observed among the participants in our study. Since response times among our participants were generally extremely fast, differences in response times for addiction-related cues and neutral cues were generally very small, thereby reducing the likelihood of finding significant effects on reaction time bias. Therefore, participants' experience with games and computers may have been a confounding factor when examining the relation between pathological gaming and reaction time bias, especially when this relation is examined using computerized behavioral tasks.

In conclusion, our results indicate that self-reported levels of pathological gaming were associated with error-related attentional bias for game cues and impairment of inhibitory responses when game cues were present. Although we found no relation between pathological gaming and reaction time bias, we believe that these inconsistent results are of great importance to future research. Because gamers generally possess fast response abilities that may interfere with specific behavioral tasks, future research should be careful in selecting reaction time-based behavioral measures to examine the relation between attentional bias and pathological gaming among a population of adolescent gamers.

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