Addictive Behaviors Reports 5 (2017) 19–28

Contents lists available at ScienceDirect

Addictive Behaviors Reports

journal homepage: www.elsevier.com/locate/abrep

Individual differences in implicit learning abilities and impulsive behavior in the context of Internet addiction and Internet Gaming Disorder under the consideration of gender

Rayna Sariyska [a,*], Bernd Lachmann [a], Sebastian Markett [b,c], Martin Reuter [b,c], Christian Montag [a,d]

[a] Institute of Psychology and Education, Ulm University, Helmholtzstraße 8/1, 89081 Ulm, Germany
[b] Department of Psychology, University of Bonn, Kaiser-Karl-Ring 9, 53111 Bonn, Germany
[c] Center for Economics and Neuroscience, University of Bonn, Nachtigallenweg 86, 53121 Bonn, Germany
[d] Key Laboratory for NeuroInformation/School of Life Science and Technology, University of Electronic Science and Technology of China, Chengdu, China

A R T I C L E I N F O

Article history:
Received 17 January 2017
Received in revised form 5 February 2017
Accepted 5 February 2017
Available online 7 February 2017

Keywords:
Internet addiction
Internet Gaming Disorder
Implicit learning
Risk-taking

A B S T R A C T

Introduction: In three consecutive studies, we aimed to investigate the relationship between problematic Internet use (PIU), Internet Gaming Disorder (IGD) and implicit learning abilities, and impulsivity/risk-taking among online video gamers and control participants.
Methods: In study 1, male visitors, recruited at the "Gamescom" in Cologne (2013), filled in a short version of the Internet Addiction Test (s-IAT), the Online Gaming Addiction Scale (OGAS), and completed an experimental task to assess implicit learning abilities. In study 2, a group of WoW gamers and control participants completed the same set up, in order to replicate the results of study 1. Study 3 used a modified version of the experiment to measure impulsivity/risk-taking in a group of healthy participants.
Results: In study 1, results revealed a significant negative correlation between the s-IAT score and the measure of implicit learning among male Gamescom participants. In study 2, the s-IAT and WoW addiction scores were negatively correlated with implicit learning only in male WoW players, which mirrors the results from study 1. In study 3, the OGAS score was positively correlated with the experimental measure of impulsivity/risk-taking.
Conclusion: In the current research project, deficient implicit learning was linked to PIU only in male participants with (a tendency towards) IGD. These findings might help to disentangle some opposing results on this relationship, when considering the gender of participants. Furthermore, higher risk-taking tendencies were associated with IGD among healthy participants, thus, suggesting the potential of risk taking as a predictor of IGD in a non-gamer population.

1. Introduction

The Internet has found its way into the daily life of many people worldwide, offering an easy way to gather information and to consume entertainment. With the growing number of Internet users, accounting for almost 50% of the world population at the moment (accessed on 07.09.16. http://www.internetlivestats.com/internet-users/), the number of reports on problematic Internet usage (PIU) is rising. In a representative study from Germany ($N = 15{,}024$ participants) Rumpf, Meyer, Kreuzer, John, and Merkeerk (2011) showed prevalences of 1.5% in Internet addiction, with younger users showing higher proportions (4% in the group of 14–16 year olds). First attempts to define and diagnose PIU[1] have been made by Kimberly Young in the year 1998 (see also first case report from Young, 1996). Since then numerous tests and screening instruments have been developed (e.g. Young, 1998b; Young, 1998a; Tao et al., 2010), in order to be able to calculate prevalences in different populations and provide patients with effective treatment. However, there is still no existing nosological classification of PIU. The research on online gaming addiction seems to be one step ahead, as recently Internet Gaming Disorder (IGD) was included in Section III of DSM-5, by this means encouraging further examinations before its consideration as a formal disorder (American Psychiatric Association). IGD

* Corresponding author. Tel.: +49 731 5026 558.
E-mail address: Rayna.sariyska@uni-ulm.de (R. Sariyska).

[1] Throughout the present paper we will be using the term Problematic Internet Use (PIU) as a substitute for Internet addiction, as there is currently no existing official diagnosis in DSM-5 and ICD 10. As Internet Gaming Disorder (IGD) was included in the Appendix of DSM-5, this term will be used as a synonym of Online Gaming addiction. Please note that not every study, that we cite in the present article, investigated IGD, using the criteria suggested in DSM-5.

http://dx.doi.org/10.1016/j.abrep.2017.02.002
2352-8532/

is considered to be a specific form of PIU, which only overlaps in small parts with the generalized form of PIU described above (e.g. Davis, 2001; Montag et al., 2015).

1.1. PIU and implicit learning/decision making

Deficits in decision making have been shown in numerous studies, investigating patients with substance and behavioral addictions (e.g. Bechara et al., 2001; Schoenbaum, Roesch, & Stalnaker, 2006). Because of similarities in the conceptualization of PIU and behavioral/substance addiction (Young, 1998a), the topic of decision-making is also of high relevance to better understand the nature of excessive Internet usage. When assessing decision making a differentiation between decision making under ambiguity and decision making under risk have been made (Brand, Labudda, & Markowitsch, 2006; Schiebener & Brand, 2015). While in decision making under ambiguity the rules for gains and losses and the probabilities of different outcomes are not explicitly explained (measured e.g. with the (first trials of the) IOWA Gambling Task or IGT), in decision making under risk explicit information about the potential consequences, and the probabilities for gains and losses is available or is calculable (measured e.g. with the Game of Dice Task or GDT) (Brand et al., 2006; Schiebener & Brand, 2015). Based on this differentiation and on the dual-process models of decision making (e.g. Epstein, 2003), Schiebener and Brand (2015) proposed a theoretical model to explain decision making under risk. In this model the role of executive functions is highlighted as a key of relevance for decision making under risk, but not decision making under ambiguity. Emotional reward and punishment are supposed to accompany both forms of decision making. Thus, both reflective processes (controlled by cognition), along with impulsive processes (induced by the anticipation of emotional reward and punishment) may be involved in decision-making processes under objective risk conditions (Schiebener & Brand, 2015). Moreover, factors such as information about the decision situation, individual attributes and situational induced states and external influences have been proposed to have modulatory effects on decision making (Schiebener & Brand, 2015).

With respect to Internet addiction a new theoretical framework was proposed by Brand, Young, Laier, Wölfling, and Potenza (2016), called an Interaction of Person-Affect-Cognition-Execution (I-PACE), where an impairment of executive functions and inhibitory control also has been highlighted to be of relevance for the development of PIU. According to this model the development and maintenance of specific Internet-use disorders underlie interactions between predisposing factors (e.g. personality and psychopathology), moderators (e.g. dysfunctional coping style and Internet expectancies), and mediators (e.g. affective and cognitive responses to situational cues). These complex interactions, combined with experiencing gratification and positive reinforcement, as a consequence of the use of a certain feature of the Internet, and with reduced executive functions and inhibitory control, could result in a specific Internet use disorder.

So far, a few empirical studies have been conducted in the context of PIU, inhibitory control and decision making. Most of them are in accordance with the aforementioned theoretical framework by Brand et al. (2016). Sun et al. (2009) for example reported worse performance in a gambling task in excessive Internet users and slower choice of a successful strategy compared to control participants. In a more recent study, Pawlikowski and Brand (2011) reported reduced decision-making ability under risk in the GDT in a group of excessive World of Warcraft (WoW) players compared to control participants. Yao et al. (2015) used a modified version of the Go/NoGo task (where gaming-related stimuli were used next to neutral stimuli) and reported reductions in inhibitory control in participants with IGD, compared to control participants. Laier, Pawlikowski, and Brand (2014) found similar results with a modified version of the IGT, when using pornographic and neutral pictures on the advantageous and/or disadvantageous card decks. Here, male participants showed deficient decision making in trials where the pornographic pictures were associated with disadvantageous card decks. However, also mixed results concerning decision making in the context of PIU or IGD were reported. In a study by Ko et al. (2010) for example Internet addicted participants showed better decision making, measured with the IGT, compared to control participants. In the study by Yao et al. (2015) already cited above, no difference in decision making using the IGT could be found between healthy participants and those with IGD. To disentangle these conflicting results further studies, examining possible interfering variables, are necessary. One particular variable is described later in the current study.

1.2. PIU, risk taking and impulsivity

Due to the initial characterization of PIU as an impulse control disorder, a number of studies were conducted to explore PIU in the context of impulsivity and risk-taking. Cao, Su, Liu, and Gao (2007) and Lee et al. (2012) showed that PIU was positively associated with trait impulsivity, measured with the Barratt Impulsiveness Scale (BIS-11). With respect to the theoretical framework by Brand et al. (2016), already introduced above, impulsivity is mentioned among the personality factors, showing most stable associations with PIU and is, thus, proposed to be one of the factors, influencing its development and maintenance. Broadly, impulsivity is characterized as "a predisposition toward rapid, unplanned reactions to internal or external stimuli, without regard to the negative consequences of these reactions to the impulsive individuals or to others" (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001; p. 1784). The related term of risk-taking is defined as "behaviors performed under uncertainty, with or without inherent negative consequences, and without robust contingency planning" (Kreek, Nielsen, Butelman, & LaForge, 2005; p. 1453). Ko et al. (2010) applied the Balloon Analog Risk Task (Lejuez et al., 2002) to measure risk-taking, but found no significant association with PIU. In the present study, we are once more looking into these associations, by applying both, self-report along with experimental measures of impulsivity/risk-taking.

1.3. The role of gender for PIU/IGD

Another important issue in the context of Internet addiction is the preference of specific features of the Internet (e.g. online shopping, online gaming), depending on gender. A representative study from Germany showed that 77.1% of Internet addicted females at the age of 14–24 years use social networking sites compared to 64,8% males at the same age (Rumpf et al., 2011). In the same study 7.2% of Internet addicted females at the age between 14 and 24 years reported using the Internet to play online video games, compared to 33.6% of males at the same age (Rumpf et al., 2011). Thus, it seems that with respect to IGD, male participants show higher preference for online-gaming, compared to female participants and were reported to be more at risk to develop IGD. Moreover, Ko, Yen, Chen, Chen, and Yen (2005) observed that older age, lower self-esteem and lower daily life-satisfaction were associated with more severe IGD among males, but not females. Despite these results, there are still just a few studies, which systematically consider the gender of participants as a moderator/mediator variable in the context of PIU. However, it is possible that these differences account for some opposing results in the field and, thus, in the following studies they will be taken into consideration.

The aim of our research project was to investigate the link between PIU, as well as IGD and implicit learning in a group of male participants with proneness to IGD (study 1). In study 2 we aimed at replicating these results, by comparing healthy participants and excessive WoW players under the consideration of gender. The purpose of study 3 was to explore the relationship between PIU, IGD and impulsivity/risk-taking (self-report and experimental data) in healthy participants.

Based on the aforementioned literature, we formulated the following hypotheses:

Fig. 1. Experimental set up of the Devil's chest – opening the chest with the devil led to losing all collected coins of a given trial.

Hypothesis 1. We expect negative associations between PIU/IGD and implicit learning abilities (study 1).

Hypothesis 2. We expect negative associations between PIU/IGD and implicit learning abilities (study 2). We expect this negative association to be strongest in the group of male WoW players.

Hypothesis 3. We expect positive associations between PIU/IGD and the self-report and experimental measures of impulsivity/risk-taking in healthy participants (study 3).

2. Study 1

2.1. Methods

2.1.1. Participants

$N = 107$ participants (99 males, 8 females, age $M = 19.52$, $SD = 3.57$) were recruited at the "Gamescom 2013" in Germany, the world's largest gaming event. However, because the very low number of female participants in the present sample ($n = 8$) and the above reported gender differences in the context of IGD (e.g. Rumpf et al., 2011), we excluded the female participants from the further analyses of the study. After also excluding participants with missing data, the sample resulted in $n = 79$ male participants (age $M = 19.81$, $SD = 3.62$). Regarding their education, 8.9% reported having university or polytechnic degree, another 40.5% reported having A-level or vocational baccalaureate diploma and 26.6% reported having secondary school leaving certificate or secondary modern school qualification, while 24% reported having no school diploma.

2.1.2. Measures

Participants answered questions about their age, gender and education, filled in a short version of the Internet addiction test (s-IAT, Pawlikowski, Altstötter-Gleich, & Brand, 2013; Cronbach's Alpha in the present sample was 0.70), containing 12 Likert-scaled items (1 = never to 5 = very often) and the Online Game Addiction Scale (OGAS, a modified version of the Gaming Addiction Scale by Lemmens, Valkenburg, & Peter, 2009, where the word "online" was added to every item; Cronbach's Alpha in the present sample was 0.66), consisting of 7 items, ranging between 1 = never and 5 = very often. Additionally, participants rated their computer gaming experience (e.g. "For how many years have you been playing computer games?" or "How many hours on average per week do you play online computer games?"). A self-report measure of risk-taking was administered, including one item on overall risk-taking tendencies ("How would you describe yourself from 0 (not at all willing to take risks) to 10 (absolutely willing to take risks)?"); German Socio-Econimic Panel (SOEP; Siedler, Schupp, Spiess, & Wagner, 2008). We used a slightly adjusted experimental task ("Devil's chest"), incorporated from a study by Eisenegger et al. (2010), in order to measure implicit learning. On each of a total of 36 trials, we presented ten pictures of closed wooden boxes on the computer screen. The boxes were aligned in one row and participants had the opportunity to subsequently open a self-selected number of boxes, working from left to right. Participants were instructed that nine of the boxes contained a virtual monetary reward (5 cents) and one contained a "devil". If participants opened only reward boxes on a given trial, they proceeded to the next trial by gaining the sum of the rewards. If they opened a box, containing the devil, among with the other boxes, they lost everything on the current trial. The upcoming position of the devil was randomized among the 36 trials, but appeared on each position from 2 to 10[2] exactly four times. Although this was not mentioned to the participants, participants with higher cognitive skills might have worked out an implicit understanding for this rule and might have learned to perform better in the course of the experiment. The total of monetary rewards by the end of the experiment is further referred to as "GAIN" and will be used as a measure of implicit learning. The experimental set up is depicted in Fig. 1.

2.1.3. Procedure

All questionnaires only available in English were translated into German by our own work group. The participants first filled in the questionnaires and then completed the Devil's chest experiment. Please note, that participants in study 1 did not receive any monetary reward after completing the experiment and that they were informed about this fact prior to completing the experiment.

2.1.4. Statistical analyses

For the following analyses the normality of the data was examined by applying the rule of thumb, suggested by Miles and Shevlin (2001; p. 74), considering the skewness of the investigated variables. Correlation analyses were computed with Pearson's or Spearman's correlations, depending on the distribution of the data, and bootstrap bias-corrected and accelerated confidence intervals (BCa 95% confidence intervals) were computed for every correlation coefficient to further test their significance. Repeated measures ANOVA was used to test for implicit learning effects, when comparing the gain in the first 18 trials with the gain in the last 18 trials of the experiment.

2.1.5. Ethics

The research project (studies 1, 2 and 3) was approved by the Local Ethic Committee of the University of Bonn, Bonn, Germany. All subjects provided informed consent before completing the study.

2.2. Results

Means and standard deviations of the variables under investigation are presented in Table 1.

[2] Of note, the "devil" box was not programmed to appear in position 1, because this would have terminated the current trial without giving participants the opportunity to choose if they wanted to proceed by opening another box.

Table 1
Mean, standard deviation (SD) and possible/actual range for the variables gaming experience (years), online gaming hours per week, s-IAT, OGAS, GAIN and risk taking (self-report).

	Mean	SD	Possible range	Actual range
Gaming expertise (years)	11.09	4.31	–	3–24
Online gaming hours per week	22.24	16.00	–	0–70
s-IAT	23.86	5.38	12–60	12–43
OGAS	14.75	4.36	7–35	7–26
GAIN	413.61	71.97	0–900[a]	160–520
Risk taking (self-report)	6.77	1.89	0–10	3–10

N = 79, risk taking (self-report) n = 64.
[a] Please note that the maximal possible range for the variable GAIN was estimated under the assumption that the devil would appear on every position between 2 and 10 for exactly four times.

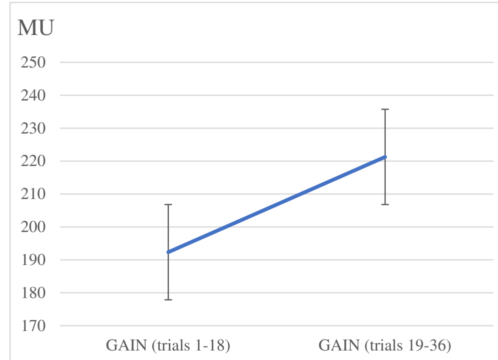

Fig. 2. Means and the standard error for the GAIN in the first 18 trials vs. the GAIN in the last 18 trials of the "Devil's chest" experiment. MU = monetary units.

2.2.1. Correlation analyses

Only the variable GAIN was not normally distributed. The age of the participants was positively correlated with GAIN (ρ = 0.27, $p < 0.05$). Moreover, GAIN showed a negative correlation with the s-IAT score (ρ = −0.26, $p < 0.05$). In addition, we computed partial correlations for GAIN and the s-IAT score to control for age. The correlation remained significant ($r = -0.28$, $p < 0.05$). The negative correlation between GAIN and the OGAS score did marginally not reach significance (ρ = −0.20, $p = 0.073$) and remained non-significant after controlling for age ($r = -0.12$, $p = 0.292$). All significant correlations remained significant after the inspection of the BCa 95% confidence intervals. Please see Table 2 for an overview of the results.

2.2.2. Manipulation check of the "Devil's chest" experiment as a measure of implicit learning

The results of the repeated measures ANOVA showed a significant mean difference between the GAIN in the first 18 trials of the experiment, compared with the last 18 trials ($F(1,78) = 17.303$, $p < 0.01$), showing that participants won more money in the second part of the experiment ($M_1 = 192.34$ and $M_2 = 221.27$ respectively) (see Fig. 2).

2.3. Discussion

To sum up, as proposed in our hypotheses, in study 1 Internet addiction was associated with deficient implicit learning abilities. This result delivers further evidence for the role of poor decision making in the context of PIU (e.g. Brand et al., 2016). The association with IGD was in the same direction, however, did not reach significance. This might be explained by the relatively small sample size and/or the relatively low internal consistency (0.66) of the OGAS scale in this study. In order to further investigate these relationships and compare the results between male and female participants and between gamers and non-gamers, study 2 was conducted.

Table 2
Correlations between GAIN in the "Devil's chest" experiment and the s-IAT, OGAS score and risk taking (self-report).

	GAIN	s-IAT	OGAS	risk taking (self-report)
GAIN	*1*			
s-IAT	*−0.264*[*]	1		
OGAS	*−0.203*	0.511[**]	1	
risk taking (self-report)	*0.148*	0.129	0.187	1

$N = 79$, risk taking (self-report) $n = 64$; Spearman correlations are depicted in *Italic*.
** $p < 0.01$.
* $p < 0.05$.

3. Study 2

The aim of the second study was to replicate the results of study 1, by using a sample of World of Warcraft (WoW) players and control participants, who were naive to WoW. Given that the association between the s-IAT and GAIN as a measure of implicit learning could be observed in male participants with proneness to IGD, we were interested to see replication of study 1's results particularly in male WoW gamers.

3.1. Methods

3.1.1. Participants

WoW players and control participants, took part in the study. The WoW players were recruited, using following criteria: WoW gaming experience for a minimum of two years. An exclusion criteria was playing other games than WoW for >7 h per week, however, participants with no experience in other games were preferably recruited. Control persons needed to be WoW naïve, hence had no experience of playing this game before. Exclusion criteria for both groups of participants were visual impairment, difficulties in reading and writing, dyschromatopsia, concussion, long-term medication, neurological and psychiatric diseases, hearing disability and high substance use. After a thorough inspection of the sample we excluded one participant due to an eating disorder and daily cannabis consumption, one participants due to neurological and psychiatric disorders and one participant from the control group due to extreme values in sIAT and OGAS, and participants with missing data, which resulted in $n = 77$ control participants (39 males) and $n = 44$ WoW players (28 males). 6.5% ($n = 5$) of control participants reported casual usage of online role-playing games (<3 h gaming per week) and 23.4% ($n = 18$) reported casual usage of Ego-shooter games (<1 h gaming per week). The mean age of the total sample was $M = 23.70$ ($SD = 3.93$). Regarding their education 10.7% reported having a university degree, another 85.9% reported having A-level or vocational baccalaureate diploma and 2.5% reported having secondary school leaving certificate or secondary modern school qualification. One person (0.9%) did not answer the items regarding education.

3.1.2. Measures

Here again the s-IAT (Pawlikowski et al., 2013; Cronbach's Alpha in the present sample was 0.76), OGAS (a modification of the GAS by Lemmens et al., 2009; Cronbach's Alpha in the present sample was 0.88) and the computer gaming experience were assessed. Additionally, the World of Warcraft Specific Problematic Usage-Engagement Questionnaire (WoW-SPUQ), consisting of 27 items, rated on a scale from 1 = "completely disagree" to 7 = "completely agree" (Peters & Malesky, 2008; Cronbach's Alpha in the present sample was 0.89) was

Table 3
Means, standard deviations (SD), possible/actual range, *t-/U* value and significance (p) for differences in means between the control participants and WoW group for the variables gaming experience (years), online gaming hours per week, GAIN, s-IAT, OGAS, WoW-SPUQ and BIS-11.

	Control group		WoW players		Possible range	Actual range	*t-/U* value	p
	Mean	SD	Mean	SD				
Male participants								
Gaming expertise (years)	9.49	6.81	14.29	4.85	–	0–22/6–25	−3.369	0.001
Online gaming hours per week	1.18	2.11	19.71	11.44	–	0–9/0–50	*30.0*	*<0.001*
GAIN	450.77	39.10	443.04	54.30	0–900	370–510/305–525	0.678	0.500
s-IAT	21.67	6.53	23.79	6.90	12–60	12–42/14–41	−1.280	*0.205*
OGAS	8.67	2.39	15.79	5.85	7–35	7–17/9–29	*94.5*	*<0.001*
WoW-SPUQ	–	–	87.57	23.26	27–189	–/53–134	–	–
BIS-11 total	65.00	13.39	64.63	8.94	30–120	40–99/53–90	0.125	0.901
BIS-11 attentional	17.13	4.95	16.57	2.85	8–32	8–30/12–21	0.579	0.565
BIS-11 motor	23.16	4.81	22.43	3.66	11–44	14–35/16–33	0.671	0.504
BIS-11 non-planning	24.71	5.32	25.74	4.77	11–44	14–40/16–40	−0.803	0.425
Female participants								
Gaming expertise (years)	3.86	5.76	11.50	5.29	–	0–15/1–20	−4.557	<0.001
Online gaming hours per week	0.09	0.43	17.56	9.06	–	0–2.5/1–37.5	*1.5*	*<0.001*
GAIN	429.74	39.98	439.06	58.72	0–900	330–510/295–510	−0.678	0.501
s-IAT	18.58	4.99	21.44	5.24	12–60	13–36/14–30	*199.5*	*0.047*
OGAS	7.11	0.51	13.50	3.69	7–35	7–10/9–21	*4.0*	*<0.001*
WoW-SPUQ	–	–	81.63	22.42	27–189	−/50–119	–	–
BIS-11 total	61.25	9.14	61.73	6.16	30–120	37–87/53–77	−0.187	0.852
BIS-11 attentional	16.61	3.55	17.06	3.38	8–32	10–25/10–22	−0.438	0.663
BIS-11 motor	21.08	3.93	21.80	3.97	11–44	12–31/17–29	−0.592	0.557
BIS-11 non-planning	23.97	4.16	23.31	2.70	11–44	13–35/17–27	0.584	0.562

Note: Mann-Whitney-U-Test was conducted for comparing the means of non-normally distributed variables. Results are depicted in italics in the table.

filled in by the WoW group only. Moreover, the Barratt Impulsivity Scale (BIS-11; Patton & Stanford, 1995; Cronbach's Alpha in the present sample was 0.85) was administrated as a measure of impulsivity (30 items are scored on a scale, ranging from 1 = "rarely/never" to 4 = "almost always/always"). With this scale, three second order factors can be assessed: attentional impulsivity is defined as an inability to focus attention or concentrate; motor impulsiveness involves acting without thinking, while non-planning impulsiveness involves a lack of "futuring" or forethought (Stanford et al., 2009). Internal consistencies for the subscales in the present study were 0.73, 0.69 and 0.69 respectively.

3.1.3. Procedure

The participants took part in a large longitudinal study to investigate biological factors next to psychological variables and their role for IGD. For the present study, only the data from the first measurement point was used to test and replicate the findings from study 1 (completing the Devil's chest experiment for a second time (T2) is clearly not comparable to being naïve with it as in study 1). The questionnaires and the experiment were completed in the same order as in study 1. Compared to study 1, however, in study 2 participants were paid the amount of money that they won in the "Devil's chest" experiment and they were informed about this fact prior to completing the experiment.

3.1.4. Statistical analyses

The data assessment was conducted analogously to study 1.

3.2. Results

The OGAS score and the online gaming hours per week were non-normally distributed in the groups of male and female control participants. Furthermore, the s-IAT score and age were non-normally distributed in the group of female control participants. The correlation between GAIN and the s-IAT score in the group of male WoW players was tested one-sided, based on the findings in study 1.

Descriptive statistics for control participants and WoW players are presented in Table 3. Here male and female control participants had significantly lower gaming experience, online gaming hours per week, and OGAS scores, compared to male and female WoW players (see Table 3). Moreover, female WoW players showed significantly higher scores on the s-IAT, compared to female control participants. All other variables did not differ significantly between control participants and the WoW players.

3.2.1. Correlation analyses

For the groups of male or female control participants, age of participants was not significantly correlated to GAIN, s-IAT or the OGAS score. All other correlations are presented in Table 4. Here, GAIN was not

Table 4
Spearman and Pearson correlations for the variables GAIN, s-IAT, OGAS and BIS-11 for the group of control participants, splitted in males and females.

	GAIN	s-IAT	OGAS	BIS-11 total	BIS-11 attentional	BIS-11 motor
Male participants						
GAIN	1					
s-IAT	−0.053	1				
OGAS	*0.238*	*0.139*	*1*			
BIS-11 total	0.020	0.248	*0.349**	1		
BIS-11 attentional	0.109	0.426**	*0.301*	0.866**	1	
BIS-11 motor	−0.064	0.094	*0.338**	0.843**	0.612**	1
BIS-11 non-planning	0.095	0.143	*0.198*	0.906**	0.707**	0.660**
Female participants						
GAIN	1					
s-IAT	*0.118*	*1*				
OGAS	*−0.088*	*0.257*	*1*			
BIS-11 total	−0.139	*0.232*	*0.156*	1		
BIS-11 attentional	0.161	*0.282*	*−0.022*	0.749**	1	
BIS-11 motor	−0.219	*0.201*	*0.292*	0.764**	0.312	1
BIS-11 non-planning	−0.138	*0.118*	*−0.119*	0.868**	0.531**	0.478**

Spearman correlations are depicted in *Italic*.
n(males) = 39, n(males, BIS-11) = 38, n(females) = 38, n(females, BIS-11) = 36.
** $p < 0.01$.
* $p < 0.05$.

Table 5
Spearman and Pearson correlations for the variables GAIN, s-IAT, OGAS, the WoW-SPUQ score and BIS-11 for the group of WoW players, splitted in males and females.

	GAIN	s-IAT	OGAS	WoW-SPUQ	BIS-11 total	BIS-11 attentional	BIS-11 motor
Male participants							
GAIN	1						
s-IAT	−0.296	1					
OGAS	−0.105	0.776**	1				
WoW-SPUQ	−0.313	0.688**	0.742**				
BIS-11 total	0.025	0.197	0.284	0.023	1		
BIS-11 attentional	0.054	−0.011	0.019	−0.219	0.658**	1	
BIS-11 motor	−0.038	0.170	0.231	0.187	0.761**	0.218	1
BIS-11 non-planning	0.033	0.220	0.312	0.027	0.892**	0.451*	0.521**
Female participants							
GAIN	1						
s-IAT	0.026	1					
OGAS	−0.024	−0.067	1				
WoW-SPUQ	−0.199	0.144	0.676**				
BIS-11 total	0.048	0.080	−0.614*	−0.157	1		
BIS-11 attentional	−0.139	0.194	−0.260	0.054	0.504	1	
BIS-11 motor	0.266	−0.013	−0.676**	−0.305	0.845**	0.170	1
BIS-11 non-planning	0.012	−0.166	0.057	0.256	0.420	−0.222	0.250

For male participants, the correlation between the GAIN in the experiment and the s-IAT score was tested one-sided.
n(males) = 28, n(males, BIS-11) = 27, n(females) = 16, n(females, BIS-11) = 15.
** $p < 0.01$.
* $p < 0.05$.

significantly linked neither to the s-IAT nor to the OGAS score for male and female participants. Furthermore, the s-IAT score was positively linked to the BIS-11 subscale attentional impulsiveness in male control participants. All significant correlations in Table 4 remained significant after the inspection of the BCa 95% confidence intervals.

For the group of male and female WoW players, age was not significantly correlated with GAIN, s-IAT, OGAS or the WoW-SPUQ score. All other correlations are presented in Table 5. Here, GAIN was negatively associated with the s-IAT, as well as the WoW-SPUQ score only in the group of male WoW players. However, these correlations only showed a trend towards significance ($r = -0.30$, $p = 0.063$, one-sided test and $r = -0.313$, $p = 0.104$, two-tailed test). All significant correlations remained significant after the inspection of the BCa 95% confidence intervals.

3.2.2. Manipulation check of the “Devil's chest” experiment as a measure of implicit learning

The results of the repeated measures ANOVA did not show a significant mean difference between the GAIN during the first 18 and the last 18 trials of the “Devil's chest” experiment in the group of male ($F(1, 38) = 1.949$, $p = 0.171$; M1 = 232.56 and M2 = 218.21) and female ($F(1, 37) = 0.594$, $p = 0.446$; M1 = 221.18 and M2 = 209.87) control participants. For the whole sample of control participants the results remained non-significant ($F(1,76) = 2.102$, $p = 0.151$), whereas in the whole sample of WoW players the results gained significance ($F(1,43) = 4.298$, $p = 0.044$) (see Fig. 3). For the group of male WoW players, the difference between trials 1–18 and 19–36 reached significance ($F(1,27) = 5.377$, $p = 0.028$, M1 = 235.54 and M2 = 205.54; hence with a lower outcome in M2 compared to M1), whereas for female WoW players it was non-significant ($F(1,15) = 0.295$, $p = 0.595$, M1 = 225.31 and M2 = 213.75).

3.3. Discussion

The aim of study 2 was to replicate the results of study one, by comparing WoW players and control participants. The negative correlations between GAIN and s-IAT and WoW-SPUQ scores showed a trend towards significance only in the group of male WoW players. However, the very small sample of male WoW

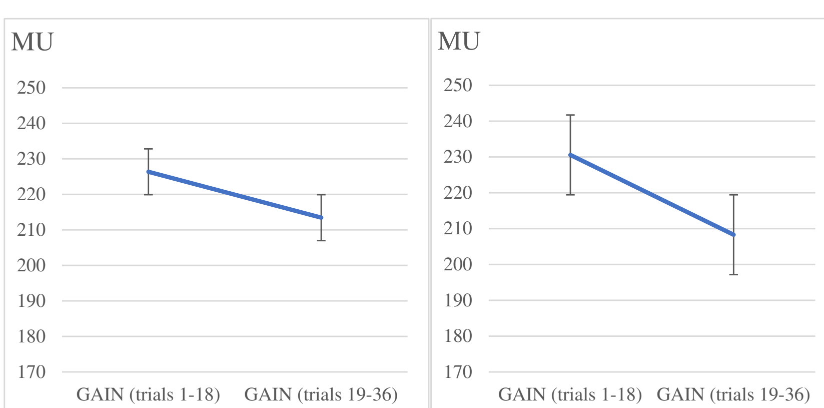

Fig. 3. Means and the standard error for the GAIN during the first 18 vs. the last 18 trials of the “Devil's chest” experiment, for control participants (left graph) and WoW-players (right graph). MU = monetary units.

players ($n = 28$) might deliver an explanation for the weaker effects. The manipulation check only showed a significant difference between the GAIN in the first and last 18 trials in the group of male WoW players, where participants showed lower gains in the second part of the experiment compared to the first part. We would like to remind the reader that participants in study 2 were paid the amount of money, which they won during the experiment and that they were aware of this fact before starting the experiment. Thus, in this case the extrinsic motivation of the participants might have been higher, compared to study 1. In fact, comparing the means of the GAIN between the Gamescom participants and the male WoW players, it is obvious that even though WoW-players did worse in the second part of the experiment, compared to the first part of the experiment, they still won more in total than male Gamescom participants (see Tables 1 and 3: $M = 413.61$ for Gamescom participants and $M = 443.04$ for male WoW players). Thus, in order to control for a potential interfering effect of motivation, we conducted an additional analysis, using the Unified-Motive-Scale-10 (UMS-10; Schönbrodt & Gerstenberg, 2012). The USM-10 data was available as a part of the bigger longitudinal study.

3.3.1. Additional analyses

In particular, we conducted a partial correlation with the variable achievement motivation (UMS-10; Schönbrodt & Gerstenberg, 2012, Cronbach's Alpha in the present study was 0.89), the s-IAT, WoW-SPUQ scores and the GAIN in study 2. The association between s-IAT and GAIN increased from $r = -0.296$, $p = 0.063$ (see Table 5; one-tailed test) to $r = -0.322$, $p = 0.054$ (one-tailed test). The association between WoW-SPUQ and GAIN also increased from $r = -0.313$, $p = 0.104$ (see Table 5; two-tailed test) to $r = -0.354$, $p = 0.082$ (two-tailed test). With respect to female WoW players and control participants, the correlations between the s-IAT, WoW-SPUQ score and GAIN remained non-significant after controlling for motivation.

4. Study 3

The focus of study 3 was to test the association between PIU, IGD and impulsivity/risk-taking by using both experimental and self-report measures.

4.1. Methods

4.1.1. Participants

After the exclusion of five participants with missing data and one participant due to responses out of the range (e.g. 200 h of computer gaming per week) the sample for the current study resulted in $N = 94$ participants (33 males). Most of them were psychology students at Ulm University, Ulm, Germany. The mean age of the total sample was $M = 23.48$ ($SD = 3.55$). Regarding their education, 27% reported having university or polytechnic degree, another 67% reported having A-level or vocational baccalaureate diploma, 6% of participants ($n = 6$) did not answer questions on their education.

4.1.2. Measures

The s-IAT (Pawlikowski et al., 2013; Cronbach's Alpha in the present sample was 0.81), the OGAS (modified version of the GAS by Lemmens et al., 2009; Cronbach's Alpha in the present sample was 0.81), BIS-11 (Patton & Stanford, 1995; Cronbach's Alpha in the present sample was 0.80) and the overall risk-taking (The German Socio-Economic Panel, SOEP; Siedler et al., 2008) were assessed. The internal consistencies for the BIS-11 subscales were as follows: attentional impulsiveness 0.70, motor impulsiveness 0.70 and non-planning impulsiveness 0.39. Furthermore, the “Devil's chest” experiment was slightly adjusted to measure impulsivity/risk-taking (compared to studies 1 and 2, here, the position of the “devil” was completely randomized among all of the trials, thus, learning was not possible). Here, the mean number of voluntarily opened boxes per trial (MNOB) was used as a measure of impulsivity/risk-taking. This is in line with the study by Eisenegger et al. (2010).

Table 6
Means, standard deviations (SD) and possible/actual range for the variables gaming experience (years), hours gaming per week, risk taking (self-report), s-IAT, OGAS, BIS-11 and MNOB.

	Mean	SD	Possible range	Actual range
Gaming expertise (years)	6.31	6.51	–	0–21
Online gaming hours per week	0.56	1.86	–	0–15
Risk taking (self-report)	5.10	1.82	0–10	1–9
s-IAT	22.99	5.71	12–60	12–42
OGAS	8.00	2.05	7–35	7–18
BIS-11 total	61.37	9.17	30–120	44–84
BIS-11 attentional	16.54	3.47	8–32	10–28
BIS-11 motor	21.68	4.33	11–44	14–35
BIS-11 non-planning	23.15	3.45	11–44	17–32
MNOB	4.90	0.79	0–10	3.22–7.5

4.1.3. Procedure

The questionnaires and the experiment were completed in the same order as in studies 1 and 2, however, here participants filled in the questionnaires on a computer screen. In this study participants received compensation (Amazon voucher or course credits) for their participation in the study, but they were not paid the particular amount of money, that they won in the computer experiment. Participants were informed about this procedure prior to completing the experiment.

4.1.4. Statistical analyses

The statistical analyses were conducted analogously to studies 1 and 2.

4.2. Results

Of note, the variables online gaming hours per week and the OGAS score were not normally distributed. Descriptive statistics are reported in Table 6. Participants had some expertise in gaming in terms of gaming expertise in years, but the actual time spent on online gaming is very low. Analog to study 2, here we compared, if male and female participants differed regarding the variables, depicted in Table 6. Significant differences were observed with the variables gaming expertise (years) ($U_{(33,61)} = 385.0$, $p < 0.001$), online gaming hours per week ($U_{(33,61)} = 663.5$, $p < 0.001$), risk-taking (self-report) ($U_{(33,61)} = 732.0$, $p < 0.05$) and OGAS ($U_{(33,61)} = 562.5$, $p < 0.001$), where male participants scored higher than female participants.

4.2.1. Correlation analyses

Age was correlated with the OGAS score ($\rho = 0.24$, $p < 0.05$). The correlation between MNOB with the OGAS score also reached significance ($\rho = 0.21$, $p < 0.05$). After controlling for age, the correlation between MNOB and the OGAS score increased to $r = 0.37$, $p < 0.01$ ($r = 0.45$, $p < 0.05$ in males and $r = 0.28$, $p < 0.05$ in females). All other correlations are presented in Table 7.

4.2.2. Manipulation check of the “Devil's chest” experiment as a measure of impulsivity/risk-taking:

MNOB was positively correlated to the BIS-11 score of the participants (see Table 7), therefore the current measure is clearly associated with impulsive behavior. There was no significant correlation between MNOB and the self-report measure of overall risk-taking (see Table 7).

Table 7
Spearman and Pearson correlations for the variables MNOB, risk taking (self-report), s-IAT, OGAS and BIS-11.

	MNOB	Risk taking (self-report)	s-IAT	OGAS	BIS-11 total	BIS-11 attentional	BIS-11 motor
MNOB	1						
risk taking (self-report)	0.086	1					
s-IAT	0.115	−0.124	1				
OGAS	*0.209**	*0.092*	*0.235**	*1*			
BIS-11 total	0.316**	0.458**	0.150	*0.283***	1		
BIS-11 attentional	0.284**	0.196	0.345**	*0.296***	0.770**	1	
BIS-11 motor	0.236*	0.576**	−0.018	*0.261**	0.847**	0.443**	1
BIS-11 non-planning	0.257*	0.299**	0.075	*0.148*	0.821**	0.487**	0.551**

Note: Spearman correlations are depicted in italics.
** $p < 0.01$.
* $p < 0.05$.

Analogously to studies 1 and 2, we compared the GAIN in the first and last 18 trials to rule out the role of learning effects. No significant differences could be found for male ($F(1,32) = 2.365$, $p = 0.134$, $M_1 = 219.24$ and $M_2 = 235.61$) or female participants ($F(1,60) = 0.155$, $p = 0.695$, $M_1 = 224.02$ and $M_2 = 220.57$). The results for the whole sample also did not gain significance ($F(1,93) = .265$, $p = 0.608$) (see Fig. 4).

5. General discussion

In the following, a summary of the results of studies 1, 2 and 3 is provided along with a discussion on their contribution to the field.

In study 1, higher s-IAT scores were associated with worse performance on the implicit learning task among male participants, with a proneness to IGD. The OGAS score of the participants, however, was not significantly associated with the variable GAIN (although there was a trend towards significance). In study 2 we aimed at replication of results of study 1 in a group of WoW players and control participants. Here, the gender of the participants was also taken into consideration. High s-IAT scores, as well as high WoW-SPUQ scores showed a trend towards low GAIN in the experiment only in the group of male WoW gamers ($r = -0.322$, $p = 0.054$, one-sided test and $r = -0.354$, $p = 0.082$, two-tailed test, respectively). The OGAS score was again not linked to GAIN in neither of the groups. In study 3, in a student sample, the experimental measure of risk taking, MNOB, was positively linked to the OGAS score, but not the s-IAT score, after controlling for age.

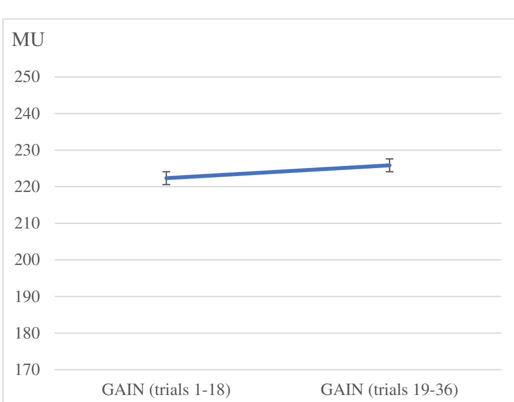

Fig. 4. Means and the standard error for the GAIN in the first 18 trials vs. the GAIN in the last 18 trials of the "Devil's chest" experiment. MU = monetary units.

To sum up, it seems, that excessive use of the Internet is associated with deficiencies in implicit learning abilities. This association was observed with the s-IAT scores and the WoW-SPUQ score, but not OGAS scores in the current study. Existing literature delivers results supporting both: deficits in decision-making among problematic Internet users (e.g. Sun et al., 2009), as well as among excessive online gamers (e.g. Yao et al., 2014). Moreover, recently a new theoretical model I-PACE (Interaction of Person-Affect-Cognition-Execution) was proposed by Brand et al. (2016), which highlights the role of reduced executive functioning and impaired decision making for the development of specific PIU. The stronger effect found for the WoW-SPUQ score, compared to the OGAS score might reflect the choice of a more specific measurement to assess WOW addiction. However, further investigations are needed.

The fact that the association between PIU and reduced implicit learning ability in the present study was found only in the group of male participants with (proneness to) IGD (study 1 and 2) might further help explain the in part conflicting results on the relation between decision making and PIU in the literature (e.g. Ko et al., 2010; Sun et al., 2009). This association, however, seems plausible as studies suggest that IGD is primarily a male kind of addiction (e.g. Rumpf et al., 2011).

Considering Hypothesis 3, some significant associations could be found between impulsivity, measured with BIS-11, and PIU/IGD (studies 2 and 3), which is consistent with findings in the literature (e.g. Lee et al., 2012). Whereas the self-report measure of risk-taking (SOEP) was not linked to PIU/IGD in neither of the studies, the experimental measure of risk-taking/impulsivity was associated with the OGAS score (study 3), but not with the s-IAT score. This particular difference might be due to issues, concerning the reliability of the measures. While self-reported risk-taking was assessed with a single item, the experimental measure of risk-taking is expected to deliver objective and reliable data. With regard to the association between MNOB and the OGAS score, the Devil's chest experiment (version 2, where the boxes were completely randomized over the 36 trials) might cover a more specific side of impulsivity (like risk-taking), which better characterizes IGD than generalized PIU. However, Ko et al. (2010) showed no difference in risk-taking (measured with the BART) between Internet addicted subjects with a tendency towards IGD and control participants. Thus, this association needs further investigation.

The manipulation check of the "Devil's chest" experiment to measure implicit learning was successful in study 1, thus, we assume that participants could implicitly extract and learn strategies to gain more money throughout the experiment. However, in study 2 no significant difference could be observed between the gain in trials 1–18 and 19–36 with the exception of the group of male WoW players, where participants showed lower gains in the second part of the experiment. Here, we showed in additional analyses that after controlling for achievement motivation, the negative association between GAIN and the s-IAT/

WOW-SPUQ score got stronger. Hence, we suggest that in study 2 the implicit learning effect was overshadowed by the effects of achievement motivation, since participants were payed the amount of money that they won in the experiment. At this point, it needs to be noted that UMS-10 measures trait achievement motivation, thus, the tendency to be motivated towards bigger achievements in general, and not a state, thus, the motivation to win more in this particular experiment. However, by controlling for UMS-10 achievement motivation, we considered the role of individual differences in trait motivation for the performance in the Devil's chest task within the sample.

The validation of the second version of the "Devil's chest" experiment to measure risk taking/impulsivity, showed that the mean number of voluntarily opened boxes (MNOB) was not significantly linked to the self-report measure of risk-taking. This might be due to the fact that the SOEP assesses general risk taking with only one item, which in turn might have a negative influence on its reliability. However, MNOB was associated with the total BIS-11 score, as well as the subscales attentional, motor and non-planning impulsivity. These results are consistent with validation studies on similar behavioral measures of risk-taking like the BART (Lejuez et al., 2002).

In the following, some of the strengths and limitation of the presented research will be discussed. One strength of the present investigation is that the role of gender was taken into consideration. Even though gender differences have been described in the context of IGD and PIU (Rumpf et al., 2011), not many investigations have particularly assessed the role of gender when examining the association between PIU/IGD and implicit learning/risk taking, as in the present study. Moreover, in study 2 the group of WoW players was recruited, using strict criteria, and not by simply applying a cut-off value in a self-report questionnaire such as the OGAS. The use of a cut-off value is problematic, since many of the cut-offs, used in studies, are sometimes arbitrarily chosen and have not been appropriately validated in a clinical setting. Last, in studies 1 to 3 we assessed both PIU and IGD, which allows to further examining the similarities and unique characteristics of both disorders.

Limitations include the low number of participants per group, especially in study 2, and participants' low age. Thus, future studies should examine more representative samples. Second, a comparison group of excessive Internet users, who were non-WoW players, was not included. Furthermore, the results of the study are based on correlational analyses, thus, no interpretations about causality are possible.

6. Conclusion

In sum, we were able to show that PIU is robustly associated with poor implicit learning abilities in male (WoW) gamers. This finding could be observed in two independent samples in the present study. Furthermore, a little bit weaker association between WOW-SPUQ and deficient implicit learning could be observed in the group of male WoW players. Moreover, higher scores on the OGAS were associated with higher tendencies for risk-taking behavior in study 3. The gender specific effect in studies 1 and 2 were further discussed in the study.

Role of funding sources

Christian Montag is awarded a Heisenberg-grant by the German Research Foundation (MO 2363/3-1). Furthermore, the present study is funded by a research grant on Internet and computer gaming addiction awarded to Christian Montag by the German Research Foundation (MO 2363/2-1). The German Research Foundation had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

Contributors

CM and RS designed the study. RS, BL and CM recruited and tested the participants. RS conducted the analyses and wrote the manuscript. BL double checked the statistical analyses and reviewed the manuscript. SM programmed the experimental tasks (versions 1 and 2) and gave a thorough feedback on the manuscript, after reviewing it. MR reviewed the manuscripts critically. All authors contributed to and have approved the final manuscript.

Acknowledgements

We thank Ralf Reichert from Turtle Entertainment for giving us the chance to conduct our experiment at the GamesCom 2013. However, Turtle Entertainment did not make any profit or have an influence on the execution of the study.

We also would like to thank Maximilian Sieber and Otilia Pasnicu, who recruited and tested the participants for study 3 as part of their Bachelor theses.

References

American Psychiatric Association. Diagnostic and statistical manual of mental disorders 5th ed., (text rev., retrieved September 7th, 2016). http://www.dsm5.org/Pages/Default.aspx

Bechara, A., Dolan, S., Denburg, N., Hindes, A., Anderson, S. W., & Nathan, P. E. (2001). Decision-making deficits, linked to a dysfunctional ventromedial prefrontal cortex, revealed in alcohol and stimulant abusers. *Neuropsychologia*, *39*(4), 376–389.

Brand, M., Labudda, K., & Markowitsch, H. J. (2006). Neuropsychological correlates of decision-making in ambiguous and risky situations. *Neural Networks*, *19*(8), 1266–1276.

Brand, M., Young, K. S., Laier, C., Wölfling, K., & Potenza, M. N. (2016). Integrating psychological and neurobiological considerations regarding the development and maintenance of specific internet-use disorders: An interaction of person-affect-cognition-execution (I-PACE) model. *Neuroscience & Biobehavioral Reviews*, *71*, 252–266.

Cao, F., Su, L., Liu, T., & Gao, X. (2007). The relationship between impulsivity and internet addiction in a sample of Chinese adolescents. *European Psychiatry*, *22*(7), 466–471.

Davis, R. A. (2001). A cognitive-behavioral model of pathological internet use. *Computers in Human Behavior*, *17*(2), 187–195.

Eisenegger, C., Knoch, D., Ebstein, R. P., Gianotti, L. R., Sándor, P. S., & Fehr, E. (2010). Dopamine receptor D4 polymorphism predicts the effect of L-DOPA on gambling behavior. *Biological Psychiatry*, *67*(8), 702–706.

Epstein, S. (2003). Cognitive experiential self-theory of personality. In T. Millon, & M. J. Lerner (Eds.), *Handbook of psychology* (pp. 159–184) (5th ed.). Hoboken: Wiley.

Internet live stats (2016). Internet Users in the World. Retrieved September 7th from http://www.internetlivestats.com/internet-users/

Ko, C. H., Yen, J. Y., Chen, C. C., Chen, S. H., & Yen, C. F. (2005). Gender differences and related factors affecting online gaming addiction among taiwanese adolescents. *The Journal of Nervous and Mental Disease*, *193*(4), 273–277 (doi:00005053-200504000-00008 [pii]).

Ko, C. H., Hsiao, S., Liu, G., Yen, J., Yang, M., & Yen, C. (2010). The characteristics of decision making, potential to take risks, and personality of college students with internet addiction. *Psychiatry Research*, *175*(1), 121–125.

Kreek, M. J., Nielsen, D. A., Butelman, E. R., & LaForge, K. S. (2005). Genetic influences on impulsivity, risk taking, stress responsivity and vulnerability to drug abuse and addiction. *Nature Neuroscience*, *8*(11), 1450–1457.

Laier, C., Pawlikowski, M., & Brand, M. (2014). Sexual picture processing interferes with decision-making under ambiguity. *Archives of Sexual Behavior*, *43*(3), 473–482.

Lee, H. W., Choi, J., Shin, Y., Lee, J., Jung, H. Y., & Kwon, J. S. (2012). Impulsivity in internet addiction: A comparison with pathological gambling. *Cyberpsychology, Behavior and Social Networking*, *15*(7), 373–377.

Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., Stuart, G. L., ... Brown, R. A. (2002). Evaluation of a behavioral measure of risk taking: The balloon analogue risk task (BART). *Journal of Experimental Psychology: Applied*, *8*(2), 75–84.

Lemmens, J. S., Valkenburg, P. M., & Peter, J. (2009). Development and validation of a game addiction scale for adolescents. *Media Psychology*, *12*(1), 77–95.

Miles, J., & Shevlin, M. (2001). *Applying regression and correlation: A guide for students and researchers*. Sage.

Moeller, F. G., Barratt, E. S., Dougherty, D. M., Schmitz, J. M., & Swann, A. C. (2001). Psychiatric aspects of impulsivity. *American Journal of Psychiatry*, *158*(11), 1783–1793.

Montag, C., Bey, K., Sha, P., Li, M., Chen, Y., Liu, W., ... Keiper, J. (2015). Is it meaningful to distinguish between generalized and specific internet addiction? Evidence from a cross-cultural study from Germany, Sweden, Taiwan and China. *Asia-Pacific Psychiatry*, *7*(1), 20–26.

Patton, J. H., & Stanford, M. S. (1995). Factor structure of the barratt impulsiveness scale. *Journal of Clinical Psychology*, *51*(6), 768–774.

Pawlikowski, M., & Brand, M. (2011). Excessive internet gaming and decision making: Do excessive world of warcraft players have problems in decision making under risky conditions? *Psychiatry Research*, *188*(3), 428–433.

Pawlikowski, M., Altstötter-Gleich, C., & Brand, M. (2013). Validation and psychometric properties of a short version of Young's internet addiction test. *Computers in Human Behavior*, *29*(3), 1212–1223.

Peters, C. S., & Malesky, L. A., Jr. (2008). Problematic usage among highly-engaged players of massively multiplayer online role playing games. *Cyberpsychology & Behavior*, *11*(4), 481–484.

Rumpf, H., Meyer, C., Kreuzer, A., John, U., & Merkeerk, G. (2011). *Prävalenz der internetabhängigkeit (PINTA). Bericht an Das Bundesministerium Für Gesundheit. Greifswald Und Lübeck. 31*. (12ff).

Schiebener, J., & Brand, M. (2015). Decision making under objective risk conditions–a review of cognitive and emotional correlates, strategies, feedback processing, and external influences. *Neuropsychology Review*, *25*(2), 171–198.

Schoenbaum, G., Roesch, M. R., & Stalnaker, T. A. (2006). Orbitofrontal cortex, decision-making and drug addiction. *Trends in Neurosciences*, *29*(2), 116–124.

Schönbrodt, F. D., & Gerstenberg, F. X. (2012). An IRT analysis of motive questionnaires: The unified motive scales. *Journal of Research in Personality*, *46*(6), 725–742.

Siedler, T., Schupp, J., Spiess, C. K., & Wagner, G. G. (2008). The german socio-economic panel as a reference data set. *Schmollers Jahrbuch*, *129*(2), 367–374.

Stanford, M. S., Mathias, C. W., Dougherty, D. M., Lake, S. L., Anderson, N. E., & Patton, J. H. (2009). Fifty years of the Barratt impulsiveness scale: An update and review. *Personality and Individual Differences*, *47*(5), 385–395.

Sun, D., Chen, Z., Ma, N., Zhang, X., Fu, X., & Zhang, D. (2009). Decision-making and prepotent response inhibition functions in excessive internet users. *CNS Spectrums*, *14*(02), 75–81.

Tao, R., Huang, X., Wang, J., Zhang, H., Zhang, Y., & Li, M. (2010). Proposed diagnostic criteria for internet addiction. *Addiction*, *105*(3), 556–564.

Yao, Y., Chen, P., Chen, C., Wang, L., Zhang, J., Xue, G., ... Fang, X. (2014). Failure to utilize feedback causes decision-making deficits among excessive internet gamers. *Psychiatry Research*, *219*(3), 583–588.

Yao, Y. W., Wang, L. J., Yip, S. W., Chen, P. R., Li, S., Xu, J., ... Fang, X. Y. (2015). Impaired decision-making under risk is associated with gaming-specific inhibition deficits among college students with Internet gaming disorder. *Psychiatry Research*, *229*(1), 302–309.

Young, K. S. (1996). Psychology of computer use: XL. Addictive use of the internet: A case that breaks the stereotype. *Psychological Reports*, *79*(3), 899–902.

Young, K. S. (1998a). *Caught in the net: How to recognize the signs of internet addiction—and a winning strategy for recovery*. John Wiley & Sons.

Young, K. S. (1998b). Internet addiction: The emergence of a new clinical disorder. *Cyberpsychology & Behavior*, *1*(3), 237–244.