FULL-LENGTH REPORT

Journal of Behavioral Addictions 5(4), pp. 666–673 (2016)
DOI: 10.1556/2006.5.2016.075
First published online October 24, 2016

Using two web-based addiction Stroops to measure the attentional bias in adults with Internet Gaming Disorder

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(Received: July 26, 2016; accepted: October 1, 2016)

Background and aims: People with substance abuse and pathological gamblers show an attentional bias. In a laboratory setting, we found an attentional bias using an addiction Stroop in adults with Internet Gaming Disorder (IGD). We aimed at investigating this effect using two web-based experiments. *Methods:* Study 1: Gamers with IGD, casual gamers, and non-gamers ($N = 81$, 28.1 ± 7.8 years) completed a web-based addiction Stroop with a fully randomized word order. They saw computer-related and neutral words in four colors and indicated the word color via keypress. Study 2: Gamers with IGD, casual gamers, and non-gamers ($N = 87$, 23.4 ± 5.1 years) completed a web-based addiction Stroop and a classical Stroop (incongruent color and neutral words), which both had a block design. We expected that in both studies, only the gamers with IGD would react more slowly to computer-related words in the addiction Stroop. All groups were expected to react more slowly to incongruent color words in the classical Stroop. *Results:* In neither study did the gamers with IGD differ in their reaction times to computer-related words compared to neutral words. In Study 2, all groups reacted more slowly to incongruent color words than to neutral words confirming the validity of the online reaction time assessment. *Discussion:* Gamers with IGD did not show a significant attentional bias. IGD may differ from substance abuse and pathological gambling in this respect; alternatively experimenting on the Internet may have introduced error variance that made it harder to detect a bias.

Keywords: attentional bias, Internet Gaming Disorder, addiction Stroop, Stroop

INTRODUCTION

With a market value of 75.3 billion US dollars in 2015, the gaming industry has surpassed the movie industry (Statista, 2016). About 1.78 billion people worldwide regularly play Internet games (Statista, 2015). Most of them play casually, but 0.2–8.7% (Choo et al., 2010; Festl, Scharkow, & Quandt, 2013) of the general population in different countries develop an Internet Gaming Disorder (IGD). They are preoccupied with games, feel restless, moody or sad when unable to play, develop a tolerance, are unable to reduce their gaming, loose interest in other recreational activities, play despite interpersonal conflicts or lack of sleep, lie about the amount of gaming they engage in, play games to escape personal problems, and jeopardise important relationship or career opportunities (American Psychiatric Association, 2013).

There are similarities between IGD and Substance Use Disorder, as well as Gambling Disorder, with regard to symptoms, comorbidities, genetics, responses to treatments, neurobiological mechanisms, and attentional processes (Brand & Laier, 2013; Yau & Potenza, 2015; Zhang et al., 2016).

People with Substance Use Disorder and pathological gamblers display an attentional bias: they direct more attention toward addiction-related stimuli than to other stimuli (Field & Cox, 2008; Hønsi, Mentzoni, Molde, & Pallesen, 2013). Attentional biases may develop because of classical conditioning (Field & Cox, 2008). The co-occurrence of the unconditioned substance with the formerly neutral stimulus results in the neutral stimulus becoming a conditioned stimulus. The conditioned response consists of an attentional orientation toward the stimulus, craving, physiological arousal, and substance-seeking behavior.

A modified version of the classical Stroop and the addiction Stroop can be used to measure attentional bias. In the classical Stroop, participants see an incongruent color word (e.g., the word "blue" printed in red) or a neutral word in one of several font colors and identify the font color (MacLeod, 1991). They generally display the Stroop interference effect and react more slowly to incongruent color words. Since reading is highly automatic and hard to suppress, the processing of the semantic content of the color words interferes with naming the incongruent font color. In the addiction Stroop, participants see an addiction-related or a neutral word and indicate its font color (Field & Cox, 2008). An attentional bias manifests itself in slower reaction times to addiction-related stimuli because the processing of the addiction-related meaning takes up limited attentional

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resources that are then unavailable for the color-naming task. Cox, Fadardi, and Pothos (2006) point to the importance of keeping basic characteristics of addiction-related and neutral words identical (number of letters, syllables, and frequency in the language) so that differences in reaction times do not stem from any differences in these aspects. Addiction-related and neutral words should both form a category.

A few studies have investigated attentional bias in people with IGD, with mixed results. Gamers displayed an attentional bias toward gaming stimuli in two experiments (Lorenz et al., 2013; Metcalf & Pammer, 2011), but not in two others (Van Holst et al., 2012). Jeromin, Nyenhuis, and Barke (2016) extended these findings and found that in an addiction Stroop, gamers with IGD show an attentional bias not only toward gaming stimuli but also toward computer stimuli in general.

All of these studies were conducted in laboratory settings, which may increase internal, but decrease external validity. Web-based experiments have the advantages of having higher external validity, accessibility to a large and diverse audience (Denissen, Neumann, & van Zalk, 2010), and can be used to recruit clinical samples with small prevalence rates, such as people with IGD.

We conducted two web-based studies and tested the following hypotheses:

1. Gamers with IGD react more slowly to computer-related words compared to neutral words in a web-based addiction Stroop with a randomized word design.
2. Gamers with IGD react more slowly to computer-related words compared to neutral words in a web-based addiction Stroop with a block design.
3. All participants react more slowly to incongruent color words compared to neutral words in a web-based classical Stroop.

GENERAL METHODS

Sampling and procedure

For each study, an invitation to participate and a link to the Internet experiment (LimeSurvey, Hamburg, Germany) were placed in forums and on social network sites. On the first page of the surveys, the participants were informed that their answers would be anonymous. They provided informed consent to participate by clicking a button. The participants answered questions concerning age and sex, filled in the Ishihara test (Ishihara Farbtafel, 2009), and the German version of the Compulsive Internet Use Scale (CIUS) (Peukert et al., 2012). Study 2 was conducted after the criteria for IGD were published in the Diagnostic and Statistical Manual of Mental Disorders, version 5 (American Psychiatric Association, 2013). Therefore, participants also filled in the German version of the Internet Gaming Disorder Questionnaire (IGDQ) (Jeromin, Rief, & Barke, 2016). Following this, they took part in the addiction Stroop and the classical Stroop (Study 2 only). The valence and the familiarity of the words used in the addiction Stroop were rated on 9-point scales (1 = *very unpleasant* or *very unfamiliar* and 9 = *very pleasant* or *very familiar*). Once they had completed the survey, participants received personal feedback with their reaction times and errors. By following a link that ensured anonymity, they could provide their e-mail addresses to take part in a draw for one of ten €20 gift vouchers for an online store.

Measures

Compulsive Internet Use Scale. The German version of the CIUS (Peukert et al., 2012) measures excessive Internet use with 14 items (e.g., "How often do you use the Internet when you are feeling down?"). The gamers were asked to refer to their Internet gaming usage. The items were rated on a 5-point scale (0 = *never* and 4 = *very often*). Higher scores indicate more compulsive use. The CIUS has good internal consistency with Cronbach's α ranging from .86 to .90 (Barke, Nyenhuis, Voigts, Gehrke, & Kröner-Herwig, 2013; Meerkerk, Van Den Eijnden, Vermulst, & Garretsen, 2009; Peukert et al., 2012).

Internet Gaming Disorder Questionnaire. The German version of the IGDQ (Jeromin, Rief, et al., 2016) measures IGD with 9-items (e.g., "Do you game to escape from or forget about personal problems, or to relieve uncomfortable feelings such as guilt, anxiety, helplessness, or depression?"). The items reflect the DSM5 criteria for IGD and the answer format is dichotomous (*yes*/*no*). The number of affirmative answers is counted and the cutoff score for diagnosing IGD is 5-points (Petry et al., 2014). This measure has moderate-to-good internal consistency with a Cronbach's α of .79 (Jeromin, Rief, et al., 2016).

Ishihara test. The Ishihara test (Ishihara Farbtafel, 2009) was used to ensure normal color vision prior to the Stroop tasks. It measures color vision with six test plates that show green and red dots that form numbers. People with normal color vision are able to identify the numbers correctly.

Statistical analysis

Statistica (version 12, StatSoft, Tulsa, USA) and SPSS (version 22, IBM, Armonk, USA) were used for the analysis. For each study, the age and the hours of recreational computer use of the groups (gamers with IGD/casual gamers/non-gamers) were analyzed with one-way analysis of variance (ANOVA). Independent *t*-tests were conducted to compare the hours of gaming per week and per session, the years of gaming, and the CIUS score between the two groups of gamers. If the assumption of homogeneity of variances was violated, Welch's *t*-test is reported. The reaction times, the number of errors, and the number of missed responses in the addiction Stroop and in the classical Stroop (only Study 2), as well as the valence and the familiarity of the stimuli in the addiction Stroop, were analyzed using 3×2 mixed design ANOVAs with the between-subjects factor group (gamers with IGD/casual gamers/non-gamers) and the within-subjects factor word type (addiction Stroop: computer-related/neutral words; classical Stroop: color/neutral words). Only correct responses were included in the analyses of the reaction time. Response times shorter than 200 ms were excluded from the analysis because they were deemed to result from slow reactions to the previous word (Whelan, 2008). Bonferroni's post-hoc tests were calculated for all significant effects in the ANOVAs. The significance value was set to $p < .05$ and Cohen's d and η^2 (Levine & Hullett, 2002) are reported as measures of effect sizes.

Ethics

The study procedures were carried out in accordance with the Declaration of Helsinki. The Institutional Review Board of the Philipps-University Marburg approved the study. All subjects were informed about the study and all provided informed consent.

STUDY 1

Methods

Participants. A total of 2,740 people provided informed consent and were screened for IGD. Of these, 663 (24.2%) people failed to fulfill the inclusion criteria (383 were excluded because they were younger than 18 years, 128 were excluded because their native language was not German, and 152 were excluded because the Ishihara test revealed that they were unable to discriminate colors). A further 1,519 (55.4%) people left the website without finishing the study. Six (0.2%) were excluded because they failed to provide serious information (e.g., by stating that they played Internet games for 168 hr a week). Three (0.1%) were excluded from the analysis, because they pressed the wrong keys and/or missed more than 30% of all trials in the addiction Stroop; we assumed that they had failed to understand the task correctly.

The remaining sample consisted of 549 participants (270 gamers and 279 non-gamers). Twenty-seven gamers (10%) were classified as having IGD (CIUS score of at least 29). Three groups were formed for the analysis: 27 gamers with IGD, 27 casual gamers (CIUS score of 6 or less), and 27 non-gamers (CIUS score of 6 or less and did not play any Internet games). The casual gamers and non-gamers were selected randomly from the sample but the groups were matched for sex.

Addiction Stroop. The task was programmed with JavaScript (version 1.8.5, Netscape, Mountain View, USA). Reaction times, pressed keys, and missed targets were saved as log files and imported into statistical software. Prior to the experiment, the participants familiarized themselves with the task in a practice using 40 animal words. For the experiment, subjects saw 20 computer-related words (e.g., monitor) and 20 neutral words belonging to the category office (e.g., pencil). Neutral and computer-related words had equal frequencies in the German language (Institut fuer Deutsche Sprache, 2009) and the same number of letters and syllables. Each word was presented twice in red, yellow, green, and blue, resulting in 320 stimuli overall. The order of words and colors was fully randomized. After the first 160 stimuli, the participants were able to take a self-timed break. Each trial lasted 1,000 ms, after which the next word appeared automatically. The words were presented in the center of the screen against a gray background. The participants were instructed to place their fingers on the keys "a," "s," "k," and "l" and to press the key corresponding to the color as quickly as possible (the keys were chosen to be conveniently located for the finger placement). Once a key was pressed, a white fixation cross appeared for the remainder of the trial.

Results

Demographics and Internet usage. Each group consisted of 70.4% males. With regard to age, the one-way ANOVA yielded a main effect for group, $F(2, 78) = 4.84$, $p = .010$, $\eta^2 = .110$. Bonferroni's post-hoc test showed that the non-gamers were older than the gamers with IGD and the casual gamers, but the two groups of gamers did not differ in their age. The one-way ANOVA revealed that the groups did not differ with regard to their recreational Internet use apart from gaming, $F(2, 78) = 1.17$, $p = .315$ (see Table 1 for details).

Gaming usage. The games most played were World of Warcraft with 39.5%, League of Legends with 6.2%, and Guild Wars with 4.9%. Gamers with IGD played more each week than the casual gamers, their individual playing sessions lasted longer and their CIUS score was higher. The groups did not differ regarding the length of time they had been playing Internet games (see Table 2 for details).

Addiction Stroop. The 3 × 2 mixed design ANOVA did not yield a main effect for group, $F(2, 78) = 2.86$, $p = .063$, word type, $F(1, 78) = 2.36$, $p = .129$, or an interaction, $F(2, 78) = 0.19$, $p = .828$ (see Figure 1 for details).

The participants pressed the wrong key in 8.6% of all trials and missed a word in 6.1% of all trials. With regard to errors, the 3 × 2 mixed design ANOVA did not

Table 1. Descriptive statistics for the gamers with IGD, the casual gamers, and the non-gamers in Study 1

	Gamers with IGD		Casual gamers		Non-gamers	
	Male	Female	Male	Female	Male	Female
Sex	19	8	19	8	19	8
	M	*SD*	*M*	*SD*	*M*	*SD*
Age (years)	24.9	7.4	28.3	7.4	31.2	7.7
Recreational Internet usage apart from gaming (hr/week)	19.7	23.2	14.3	16.9	12.7	11.1

Table 2. Characteristics of the gamers with IGD and the casual gamers regarding their gaming usage in Study 1

	Gamers with IGD		Casual gamers					
	M	*SD*	*M*	*SD*	*t*	*df*	*p*	*d*
Gaming time (hr/week)	22.9	15.6	11.2	7.1	3.528[a]	36.5	.001	0.965
Duration of gaming sessions (hr)	3.9	2.8	2.7	1.3	2.100[a]	36.2	.043	0.550
Years of gaming	4.8	1.9	4.5	2.7	0.480[a]	46.9	.633	–
CIUS score	33.4	3.3	4.4	1.6	41.424[a]	37.1	<.001	11.183

[a]Welch's *t*-test.

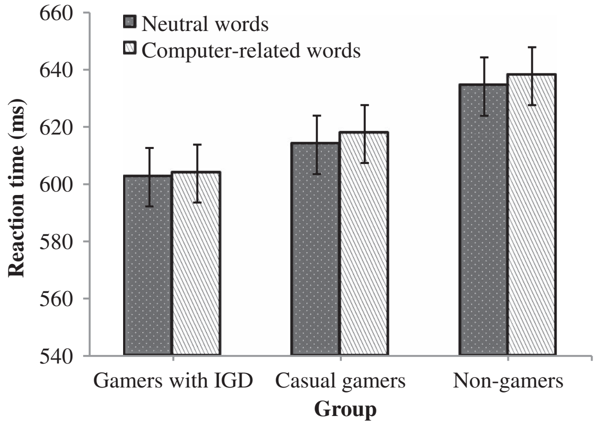

Figure 1. Mean reaction times (±SE) to neutral and computer-related words in the addiction Stroop in Study 1

show a main effect for group, $F(2, 78) = 0.001$, $p = .999$, word type, $F(1, 78) = 0.78$, $p = .381$, or an interaction, $F(2, 78) = 0.34$, $p = .714$. The analysis of missed words with a 3 × 2 ANOVA did not yield a main effect for group, $F(2, 78) = 0.24$, $p = .787$, word type, $F(1, 78) = 0.93$, $p = .339$, or an interaction, $F(2, 78) = 0.76$, $p = .472$.

Valence and familiarity. With regard to valence, the 3 × 2 mixed design ANOVA showed a main effect for word type, $F(1, 78) = 23.89$, $p < .001$, $\eta^2 = .128$ and an interaction, $F(2, 78) = 4.64$, $p = .013$, $\eta^2 = .050$. Bonferroni's post-hoc tests revealed that the gamers with IGD rated computer-related words more positive than neutral words. There was no main effect for group, $F(2, 78) = 0.26$, $p = .769$ (see Figure 2 for details).

With regard to familiarity, the 3 × 2 mixed design ANOVA yielded a main effect for word type, $F(1, 78) = 13.44$, $p < .001$, $\eta^2 = .046$, indicating that all of the groups were more familiar with computer-related than with neutral words. There was no main effect for group, $F(2, 78) = 1.06$, $p = .351$, or an interaction, $F(2, 78) = 2.67$, $p = .076$ (see Figure 2 for details).

Discussion

In Study 1, gamers with IGD did not differ in their reaction times to computer-related words compared to neutral words in an addiction Stroop and did not display an attentional bias. This result contrasts with a study by Jeromin, Nyenhuis, et al. (2016), where the same addiction Stroop was used and an attentional bias was detected in gamers with IGD. Waters, Feyerabend, Paton, and Petroskey (2000) found that smokers displayed an attentional bias in an addiction Stroop when alternating blocks of neutral and smoking-related words were used, but not when the word order was randomized. In order to eliminate this possible effect of the Stroop design, we repeated the experiment in Study 2 and used an addiction Stroop with a block design. Furthermore, to investigate whether experimenting on the Internet may have influenced the reaction times and prevented us from detecting a bias, we also included a classical Stroop, since the Stroop interference is a robust and well-established effect (MacLeod, 1991).

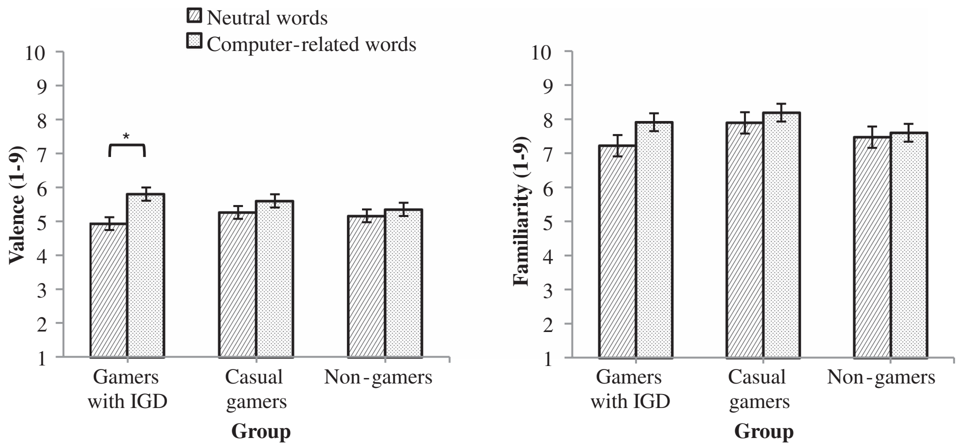

Figure 2. Valence and familiarity ratings (±SE) of neutral and computer-related words in the addiction Stroop in Study 1. Brackets indicate significant post-hoc tests, *$p < .001$

STUDY 2

Methods

Participants. A total of 2,872 people provided informed consent and were screened for IGD. Of these, 722 (25.1%) did not fulfill the inclusion criteria (374 were excluded because they were younger than 18 years, 160 were excluded because their native language was not German, and 188 were excluded because the Ishihara test revealed that they were unable to discriminate colors). A further 1,451 (50.5%) people left the website without finishing the study. Seven (0.2%) were excluded because they failed to provide serious information. Six (0.2%) were excluded from the analysis because they pressed the wrong key and/or missed more than 30% of all trials in at least one of the Stroop tasks. The final sample consisted of 686 participants (544 gamers and 142 non-gamers). Twenty-nine gamers (5.3%) fulfilled five or more criteria and were classified as having IGD. Three groups were formed for the analysis: 29 gamers with IGD, 29 casual gamers (who fulfilled zero criteria for IGD), and 29 non-gamers (who fulfilled zero criteria for IGD and did not play any Internet games). The casual gamers and non-gamers were selected randomly from the sample. Since all gamers with IGD were male, we selected only males for the other two groups.

Addiction Stroop. We used the same addiction Stroop as in Study 1 but with a block design. Two blocks with computer-related and two blocks with neutral words were presented in alternating order; each block lasted 48 s. There were 12 words per block, each shown in four colors, resulting in 192 trials overall. The block with which the participants began, and the order of words within the blocks, were randomized.

Classical Stroop. The timing and block structure of the classical Stroop were the same as in the addiction Stroop. The only difference was the word types used. There were two blocks with color words ("red," "blue," "green," and "yellow") presented in incongruent colors and two blocks with numeral words ("zero," "five," "nine," and "eleven"). The color words were shown four times in three incongruent colors per block (e.g., the word "red" was shown in blue, green, and yellow, but not in red). The numeral words were shown three times in four colors per block (e.g., "zero" shown in red, blue, green, and yellow). This resulted in 192 trials overall. Both categories of words were adjectives and had the same number of syllables, letters, and equal frequencies in the German language (Institut fuer Deutsche Sprache, 2009).

Results

Demographics and Internet usage. All participants were male. With regard to age, the one-way ANOVA did not yield a main effect for group, $F(2, 84) = 0.01$, $p = .989$. In respect of the recreational Internet use, apart from gaming, the one-way ANOVA did not reveal a main effect for group, $F(2, 84) = 1.74$, $p = .182$ (see Table 3 for details).

Gaming usage. World of Warcraft with 69%, Call of Duty with 17.2%, and FIFA with 10.3% were the games most played. Gamers with IGD played more each week than the casual gamers, their individual playing sessions lasted longer and their CIUS score was higher. The groups did not differ in the length of time they had been playing Internet games (see Table 4 for details).

Addiction Stroop. The 3 × 2 mixed design ANOVA did not yield a main effect for group, $F(2, 84) = 0.10$, $p = .904$, word type, $F(1, 84) = 0.36$, $p = .548$, or an interaction, $F(2, 84) = 2.15$, $p = .123$ (see Figure 3 for details).

The participants pressed the wrong key in 9.5% of all trials and missed a word in 5.7% of all trials. With regard to errors, the 3 × 2 mixed design ANOVA did not show a main effect for group, $F(2, 84) = 2.87$, $p = .063$, word type, $F(1, 84) = 1.07$, $p = .305$, or an interaction, $F(2, 84) = 0.87$,

Table 3. Descriptive statistics for the gamers with IGD, the casual gamers, and the non-gamers in Study 2

	Gamers with IGD		Casual gamers		Non-gamers	
	Male	Female	Male	Female	Male	Female
Sex	29	0	29	0	29	0
	M	*SD*	*M*	*SD*	*M*	*SD*
Age (years)	23.3	5.3	23.3	5.3	23.5	4.9
Recreational Internet usage apart from gaming (hr/week)	18.4	21.8	11.8	10.8	19.3	15.7

Table 4. Characteristics of the gamers with IGD and the casual gamers regarding their gaming usage in Study 2

	Gamers with IGD		Casual gamers					
	M	*SD*	*M*	*SD*	*t*	*df*	*p*	*d*
Gaming time (hr/week)	25.2	20.2	10.3	7.8	3.722[a]	36.2	.001	0.973
Duration of gaming sessions (hr)	4.9	3.8	2.8	2.3	2.630[a]	46.5	.012	0.669
Years of gaming	11.8	4.7	11.2	4.9	0.491[a]	55.8	.625	–
CIUS score	29.0	11.3	12.1	6.9	6.866[a]	46.3	<.001	1.805

[a]Welch's *t*-test.

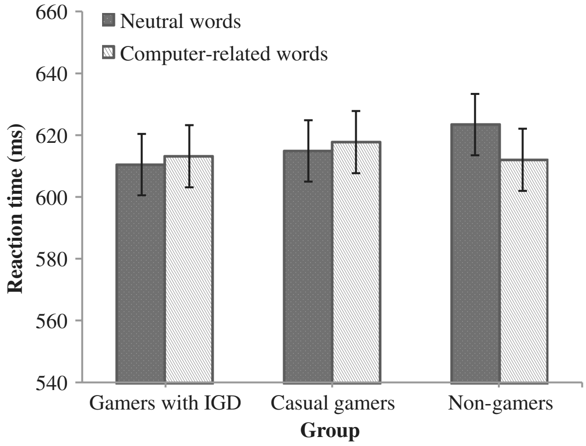

Figure 3. Mean reaction times (±SE) to neutral and computer-related words in the addiction Stroop in Study 2

$p = .424$. The analysis of missed words with a 3×2 ANOVA did not yield a main effect for group, $F(2, 84) = 1.97$, $p = .146$, word type, $F(1, 84) = 0.04$, $p = .836$, or an interaction, $F(2, 84) = 1.50$, $p = .229$.

Valence and familiarity. With regard to valence, the 3×2 mixed design ANOVA showed a main effect for word type, $F(1, 84) = 25.94$, $p < .001$, $\eta^2 = .128$ and an interaction, $F(2, 84) = 6.43$, $p = .003$, $\eta^2 = .64$. Bonferroni's post-hoc tests revealed that the gamers with IGD rated computer-related words more positive than neutral words. There was no main effect for group, $F(2, 78) = 2.03$, $p = .138$ (see Figure 4 for details).

With regard to familiarity, the 3×2 mixed design ANOVA yielded a main effect for word type, $F(1, 84) = 17.64$, $p < .001$, $\eta^2 = .072$, and an interaction, $F(2, 84) = 4.6$, $p = .012$, $\eta^2 = .038$. Bonferroni's post-hoc tests revealed that the gamers with IGD were more familiar with computer-related than with neutral words. There was no main effect for group, $F(2, 84) = 1.57$, $p = .214$ (see Figure 4 for details).

Classical Stroop. The 3×2 mixed design ANOVA did not yield a main effect for group, $F(2, 84) = 0.85$, $p = .431$, or an interaction, $F(2, 84) = 0.53$, $p = .593$. There was a main effect for word type, $F(1, 84) = 41.34$, $p < .001$, $\eta^2 = .144$, indicating that all groups reacted more slowly to incongruent colour words compared to neutral words (see Figure 5 for details).

The participants pressed the wrong key in 11.6% of all trials and missed a word in 7.8% of all trials. With regard to errors, the 3×2 mixed design ANOVA did not show a main effect for group, $F(2, 84) = 0.87$, $p = .423$, word type, $F(1, 84) = 1.29$, $p = .260$, or an interaction, $F(2, 84) = 0.70$, $p = .499$. The analysis of missed words with a 3×2 ANOVA did not yield a main effect for group, $F(2, 84) = 0.23$, $p = .797$, or an interaction, $F(2, 84) = 0.51$, $p = .600$. There was a main effect for word type, $F(1, 84) = 69.92$, $p < .001$, $\eta^2 = .450$, indicating that all groups missed more incongruent colour words than neutral words.

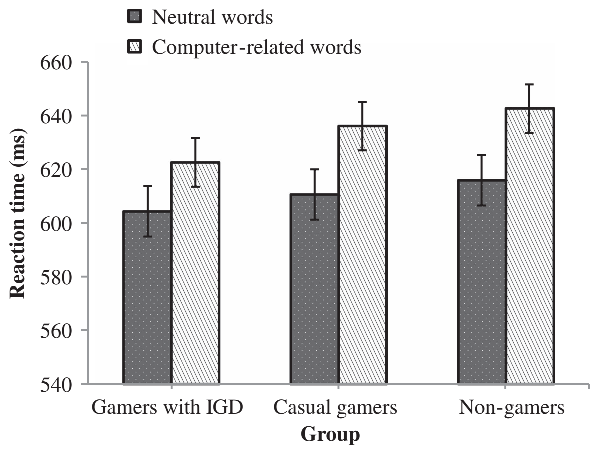

Figure 5. Mean reaction times (±SE) to neutral and computer-related words in the classical Stroop in Study 2

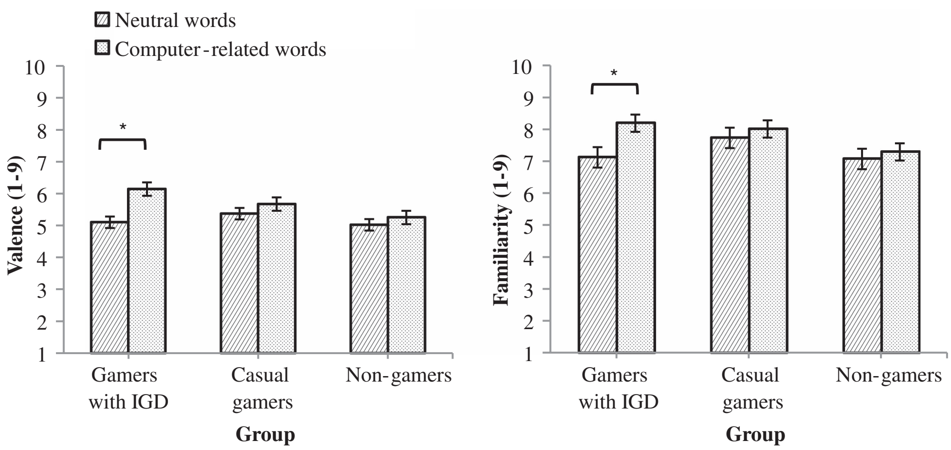

Figure 4. Valence and familiarity ratings (±SE) of neutral and computer-related words in the addiction Stroop in Study 2. Brackets indicate significant post-hoc tests, $*p < .001$

Discussion

In Study 2, gamers with IGD did not differ in their reaction times to computer-related words compared to neutral words in an addiction Stroop with a block design and did not display an attentional bias. Hence, using a block design instead of one with a randomized word order did not change the result. However, the participants displayed the interference effect in a classical Stroop task: they reacted more slowly to incongruent color words compared to neutral words. This indicates that our web-based experiments were a valid set-up for detecting reaction time differences and that our participants took the task seriously.

SUMMARY AND CONCLUDING DISCUSSION

This is one of the few experimental studies with gamers with IGD. Our aim was to replicate Jeromin, Nyenhuis, et al.'s (2016) study using a larger sample that consisted of gamers from the general population. In so doing, we used addiction Stroops with a randomized and a block design to investigate the attentional bias in gamers with IGD. In neither design was a bias detected. In Study 2, all participants displayed the interference effect in a classical Stroop.

The studies reported here employed the same words as our previous study (Jeromin, Nyenhuis, et al., 2016), in which an attention bias was found; the main difference between the studies being the mode of administration (laboratory vs. Internet). Therefore, it is important to consider whether we failed to find an attentional bias in gamers with IGD due to the web-based experimental design. Internet experiments may increase error variance because some variables that are under control in the laboratory (e.g., distractions and time of day) cannot be controlled in an online setting, making it harder to detect a bias. In the web-based Stroops, the participants reacted 28–31 ms more slowly than in the laboratory. However, in the classical Stroop, the participants displayed the Stroop interference effect indicating that experimenting online generally works. However, this may be limited to large effects – the classical Stroop effect is very robust and had a large effect size ($\eta^2 = .144$).

In web-based experimenting, one also has less control over whether the instructions are correctly understood and the task undertaken seriously. However, this does not appear to have been a problem in the present study: the participants pressed the wrong key in only 8.6–9.5% of all trials and missed a word in 5.7–6.1%. This is comparable to what we found in the laboratory with 10.2% faulty and 6.2% missing trials (Jeromin, Nyenhuis, et al., 2016).

Furthermore, was the design of the addiction Stroop at fault? Using a block design rather than a randomized word design may facilitate the detection of a bias (Waters et al., 2000). However, employing a block design in Study 2 did not change the negative result. The stimuli for the Stroop task were carefully selected according to the recommendations of Cox et al. (2006). There were no low-level differences between neutral and computer-related words that could have influenced reaction times. Only gamers with IGD, but not casual gamers, displayed a higher valence for computer-related words in both studies. This shows that computers are regarded as more positive by gamers who are playing excessively and this supports the stimulus selection. It is important that all groups are familiar with both categories of words; otherwise, the differing familiarity could influence reaction times (Cox et al., 2006). This was the case in the present studies.

The dropout rate is comparable to other Internet studies: 50.5–55.4% of the participants left the website without finishing the study. In a survey of dropout rates, Musch and Reips (2000) reported that between 1% and 87% of the samples terminated prematurely.

This leads us to the conclusion that the failure to find an attentional bias with regard to computer-related words is not the result of experimental limitations, but has to be taken seriously. A computer is regularly paired with gaming and, according to the theory (Field & Cox, 2008), it should become a conditioned stimulus giving rise to an attentional bias. However, gamers probably use their computers not only for gaming but also for countless other activities (e.g., watching films, working, and chatting). Therefore, the connection between a computer and the gaming experience may not be exclusive and predictive enough for a computer to become a conditioned stimulus and result in an attentional bias. Using an addiction Stroop with gaming-related words, Metcalf and Pammer (2011) found an attentional bias in gamers with IGD, whereas Van Holst et al. (2012) failed to do so. Gaming-related words may be less frequent in the language than potential control words and less familiar to the control group, both of which can influence reaction times.

To conclude, results from two web-based addiction Stroops provided evidence that gamers with IGD do not display a significant attentional bias. Further studies should follow this up and employ more direct measures, such as eye tracking.

Funding sources: No financial support was received for this study.

Authors' contribution: FJ and AB designed the study. WR contributed to the design. FJ and AB conducted the statistical analyses. FJ wrote the first draft of the manuscript and all authors contributed to and approved the final manuscript. All authors had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Conflict of interest: The authors declare no conflict of interest.

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