Philipps Universität Marburg

Aufmerksamkeitsbias bei Personen mit einer Störung durch Spielen von Internetspielen

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Zusammenfassung

Die diagnostischen Kriterien für die Störung durch Spielen von Internetspielen (SSIS) basieren auf denen für die Störung durch Glücksspielen und Störungen durch Substanzkonsum. Es stellt sich die Frage, ob den Störungen auch vergleichbare aufrechterhaltende Mechanismen zugrunde liegen wie beispielsweise Entzugssymptome, eine Toleranzentwicklung oder ein Aufmerksamkeitsbias. Ein Aufmerksamkeitsbias manifestiert sich in einer verstärkten Aufmerksamkeitslenkung auf suchtbezogene Stimuli und ist ein robuster Befund bei Personen mit Abhängigkeiten und exzessiven Glücksspielern. In der vorliegenden Dissertation wurde untersucht, ob Personen mit einer SSIS einen Aufmerksamkeitsbias in Bezug auf computerbezogene Stimuli zeigen.

In Studie 1 wurden die Gütekriterien eines Fragebogens zur Erfassung der SSIS anhand einer Stichprobe deutschsprachiger Internetspieler[1] überprüft. Der *Internet Gaming Disorder Questionnaire* wies eine akzeptable interne Konsistenz und eine eindimensionale Faktorenstruktur auf.

In Studie 2 wurde bei pathologischen Internetspielern und Nichtspielern der Aufmerksamkeitsbias in Bezug auf Computerstimuli mithilfe eines Suchtstroops und einer Visual Probe untersucht. In beiden Paradigmen wurde mithilfe von Reaktionszeiten indirekt auf einen Aufmerksamkeitsbias geschlossen. Im Suchtstroop sahen die Probanden computerbezogene und neutrale Wörter in randomisierter Wortfolge. Die pathologischen Internetspieler zeigten einen Aufmerksamkeitsbias; sie reagierten langsamer auf die computerbezogenen als auf die neutralen Wörter. In der Visual Probe sahen die Probanden computerbezogene und neutrale Bilder. Es wurde kein Aufmerksamkeitsbias gefunden; die pathologischen Internetspieler reagierten genauso schnell auf die computerbezogenen wie auf die neutralen Bilder. Die Studie wurde im Labor durchgeführt und es nahmen Studierende teil.

Die Studien 3A und 3B wurden im Internet durchgeführt, um Studie 2 mit einer größeren und heterogeneren Stichprobe zu replizieren. In beiden Studien wurde bei Internetspielern mit einer SSIS, Internetspielern ohne eine SSIS und Nichtspielern der Aufmerksamkeitsbias in Bezug auf Computerstimuli mithilfe eines Suchtstroops untersucht. In Studie 3A zeigten Personen mit einer SSIS in einem Suchtstroop mit randomisierter Wortfolge keinen Aufmerksamkeitsbias. In Studie 3B wurde in einem Suchtstroop mit Blockdesign ebenfalls

[1]Aus Gründen der besseren Lesbarkeit wird auf die gleichzeitige Verwendung männlicher und weiblicher Sprachformen verzichtet. Sämtliche Personenbezeichnungen gelten gleichermaßen für beide Geschlechter.

kein Bias gefunden. Alle Probanden in Studie 3B zeigten den Interferenzeffekt in einem Farbstroop; sie reagierten langsamer auf Farbwörter in einer inkongruenten Schriftfarbe als auf neutrale Wörter.

Um zu überprüfen, ob die unterschiedlichen Ergebnisse in den Studien 2 und 3A sowie B auf die verschiedenen Durchführungsmodalitäten zurückgingen, wurde in Studie 4 die Äquivalenz von Reaktionszeitmessungen im Labor und im Internet mithilfe eines Farbstroops untersucht. Psychologiestudierende der Universität Marburg wurden im psychologischen Institut randomisiert auf zwei Gruppen aufgeteilt. Sie nahmen im Labor (Gruppe 1) oder an einem Ort ihrer Wahl über das Internet teil (Gruppe 2). Studierende anderer Fachrichtungen an unterschiedlichen Universitäten (Gruppe 3) und Personen aus der Allgemeinbevölkerung (Gruppe 4) nahmen ebenfalls an einem Ort ihrer Wahl über das Internet teil. Alle Gruppen zeigten den Stroop-Interferenzeffekt. Die Gruppen 3 und 4 hatten äquivalente Reaktionszeiten zu denen von Gruppe 1. Gruppe 2 reagierte langsamer und ihre Ergebnisse waren nicht äquivalent zu jenen von Gruppe 1. Möglicherweise waren die Probanden weniger motiviert als die in den anderen Gruppen, da sie unbeabsichtigt einen höheren Zeitaufwand hatten.

In drei von vier Experimenten wurde keine Evidenz für den Aufmerksamkeitsbias bei Personen mit einer SSIS gefunden. Zwei davon wurden im Internet durchgeführt, was die Ergebnisse beeinflusst haben könnte. In Studie 4 wurden jedoch im Internet weitgehend äquivalente Reaktionszeiten zu denen im Labor gemessen. Die Experimente nutzten Reaktionszeiten als indirektes Maß für den Aufmerksamkeitsbias. Der Aufmerksamkeitsbias sollte in Studien mit direkten Maßen wie Blickbewegungsmessungen oder Elektroenzephalographie weiter untersucht werden.

Abstract

The diagnostic criteria for Internet Gaming Disorder (IGD) are based on those for Gambling Disorder and Substance Use Disorders. The question arises whether these disorders also share features in the maintenance such as an abstinence phenomenon, a development of tolerance or an attentional bias. An attentional bias manifests itself in an increased attention towards stimuli that are associated with a disorder and is a robust finding in people with addictions and excessive gamblers. In this dissertation it was investigated whether persons with an IGD would show an attentional bias towards computer-related stimuli.

In study 1, the reliability and validity of a questionnaire that assesses IGD was investigated in a sample of German-speaking Internet gamers. The *Internet Gaming Disorder Questionnaire* had an acceptable internal consistency and a unidimensional factorial structure.

In study 2, it was investigated whether pathological Internet gamers and non-gamers would show an attentional bias towards computer stimuli using an addiction Stroop and a visual probe. In both paradigms, reaction times served as an indirect indicator of an attentional bias. In the addiction Stroop, the participants saw computer-related and neutral words in a randomized word order. The pathological Internet gamers displayed an attentional bias in the addiction Stroop; they reacted more slowly to computer-related compared to neutral words. In the visual probe, the participants saw computer-related and neutral pictures. The visual probe did not result in an attentional bias; the pathological Internet gamers reacted exactly as fast to computer-related as to neutral pictures. The study was conducted in a laboratory and students took part.

To replicate study 2 with a bigger and more heterogeneous sample, studies 3A and 3B were carried out on the Internet. In both studies, the attentional bias towards computer stimuli was examined in Internet gamers with an IGD, Internet gamers without an IGD, and non-gamers using an addiction Stroop. In study 3A, the persons with IGD did not display an attentional bias in an addiction Stroop with a randomized word order. In study 3B, they also did not display the bias in an addiction Stroop with a block design. All participants in study 3B showed the interference effect in a colour Stroop task; they reacted more slowly to colour words in an incongruent font colour than to neutral words.

To investigate whether the different results in study 2, 3A, and B deemed from the varying implementation modalities, the equivalence of reaction times measured in the laboratory and on the Internet was investigated using a colour Stroop task in study 4. Psychology students of the University of Marburg were randomized into two groups at the

psychological institute. They took part in the laboratory (group 1) or at a place of their choice via the Internet (group 2). Persons studying different subjects at other universities (group 3) and people from the general population (group 4) also took part at a place of their choice via the Internet. All groups displayed the Stroop interference effect. The reaction times of group 3 and 4 were equivalent to those of group 1. Group 2 reacted more slowly and their results were not equivalent to those of group 1. Possibly, the participants were less motivated than those in the other groups because they inadvertently had a higher expenditure of time.

Three out of four experiments did not provide evidence for an attentional bias in people with an IGD. Two of those were conducted on the Internet which might have influenced the results. However, study 4 showed that the reaction times measured on the Internet were mostly equivalent to those obtained in the laboratory. All experiments used reaction times as an indirect measure for the attentional bias. The attentional bias should be investigated further with more direct measures such as eye tracking or electroencephalography.

Theoretischer und empirischer Hintergrund

Internetspiele

2016 nutzten 34.3 Millionen Menschen in Deutschland regelmäßig Internetspiele (Statista, 2017). Im Gegensatz zu Glücksspielen, geht es in Internetspielen nicht darum, reales Geld zu gewinnen (Yau & Potenza, 2015), sondern in einer virtuellen Welt zu kämpfen, Städte zu erobern oder Rätsel zu lösen (Elliott, Golub, Ream & Dunlap, 2012; Metcalf & Pammer, 2013). Internetspiele haben jedoch, ähnlich wie Glücksspiele, ein großes Suchtpotenzial, da die Spieler durch ein operantes Anreizsystem im Spiel intermittierend positiv verstärkt werden (Rehbein, Kleimann & Mößle, 2009). Zudem ist es im Spiel einfacher als im realen Leben, Erfolge zu erzielen und in der anonymen Spielwelt können sich Personen selbstbewusster, stärker oder attraktiver darstellen. Die am häufigsten vertretenen Spielgenres lassen sich durch die in Tabelle 1 dargestellten Eigenschaften charakterisieren, es gibt mittlerweile jedoch auch Mischformen. In einem Massenspiel sind tausende Spieler über einen Server verbunden und befinden sich in einer gemeinsamen Spielwelt (Barnett & Coulson, 2010). Mehrspieler bedeutet, dass Personen nicht gegen den Computer spielen, sondern gegen andere Spieler. Teilweise ist eine Kooperation mit anderen Personen sogar notwendig, um erfolgreich zu sein (Cole & Griffiths, 2007). Hierzu schließen sich viele Spieler zu dauerhaften Gruppen zusammen, den sogenannten Gilden oder Klans. In einigen bestehen Regeln bezüglich der Zeit, die jedes Mitglied mindestens ins Spiel zu investieren hat. In Rollenspielen geht es unter anderem darum, eine Spielfigur, den Avatar oder Champion, weiterzuentwickeln und mit neuen Fähigkeiten oder Ausrüstungsgegenständen zu versehen (Barnett & Coulson, 2010). Teilweise besteht eine hohe Identifikation mit der über Jahre verwendeten Spielfigur (Bessière, Seay & Kiesler, 2007). Ausschließlich die *Massively multiplayer online role-playing games* (*MMORPG*) sind persistent, was bedeutet, dass sich das Spielgeschehen in Echtzeit weiter entwickelt, auch wenn eine Person gerade nicht eingeloggt ist und spielt. Spieler können daher das Gefühl bekommen, bedeutsame Entwicklungen zu verpassen, wenn sie länger nicht spielen. Zudem enden MMORPG niemals, da es kein höchstes Level und keine letzte Schlacht gibt (Ng & Wiemer-Hastings, 2005). Dies führt dazu, dass Spieler immer mehr Zeit investieren (van Rooij, Schoenmakers, Vermulst, van den Eijnden & van de Mheen, 2011). In *Egoshootern*, einer Sonderform der Shooter, sehen Personen die Spielwelt aus der Ichperspektive, was den Eindruck vermitteln soll, sich physisch in der Spielwelt zu befinden (Elliott et al., 2012).

Tabelle 1

Eigenschaften der verschiedenen Internetspielgenres

	Action-Adventure	MMORPG	Shooter	Simulation	Strategie
Beispielhafte Aufgaben	Kämpfen, Rätsel lösen	Kämpfen, Rätsel lösen	Kämpfen	Bauen, Sport	Kämpfen, erobern
Massenspiel	Nein	Ja	Nein	Nein	Nein
Mehrspieler	Möglich	Ja	Möglich	Nein	Nur MOBA
Spielgruppen	Nein	Ja	Ja	Nein	Teilweise
Rollenspiel	Teilweise	Ja	Nein	Teilweise	Teilweise
Persistenz	Nein	Ja	Nein	Nein	Nein
Endlosigkeit	Nein	Ja	Nein	Nein	Nein
Ichperspektive	Nein	Nein	Nur Egoshooter	Nein	Nein
Plattform	Computer, Konsole	Computer	Computer, Konsole	Computer, Konsole	Computer
Beispiel	Tomb Raider (Square Enix, Tokio, Japan)	World of Warcraft (Activision Blizzard, Santa Monica, USA)	Counter Strike (Electronic Arts, Redwood City, USA)	Die Sims 4 (Electronic Arts, Redwood City, USA)	League of Legends (Riot Games, Los Angeles, USA)

Anmerkung. MMORPG (Massively multiplayer online role-playing games), MOBA (Multiplayer online battle arena).

Aufgrund der oben genannten Charakteristika stellen MMORPG ein besonders großes Risiko für den pathologischen Gebrauch dar. Das Spielen von MMORPG ist ein Prädiktor für die Entwicklung der Störung durch Spielen von Internetspielen (SSIS) (Rehbein, Kleimann & Mössle, 2010). Eine experimentelle Studie von Smyth (2007) zeigte darüber hinaus, dass MMORPG zu negativeren Auswirkungen führen als andere Spielformen. Symth teilte Studierende randomisiert einer Spielart zu (Glücksspiel, Action-Adventure oder MMORPG).

Er instruierte sie, einen Monat lang so viel zu spielen, wie sie wollten, aber mindestens eine Stunde pro Woche. MMORPG-Nutzer spielten mehr und zeigten im Anschluss einen schlechteren allgemeinen Gesundheitszustand, geringere Schlafqualität und mehr negative Auswirkungen des Spiels auf ihr Studium und ihre Freundschaften als die anderen Probanden.

Störung durch Spielen von Internetspielen

Exzessives Internetspielen hängt mit psychosozialen Problemen zusammen wie zum Beispiel nachlassender Leistung im beruflichen oder akademischen Kontext bis hin zum Schulabbruch und Arbeitsplatzverlust, Vernachlässigung anderer Freizeitbeschäftigungen oder Beziehungen außerhalb des Spiels, interpersonellen Konflikten, Einsamkeit und Schlafstörungen (Batthyány, Müller, Benker & Wölfling, 2009; Chen & Tzeng, 2010; Chiu, Lee & Huang, 2004; Griffiths, Davies & Chappell, 2004; Hellström, Nilsson, Leppert & Slund, 2012; Jeong & Kim, 2011; Lemmens, Valkenburg & Peter, 2011; Liu & Peng, 2009; Lo, Wang & Fang, 2005; Peng & Liu, 2010; Rehbein et al., 2010; Rehbein, Kliem, Baier, Mößle & Petry, 2015; Shen & Williams, 2011; Skoric, Teo & Neo, 2009; Van Rooij, Kuss, Griffiths, Shorter & van de Mheen, 2013; van Rooij et al., 2011).

Die SSIS wurde erstmalig in den Anhang der fünften Ausgabe des *Diagnostischen und Statistischen Manuals Psychischer Störungen* (*DSM-5*) als vorläufige Diagnose mit weiterem Forschungsbedarf aufgenommen (American Psychiatric Association, 2013). Bei der Störung führt das Spielen von Internetspielen zu klinisch bedeutsamen Beeinträchtigungen und Leiden. Die Kriterien sind orientiert an jenen für Störungen durch Substanzkonsum und die Störung durch Glücksspielen (Petry et al., 2014). Fünf der folgenden neun Kriterien müssen zwölf Monate lang erfüllt sein, um die Diagnose zu stellen: Übermäßige Beschäftigung mit Internetspielen, Entzugssymptome, Entwicklung von Toleranz, Unfähigkeit, mit dem Spielen aufzuhören oder es zu verringern, Aufgabe anderer Hobbies und Aktivitäten zugunsten des Spielens, Fortsetzung des Spielens trotz damit einhergehender psychosozialer Probleme, Lügen über das Ausmaß des Spielens, Spielen, um negativer Stimmung zu entgehen (Eskapismus) und Gefährdung oder Verlust einer wichtigen Beziehung, der Arbeit oder der Ausbildung aufgrund des Spielens (American Psychiatric Association, 2013). Es wird im DSM-5 darauf hingewiesen, dass die Bezeichnung Internetspiele auch solche mit einschließt, die offline gespielt werden können.

Bisherige Studien nutzten unterschiedliche Kriterien und Fragebögen, um die SSIS zu erfassen (King, Haagsma, Delfabbro, Gradisar & Griffiths, 2013). Dies erschwerte Vergleiche und führte zu uneinheitlichen Prävalenzraten zwischen 0.2% und 8.7% in verschiedenen

Ländern (Choo et al., 2010; Festl, Scharkow & Quandt, 2013). In Deutschland lag die Punktprävalenz bei Schülern der neunten Klassen bei 1.2% (Rehbein et al., 2015). Obwohl die SSIS nicht nur im Kindes-, sondern auch im Erwachsenenalter auftritt (Beutel, Hoch, Wölfling & Müller, 2011), liegen für andere Altersgruppen zum gegenwärtigen Zeitpunkt noch keine repräsentativen Studien vor, in welchen die neun DSM-5 Kriterien genutzt wurden.

Aufmerksamkeitsbias

Ein Aufmerksamkeitsbias ist ein robuster Befund bei Personen mit einer Störung durch Substanzkonsum (Cox, Fadardi & Pothos, 2006; Leeman, System, Haven, Robinson & Waters, 2014; Robbins & Ehrman, 2004) oder einer Störung durch Glücksspielen (Hønsi, Mentzoni, Molde & Pallesen, 2013). Er äußert sich in einer verstärkten Aufmerksamkeitslenkung auf suchtbezogene Reize. Field und Cox (2008) zufolge entsteht er durch klassische Konditionierung. Ein zunächst neutraler Stimulus (NS, beispielsweise eine Zigarettenschachtel) tritt häufig in der Umgebung eines unkonditionierten Stimulus (US, beispielsweise Nikotin) auf. Der NS wird so zum konditionierten Stimulus (CS), welcher körperliche Erregung und Verlangen nach dem US hervorruft. Da der CS den US vorhersagt, ist er besonders salient und zieht die Aufmerksamkeit auf sich. Der Aufmerksamkeitsbias spielt eine Rolle in der Aufrechterhaltung von Süchten. Wenn Personen mit einer Störung durch Substanzkonsum oder Glücksspielen suchtbezogene Reize verstärkt wahrnehmen, verspüren sie Verlangen nach der Droge respektive dem Verhalten (Field, Munafò & Franken, 2009), was wiederum zu erneutem Konsum führt und Abstinenz erschwert (Cox, Hogan, Kristian & Race, 2002). Der Aufmerksamkeitsbias war in Langzeitstudien ein Prädiktor für zukünftigen Substanzkonsum bei Personen mit Alkoholabhängigkeit (Janssen, Larsen, Vollebergh & Wiers, 2015) Kokainabhängigkeit (Marhe, Luijten, van de Wetering, Smits & Franken, 2013) und Nikotinabhängigkeit (Powell, Dawkins, West, Powell & Pickering, 2010). Ein Training zur Modifikation des Aufmerksamkeitsbias, bei welchem Patienten mit Alkoholsucht trainierten, ihre Aufmerksamkeit von suchtbezogenen Stimuli zu lösen, verlängerte ihre Abstinenzzeit im Vergleich zu Patienten, die ein Placebotraining erhielten (Schoenmakers et al., 2010).

Der Aufmerksamkeitsbias kann entweder direkt mithilfe von Blickbewegungsmessungen oder Elektroenzephalographie oder indirekt durch Experimente mit Reaktionszeitmessungen untersucht werden (Field & Cox, 2008). Die am häufigsten verwendeten indirekten Paradigmen sind der Suchtstroop und die Visual Probe.

Der Suchtstroop ist eine Weiterentwicklung des klassischen Farbstroops (Stroop, 1935). Bei letzterem werden den Personen einzelne Wörter in verschiedenen Farben gezeigt und ihre Aufgabe ist es, die Schriftfarbe zu benennen. Dabei handelt es sich um Farbwörter in einer inkongruenten Schriftfarbe (z. B. das Wort „grün" in gelber Schriftfarbe) sowie neutrale Wörter. Lesen ist ein automatisierter Prozess und schwer zu unterdrücken (MacLeod, 1991). Das Lesen der Farbwörter interferiert mit dem Benennen einer abweichenden Schriftfarbe, sodass sich die Reaktionszeiten im Vergleich zu den neutralen Wörtern verlangsamen. Beim Suchtstroop werden den Personen mit einer Störung durch Substanzkonsum oder Glücksspielen suchtbezogene und neutrale Wörter in verschiedenen Farben gezeigt, verbunden mit der Instruktion, die Schriftfarbe per Tastendruck anzugeben (Cox et al., 2006). Ein Aufmerksamkeitsbias manifestiert sich in einer *langsameren* Reaktionszeit bei den suchtbezogenen Wörtern, da man davon ausgeht, dass die Personen den semantischen Gehalt der für sie salienten Wörter verarbeiten. Dies interferiert dann mit der eigentlichen Aufgabe, der Benennung der Schriftfarbe. Es ist wichtig, dass sich die suchtbezogenen und neutralen Wörter nicht in grundlegenden Eigenschaften wie Silben- und Buchstabenanzahl oder Häufigkeit in der Sprache unterscheiden, damit alle Unterschiede in den Reaktionszeiten auf den semantischen Gehalt der Wörter zurückzuführen sind (Cox et al., 2006). Da die suchtbezogenen Wörter eine inhaltliche Kategorie bilden, sollte dies auch bei den neutralen Wörtern der Fall sein.

Eine weitere Möglichkeit, den Aufmerksamkeitsbias zu erfassen, ist die Visual Probe, welche auf einem anderen Rational beruht. Bei der Visual Probe werden ein suchtbezogenes und ein neutrales Bild nebeneinander auf einem Monitor präsentiert (Field & Cox, 2008). Anschließend erscheint ein leerer Bildschirm und daraufhin ein Zielreiz an der vorherigen Position eines der Bilder. Die Probanden sollen mit einem Tastendruck den Ort des Zielreizes angeben und ihre Reaktionszeiten werden gemessen. Ein Aufmerksamkeitsbias zeigt sich, wenn Personen mit einer Störung durch Substanzkonsum oder Glücksspielen *schneller* auf Zielreize reagieren, welche auf suchtbezogene Bilder folgen, im Vergleich zu Zielreizen, die auf neutrale Bilder folgen, da Menschen schneller auf einen Stimulus reagieren, wenn er in einer Region erscheint, auf die sie bereits die Aufmerksamkeit gerichtet haben (Posner, Snyder & Davidson, 1980). Wenn Personen mit einer Störung durch Substanzkonsum oder Glücksspielen schneller auf einen Zielreiz reagieren, der auf ein suchtbezogenes Bild folgt, kann geschlussfolgert werden, dass sie ihre Aufmerksamkeit auf dieses gerichtet hatten (Field & Cox, 2008). Für wie viele Millisekunden (ms) die Bilder präsentiert werden (Reizeinsatzzeit), kann bei der Visual Probe variiert werden. Mit einer kurzen Reizeinsatzzeit kann eine initiale Aufmerksamkeitsverlagerung zum relevanten Stimulus erfasst werden, mit einer langen Reizeinsatzzeit hingegen Probleme, sich von diesem zu lösen.

Experimente im Internet

In den letzten Jahren wurden zunehmend psychologische Studien und mittlerweile auch komplexe Experimente im Internet durchgeführt (Dandurand, Shultz & Onishi, 2008; Germine et al., 2012). Internetstudien und -experimente sind ökonomisch, da viele Personen gleichzeitig teilnehmen können und keine Versuchsleiter oder -räume benötigt werden (Denissen, Neumann & van Zalk, 2010; Reips, 2002). So können keine ungewollten Versuchsleitereffekte auftreten (Rosenthal, 1966). Für Probanden sind sie praktisch, da sie Zeitpunkt und Ort der Teilnahme selbst bestimmen können. Personen geben im Internet aufgrund der größeren Anonymität eher persönliche Informationen preis (Kays, Gathercoal & Buhrow, 2012) und ihre Antworten sind weniger verzerrt durch soziale Erwünschtheit (Joinson, 1999; Richman, Kiesler, Weisband & Drasgow, 1999). Die große Reichweite des Internets ermöglicht es, heterogene Stichproben anzuwerben (Gosling, Vazire, Srivastava & John, 2000) anstelle der üblicherweise für psychologische Studien rekrutierten Psychologiestudentinnen (Hewson, Vogel & Laurent, 2016; Peterson, 2014). Es ist zudem leichter, ausreichend große Stichproben von Personen mit einer seltenen Störung anzuwerben (Mangan & Reips, 2007).

Beim Experimentieren im Internet sind jedoch auch einige Herausforderungen zu beachten. Da bei Internetstudien kein Versuchsleiter anwesend ist und jegliche Kommunikation computervermittelt stattfindet, fühlen sich die Teilnehmer weniger sozial verpflichtet, Studien zu Ende zu führen als im Labor (Musch & Reips, 2000; Taddicken, 2008). Dies ist vor allem problematisch bei systematischen Abbrüchen in einer Experimentalbedingung (Reips, 2002). Da kein Versuchsleiter anwesend ist, kann zudem niemand Fragen zum Verständnis der Aufgabe beantworten oder intervenieren, wenn die Teilnehmenden sie falsch ausführen. Besonders komplexe Experimente wie Reaktionszeitmessungen können fehleranfällig sein, da Störfaktoren verschiedener Herkunft schlechter kontrolliert werden können (Eichstaedt, 2002): Die Probanden können durch Hintergrundgeräusche oder Nebentätigkeiten abgelenkt werden, Internetverbindungen können Störungen unterliegen, unterschiedliche Hard- und Software kann einen Einfluss haben und mehrere gleichzeitig ausgeführte Programme oder Downloads können den Computer verlangsamen, an dem das Experiment läuft. Die nur exemplarisch genannten Probleme legen den Schluss nahe, dass Experimente im Internet nicht die gleiche Qualität aufweisen wie solche in einer standardisierten Laborbedingung. Dennoch ist es, gerade in Anbetracht der vielen Vorteile, relevant zu prüfen, ob Internetexperimente zu validen Ergebnissen führen, welche äquivalent zu jenen sind, die im Labor gefunden werden.

Darstellung des Dissertationsvorhabens und Herleitung der Fragestellungen

Die SSIS betrifft in Deutschland 1.2% der Schüler der neunten Klassen, bei weiteren 4.7% sind die Kriterien teilweise erfüllt (Rehbein et al., 2015). Sie kann zu erheblichen psychosozialen Problemen führen, da manche der Betroffenen beispielsweise aufgrund ihres hohen Spielkonsums unentschuldigt nicht in die Schule gehen oder ihre Arbeit verlieren (Han, Hwang & Renshaw, 2010; Hellström et al., 2012; Rehbein et al., 2015). Bisherige Studien haben vor allem korrelativ untersucht, welche psychosozialen Probleme mit der SSIS zusammenhängen. Es fehlen experimentelle Studien, die Rückschlüsse auf zugrundeliegende Mechanismen der Störung zulassen (Petry, 2011).

Durch die Aufnahme der SSIS als Forschungsdiagnose in das DSM-5 stehen einheitliche Kriterien für die Diagnostik der Störung zur Verfügung (American Psychiatric Association, 2013). Dies trägt dazu bei, zukünftige Studien besser vergleichbar zu machen und ermöglicht Psychotherapeuten und Psychiatern die Diagnostik und störungsspezifische Therapieplanung. Die Mitglieder der DSM-5-Arbeitsgruppe zur SSIS entwickelten den Fragebogen *Internet Gaming Disorder Questionnaire* (*IGDQ*), welcher die Kriterien der SSIS erfragt (Petry et al., 2014). Er liegt in zehn Sprachen vor, wurde aber bisher noch nicht validiert. Um die SSIS im deutschen Sprachraum diagnostizieren zu können, sollten in Studie 1 daher zunächst die Gütekriterien der deutschen Version des IGDQ anhand einer Stichprobe erwachsener Internetspieler überprüft werden.

Die diagnostischen Kriterien für die SSIS sind orientiert an denen für Störungen durch Substanzkonsum und die Störung durch Glücksspielen (Petry et al., 2014). Der Aufmerksamkeitsbias im Sinne einer verstärkten Aufmerksamkeitslenkung auf suchtbezogene Reize ist bedeutsam für die Aufrechterhaltung einer Störung durch Substanzkonsum (Janssen et al., 2015; Marhe et al., 2013; Powell et al., 2010). Es stellt sich die Frage, ob sich ein ähnlicher Aufmerksamkeitsbias auch bei Personen mit einer SSIS zeigt. Die Befundlage ist bisher nicht eindeutig: In zwei Experimenten wurde ein Aufmerksamkeitsbias gefunden (Lorenz et al., 2013; Metcalf & Pammer, 2011), in drei anderen hingegen nicht (van Holst et al., 2012; Zhang et al., 2016). In diesen fünf Experimenten wurde der Aufmerksamkeitsbias nur mit Stimuli untersucht, die sich direkt auf den Inhalt der Internetspiele beziehen, beispielsweise mit Wörtern wie *Battle* oder *Warcraft* in einem Suchtstroop oder Bildern von Spielsituationen in einer Visual Probe. In Hinblick auf die Konditionierungstheorie (Field & Cox, 2008) stellt sich besonders die Frage, ob Personen mit einer SSIS einen Aufmerksamkeitsbias bei allgemeinen computerbezogenen Stimuli zeigen. Dies könnten Wörter wie *Tastatur* oder *Monitor* oder Bildern von diesen Gegenständen sein. Diese werden im Sinne der Konditionierungstheorie zu konditionierten Stimuli und lösen Verlangen nach dem Spielen aus, während die Spiele selbst die unkonditionierten Stimuli sind. Computer werden zum Spielen genutzt, aber auch für notwendige Alltagstätigkeiten wie E-Mails oder Hausaufgaben gebraucht, sodass es schwer ist, sich von ihnen fernzuhalten, um kein Verlangen nach dem Spielen zu erleben. Sollte sich ein Aufmerksamkeitsbias bei allgemein computerrelevanten Stimuli zeigen, wäre dies relevant für das Verständnis der Aufrechterhaltung der Störung und für die Planung von Psychotherapieinhalten. Ein Modifikationstraining für den Aufmerksamkeitsbias wird im Rahmen von Therapien bei Störungen durch Substanzkonsum verwendet (Attwood, O'Sullivan, Leonards, Mackintosh & Munafò, 2008; Schoenmakers et al., 2010) und könnte auch bei Personen mit einer SSIS zum Einsatz kommen. In Studie 2 wurde daher zunächst in zwei Laborexperimenten der Aufmerksamkeitsbias in Bezug auf allgemeine Computerstimuli bei pathologischen Internetspielern untersucht. In den Studien 3A und B sollten die Ergebnisse von Studie 2 mithilfe einer größeren und nicht-studentischen Stichprobe repliziert werden. Daher wurde in zwei Internetexperimenten geprüft, ob Personen aus der Allgemeinbevölkerung mit einer SSIS einen Aufmerksamkeitsbias bei computerbezogenen Stimuli zeigen.

Experimente im Internet sind hilfreich, um eine ausreichend große Stichprobe von Personen zu testen, welche eine Störung mit einer kleinen Prävalenzrate haben, wie beispielsweise die SSIS. Um zu prüfen, ob die unterschiedlichen Ergebnisse der Studien 2 und 3A sowie B auf die verschiedenen Experimentalbedingungen (Labor und Internet) zurückzuführen wären, wurde in Studie 4 die Äquivalenz von Reaktionszeiten im Labor und im Internet untersucht. Bisher wurden in zwei Studien die im Labor erfassten Reaktionszeiten in einem klassischen Farbstroop mit denen im Internet verglichen (Linnman, Carlbring, Åhman, Andersson & Andersson, 2006; Semmelmann & Weigelt, 2016). Diese Studien geben einen ersten Hinweis darauf, dass komplexe Experimente wie der Farbstroop im Internet durchgeführt werden können, da sich der Interferenzeffekt sowohl im Labor als auch im Internet zeigte, wobei im Internet insgesamt langsamere Reaktionszeiten gemessen wurden. Die Ergebnisse unterliegen jedoch einer gravierenden methodischen Einschränkung, da keine Äquivalenztestungen durchgeführt wurden, um zu prüfen, ob die Reaktionszeiten statistisch äquivalent waren. Mithilfe von zweiseitigen Hypothesentestungen ist es unmöglich zu zeigen, dass kein Unterschied zwischen zwei Bedingungen besteht (Barker, Luman, McCauley & Chu, 2002). Es wird die Alternativhypothese getestet, dass es einen Unterschied zwischen Gruppen gibt und die Nullhypothese verworfen, dass es keinen gibt (Bortz, 2005). Wenn die Daten zeigen, dass man die Alternativhypothese nicht annehmen kann, erlaubt dies nicht die

Schlussfolgerung, dass die Nullhypothese wahr ist, sondern nur, dass nicht genug Evidenz vorliegt, um die Alternativhypothese zu akzeptieren. Daher muss eine Äquivalenztestung durchgeführt werden, um zu prüfen, ob eine Differenz zwischen zwei Bedingungen kleiner ist als ein akzeptabler Wert (Barker et al., 2002). Hierzu wird ein Äquivalenzbereich δ definiert, in welchen die Ergebnisse fallen müssen, um als äquivalent zu gelten (Walker & Nowacki, 2011). In Studie 4 wurde daher erstmalig getestet, ob sich im Labor und im Internet äquivalente Reaktionszeiten in einem Farbstroop zeigten.

Zusammenfassend ergeben sich für die vorliegende Dissertation die folgenden Fragestellungen:

Ist die deutsche Version des IGDQ ein reliables und valides Instrument, um die SSIS zu erfassen? (Studie 1)

Zeigen pathologische Internetspieler beziehungsweise Personen mit einer SSIS einen Aufmerksamkeitsbias bei computerbezogenen Stimuli? (Studie 2 und Studie 3 A und B)

Lassen sich im Internet und im Labor äquivalente Reaktionszeiten erfassen? (Studie 4)

Zusammenfassungen der Studien

Studie 1: Überprüfung der Gütekriterien des Fragebogens *Internet Gaming Disorder Questionnaire*

Quelle. Jeromin, F., Rief, W. & Barke, A. (2016). Validation of the Internet Gaming Disorder Questionnaire in a sample of adult German speaking Internet gamers. *Cyberpsychology, Behavior, and Social Networking*, *19*(7), 453–459. DOI: 10.1089/cyber.2016.0168

Hintergrund. Die SSIS wurde in den Anhang des DSM-5 als Diagnose mit weiterem Forschungsbedarf aufgenommen (American Psychiatric Association, 2013). Es ergibt sich der Bedarf eines reliablen und validen Fragebogens, um die Störung diagnostizieren zu können. Petry et al. (2014) entwickelten den *IGDQ*, der die Kriterien für die SSIS mit neun Items erfasst. Der Fragebogen weist ein dichotomes Antwortformat mit 0 (*nein*) und 1 (*ja*) auf. Die Diagnose kann ab einem Summenwert von fünf gestellt werden (American Psychiatric Association, 2013). Die Autoren übersetzten ihn aus dem Englischen in zehn weitere Sprachen unter Berücksichtigung der Empfehlungen der World Health Organization (2015) für die Übersetzungen von Fragebögen. Die psychometrischen Eigenschaften der IGDQ wurden bisher noch nicht überprüft. Diese Studie hatte zum Ziel, die Reliabilität, Validität und Faktorenstruktur der deutschen Version des Fragebogens anhand einer Stichprobe erwachsener deutschsprachiger Internetspieler zu untersuchen.

Methode. Die Einladung zur Teilnahme an der Studie wurde in Foren zum Thema Internetspiele und in sozialen Netzwerken platziert. 894 Personen, welche regelmäßig Internetspiele spielten, nahmen an der Studie teil, was als eine sehr gute Stichprobengröße für eine Fragebogenvalidierung gelten kann (Bühner, 2011; Fisseni, 1997). Im Mittel waren die Teilnehmer 26.5 Jahre alt (*SD* = 8.5 Jahre) und in einem Altersbereich zwischen 18 und 75 Jahren. 781 (87.3%) waren männlich. Die Probanden konnten auf den Link zur Onlinestudie (LimeSurvey, Hamburg, Germany) klicken und dort ihr Einverständnis zur Teilnahme geben. Sie füllten die deutschen Versionen des IGDQ und der *Compulsive Internet Use Scale* (*CIUS*) (Peukert et al., 2012) aus. Zudem machten sie Angaben zu ihrem Alter, ihrem Geschlecht und dem zeitlichen Umfang ihrer Internetspielnutzung. Die Teilnehmenden konnten Geschenkgutscheine gewinnen. Item- und Reliabilitätsanalysen wurden berechnet. Die Stichprobe wurde randomisiert in zwei Teile geteilt, um die Faktorenstruktur zu untersuchen.

Eine Maximum Likelihood Analyse wurde für die Subgruppe A berechnet, eine konfirmatorische Faktorenanalyse für die Subgruppe B. Aufgrund des dichotomen Antwortformats des IGDQ, wurden tetrachorische Korrelationen als Grundlage für die Faktorenanalyse berechnet (Kubinger, 2003).

Ergebnisse. Das meistgespielte Spiel war das MMORPG World of Warcraft (Activision Blizzard, Santa Monica, USA). Der mittlere IGDQ Summenwert für alle Probanden lag bei 1.7 (SD = 1.86), was der Erfüllung von 1.7 Kriterien entspricht. 71 Teilnehmer (7.94%) hatten einen Summenwert von mindestens 5 und erfüllten somit die Diagnose SSIS. Sie spielten im Durchschnitt 26 Stunden pro Woche Internetspiele (SD = 22.4). Die übrigen Probanden spielten im Mittel 17.7 Stunden pro Woche (SD = 15.3). Der IGDQ hatte ein Cronbachs α von .70. Die mittlere Itemschwierigkeit lag bei $p_{\mathrm{i}} = .19$ und die mittlere Trennschärfe bei $r_{\mathrm{itc}} = .39$. Der IGDQ Summenwert korrelierte mit dem CIUS Summenwert ($r = .59$, $p < .001$) und der Zeit, welche die Probanden wöchentlich mit Internetspielen zubrachten ($r = .24$, $p < .001$). Barletts Test auf Spherizität zeigte für die Subgruppe A, dass die Korrelationen zwischen den Items groß genug waren, um eine Maximum Likelihood Faktorenanalyse durchzuführen, $\chi^2(36) = 488.19$, $p < .001$. Ein KMO in Höhe von .79 sprach für eine gute Eignung der Daten für die Analyse. Velicers Minimum Average Partial Test (Velicer, 1976) ergab, dass Komponente extrahiert werden sollte. Sie klärte 30.26% der Varianz auf. Die konfirmatorische Faktorenanalyse bestätigte die Extraktion einer Komponente. Das Verhältnis der Freiheitsgrade zum χ^2 war 2.6, $\chi^2(27) = 70.193$, $p < .001$. Der komparative Anpassungsindex (CFI) lag bei .915, die Approximationsdiskrepanzwurzel (RMSEA) bei .061 (Konfidenzintervall: 0.044 – 0.079) und die Residualdiskrepanzwurzel (SRMR) bei .047.

Diskussion. Der IGDQ hatte eine akzeptable interne Konsistenz (Kline, 2000). Die mittlere Trennschärfe der Items lag über der Grenze von .30 (Fisseni, 1997), was für eine moderate Diskriminationsfähigkeit spricht. Eine Ausnahme war Item 1 ($r_{itc} = .28$), welches nach einer übermäßigen Beschäftigung mit Internetspielen fragt. Es ist zu erwarten, dass die Diskriminationsfähigkeit dieses Items gering ist, da auch Personen ohne SISS, welche gerne, aber nicht exzessiv spielen, sich viel mit dem Spielen beschäftigen. Dieses Kriterium ist daher notwendig, aber nicht ausreichend für die Diagnose SISS. Die Maximum Likelihood sowie die konfirmatorische Faktorenanalyse sprachen beide für die Extraktion einer Komponente. Die Tests auf Anpassungsgüte waren dabei zufriedenstellend, abgesehen vom CFI (Schreiber, Stage, King, Nora & Barlow, 2006). Die aufgeklärte Varianz war mit 30.26% vergleichsweise gering. Dies liegt möglicherweise daran, dass die Items zwar den Kriterien für eine zugrundeliegende Störung entsprechen, jedoch konzeptuell unterschiedliche Symptome und problematische Verhaltensweisen erfragen. Zudem handelt es sich beim IGDQ um eine Selbstberichts-Checkliste für die Kriterien der SSIS. Die Korrelation des IGDQ mit dem CIUS und der Zeit, welche die Probanden wöchentlich mit Internetspielen zubrachten, ist ein erster Indikator dafür, dass der Fragebogen valide Interpretationen zulässt. Die klinische Validität des IGDQ sollte im Rahmen von Feldstudien und diagnostischen Interviews weiter untersucht werden.

Studie 2: Untersuchung des Aufmerksamkeitsbias bei Personen mit einer SSIS mithilfe eines Suchtstroops und einer Visual Probe

Quelle. Jeromin, F., Nyenhuis, N. & Barke, A. (2016). Attentional bias in excessive Internet gamers: Experimental investigations using an addiction Stroop and a visual probe. *Journal of Behavioral Addictions*,*5*(1), 32–40. DOI: 10.1556/2006.5.2016.012

Hintergrund. Personen mit einer Störung durch Glücksspielen oder Störungen durch Substanzkonsum zeigen einen Aufmerksamkeitsbias im Sinne einer vermehrten Aufmerksamkeitshinwendung zu suchtbezogenen Stimuli (Cox et al., 2006; Hønsi et al., 2013; Leeman et al., 2014; Robbins & Ehrman, 2004). Es gibt Hinweise darauf, dass pathologische Internetspieler einen Aufmerksamkeitsbias bei inhaltlich spielbezogenen Reizen zeigen (Lorenz et al., 2013; Metcalf & Pammer, 2011). Relevant ist darüber hinaus ein Aufmerksamkeitsbias für allgemeine Computerstimuli, welcher nach dem Modell von Field und Cox (2008) vorhergesagt wird. Ziel der vorliegenden Studie war es, mithilfe eines Suchtstroops und einer Visual Probe zu untersuchen, ob pathologische Internetspieler einen Aufmerksamkeitsbias in Bezug auf allgemeine computerbezogene Stimuli zeigen.

Methode. Die Probanden (Studierende) wurden durch Aushänge in der Universität auf die Studie aufmerksam gemacht. Es nahmen 21 pathologische Internetspieler und 30 Personen, die keinerlei Internetspiele nutzten, teil. Im Mittel waren sie 23.7 Jahre alt (*SD* = 2.7 Jahre) und in einem Altersbereich zwischen 20 und 33 Jahren. 36 waren männlich (70.6%). Die Farbsichtigkeit der Probanden wurde mit dem Ishiharatest überprüft (Ishihara Farbtafel, 2009). Die Teilnehmenden machten Angaben zu ihrem Alter, ihrem Geschlecht und dem zeitlichen Umfang ihrer Internetspielnutzung. Da die Kriterien für die SSIS zum Zeitpunkt der Studie noch nicht vorlagen, wurde pathologisches Internetspielen mit dem CIUS erfasst. Anschließend nahmen sie an einem Suchtstroop und einer Visual Probe teil und ihre Reaktionszeiten wurden gemessen. Sie erhielten Versuchspersonenstunden oder eine monetäre Vergütung für ihre Teilnahme. Die Experimente wurden mit Presentation (Version 14.8, Neurobehavioral Systems, Berkeley, USA) programmiert und die Darbietungsreihenfolge wurde randomisiert. Beide Paradigmen wurden zunächst in Übungsdurchgängen mit Tierwörtern von den Probanden gelernt. Für den Stroop sahen die Teilnehmer 20 neutrale Wörter, die zur Kategorie Büro gehörten (z. B. Telefon) und 20 computerbezogene Wörter (z. B. Tastatur), welche die gleiche Frequenz im Deutschen hatten (Institut für Deutsche Sprache, 2009) sowie die gleiche Anzahl an Buchstaben und Silben.

Jedes Wort wurde zweimal in rot, gelb, grün und blau präsentiert, sodass es 320 Durchgänge mit randomisierter Abfolge gab. Die Wörter wurden einzeln für 1000 ms auf einem Computermonitor präsentiert. Die Probanden sollten per Tastendruck die Schriftfarbe angeben. Drückte eine Person vor Ablauf der 1000 ms eine Taste, erschien für die restliche Zeit ein Fixationskreuz. Ein Aufmerksamkeitsbias zeigte sich im Suchtstroop durch eine *langsamere* Reaktionszeit bei den computerbezogenen im Vergleich zu den neutralen Wörtern. Für die Visual Probe wurden 10 neutrale technische Bilder (z. B. ein Radio) und 10 computerbezogene Bilder (z. B. ein Monitor) gezeigt, welche sich nicht in Kontrast, Helligkeit, Größe oder visueller Komplexität unterschieden. Jeder der 480 Durchgänge dauerte 1700 ms und die Bilder wurden in randomisierter Reihenfolge gezeigt. Zunächst sahen die Probanden ein neutrales und ein computerbezogenes Bild rechts und links von einem Fixationskreuz auf dem Computermonitor für 150 oder 450 ms (kurze oder lange Reizeinsatzzeit). Anschließend sahen sie für 50 ms nur das Fixationskreuz und danach erschien ein Zielreiz in Form eines gelben Quadrats für 200 ms an der Stelle, wo zuvor eines der beiden Bilder zu sehen war. Dann erschien für 1300 (bei der kurzen Reizeinsatzzeit) oder 1000 ms (bei der langen Reizeinsatzzeit) erneut das Fixationskreuz. Per Tastendruck sollten die Teilnehmer die Position des Zielreizes angeben. Ein Aufmerksamkeitsbias zeigte sich in der Visual Probe durch eine *schnellere* Reaktionszeit bei Zielreizen, welche den computerbezogenen Bildern folgten im Vergleich zu Zielreizen, welche den neutralen Bildern folgten.

Ergebnisse. Die pathologischen Internetspieler nutzen Internetspiele im Durchschnitt 15.4 Stunden pro Woche (SD = 11.3). In Bezug auf den Suchtstroop zeigte die 2x2 Varianzanalyse (ANOVA) bei gemischten Designs keinen Haupteffekt für die Gruppe, $F(1,46) = 0.92$, $p = .34$, oder die Wortart, $F(1,46) = 0.03$, $p = .86$, aber eine Interaktion Gruppe x Wortart, $F(1,46) = 12.13$, $p = .001$, $\eta^2 = .209$. LSD Post-hoc-Tests ergaben, dass die pathologischen Internetspieler langsamer auf die computerbezogenen Wörter (583.2 ms ± 42.2 ms) als auf die neutralen Wörter reagierten (573.7 ms ± 41.2 ms). Die Nicht-Spieler reagierten langsamer auf die neutralen Wörter (597.5 ms ± 57.9 ms) als auf die computerbezogenen Wörter (587.0 ms ± 50.3 ms). In Bezug auf die Visual Probe zeigte die 2x2x2 ANOVA bei gemischten Designs einen Haupteffekt für die Gruppe, $F(1,49) = 4.59$, $p = .037$, $\eta^2 = .086$. Demnach reagierten die pathologischen Internetspieler insgesamt schneller als die Nicht-Spieler. Zudem zeigte sich ein Haupteffekt für die Reizeinsatzzeit, $F(1,49) = 51.34$, $p < .001$, $\eta^2 = .512$. Alle Probanden reagierten schneller nach langen Reizeinsatzzeiten als nach kurzen. Es zeigte sich kein Haupteffekt für die Bildart, $F(1,49) = 1.22$, $p = .28$. Außerdem zeigten sich keine Interaktionen für Reizeinsatzzeit x Gruppe, $F(1,49) = 0.51$, $p = .48$, Bildart x Gruppe, $F(1,49) = 0.40$, $p = .84$, Reizeinsatzzeit x Bildart, $F(1,49) = 3.11$, $p = .08$, oder Reizeinsatzzeit x Bildart x Gruppe, $F(1,49) = 1.32$, $p = .26$.

Diskussion. Die pathologischen Internetspieler zeigten einen Aufmerksamkeitsbias in einem Suchtstroop. Dies bedeutet, dass nicht nur spielbezogene (Lorenz et al., 2013; Metcalf & Pammer, 2011), sondern auch allgemeine Computerstimuli vermehrt die Aufmerksamkeit der pathologischen Spieler auf sich ziehen. Dies kann unter anderem den pathologischen Gebrauch des Spielens aufrecht erhalten. Beispielsweise könnte ein Jugendlicher, der gerade seine Hausaufgaben macht, automatisch und unbewusst die Aufmerksamkeit auf den im Zimmer befindlichen Computer richten, Verlangen nach dem Spiel spüren und sich dafür entscheiden, die Hausaufgaben nicht zu erledigen und stattdessen zu spielen. In der Visual Probe wurde hingegen kein Aufmerksamkeitsbias gefunden. Möglicherweise war die Aufgabe zu einfach für die pathologischen Internetspieler. Sie trainieren ihre Reaktionszeiten beim Spielen (Dye, Green& Bavelier, 2009) und waren insgesamt schneller als die Nicht-Spieler. Dies könnte zu einem Deckeneffekt geführt haben, sodass die Aufmerksamkeitslenkung auf das computerbezogene Bild die Reaktionszeit nicht weiter steigern konnte. Marks et al. (2014) kombinierten eine Visual Probe mit einer Blickbewegungsmessung bei Personen mit einer Kokainabhängigkeit. Sie fanden keinen Aufmerksamkeitsbias in den Reaktionszeiten, aber die Probanden fixierten die suchtbezogenen Bilder länger als die neutralen. Blickbewegungsmessungen bei Internetspielern könnten daher dazu beitragen, einen möglichen Aufmerksamkeitsbias genauer zu untersuchen.

Studie 3: Untersuchung des Aufmerksamkeitsbias bei Personen mit einer SSIS mithilfe zweier webbasierter Suchtstroops

Quelle. Jeromin, F., Rief, W. & Barke, A. (2016). Using two web-based addiction Stroops to measure the attentional bias in adults with Internet Gaming Disorder. *Journal of Behavioral Addictions*, *5*(4), 666–673. DOI: 10.1556/2006.5.2016.075

Hintergrund. In früheren Studien zeigten sich gemischte Befunde in Bezug auf den Aufmerksamkeitsbias bei Personen mit einer SSIS. In zwei Experimenten wurde ein Aufmerksamkeitsbias in Form einer verstärkten Aufmerksamkeitslenkung auf spielbezogene Reize gefunden (Lorenz et al., 2013; Metcalf & Pammer, 2011). In drei anderen Experimenten konnte er nicht gezeigt werden (van Holst et al., 2012; Zhang et al., 2016). Jeromin, Nyenhuis und Barke (2016) erweiterten diese Ergebnisse und demonstrierten mithilfe eines Suchtstroops, dass pathologische Internetspieler nicht nur einen Aufmerksamkeitsbias in Bezug auf spielbezogene, sondern auch in Bezug auf computerbezogene Stimuli im Allgemeinen zeigten. Alle Experimente wurden im Labor durchgeführt. Ziel der Studie 3 war es, die Ergebnisse der Studie 2 mithilfe einer größeren und heterogeneren Stichprobe zu replizieren. Dazu wurde der vermutete Aufmerksamkeitsbias mithilfe von zwei webbasierten Suchtstroops getestet. Es wurden zwei unabhängige Studien durchgeführt, die im nachfolgenden 3A und 3B genannt werden. Da sich in Experiment 3A in einem Suchtstroop mit randomisierter Wortfolge kein Aufmerksamkeitsbias zeigte, wurde in Studie 3B ein Suchtstroop mit einem Blockdesign verwendet. An Studie 2 nahmen zwei Gruppen teil, pathologische Internetspieler und Personen, die keinerlei Internetspiele nutzten. Die Ergebnisse lassen keine Schlüsse dahingehend zu, ob ein potentieller Aufmerksamkeitsbias aufgrund der SSIS zustande kam und sich demnach nur bei Internetspielern mit einer SSIS zeigte und nicht bei Internetspielern, deren Spielverhalten unauffällig ist und die keine SSIS haben. In den Studien 3A und 3B wurden daher drei Gruppen von Personen untersucht, die Internetspieler mit einer SSIS, die ohne eine SSIS und die Nichtspieler.

Methode. Für beide Studien wurden die Einladungen zur Teilnahme in sozialen Netzwerken und in internetspielbezogenen Foren platziert. Am ersten Experiment nahmen je 27 pathologische Internetspieler, nicht-pathologische Internetspieler sowie Nicht-Spieler teil. Pro Gruppe gab es 19 Männer (70.4%). Im Mittel waren die Teilnehmer 28.1 Jahre alt (*SD* = 7.8) und in einer Altersspanne zwischen 15 und 51 Jahren. Am zweiten Experiment nahmen je 29 männliche Internetspieler mit einer SSIS, Internetspieler ohne eine SSIS sowie Nicht-Spieler teil. Das Durchschnittsalter lag bei 23.4 Jahren (*SD* = 5.1, Alterspanne: 18 bis 42 Jahre). Die Probanden konnten auf den Link zur Onlinestudie klicken (LimeSurvey, Hamburg, Germany) und dort ihr Einverständnis zur Teilnahme geben. Sie machten Angaben zu ihrem Alter, ihrem Geschlecht und dem zeitlichen Umfang ihrer Internetspielnutzung. Ihre Farbsichtigkeit wurde mit dem Ishihara Test (Ishihara Farbtafel, 2009) überprüft. Pathologisches Internetspielen wurde mit dem CIUS (Peukert et al., 2012) sowie, in Studie 3B, mit dem IGDQ (Jeromin, Rief& Barke, 2016) erfasst. Anschließend nahmen sie an einem Suchtstroop teil. In Studie 3B führten sie zusätzlich einen Farbstroop aus. Die Teilnehmenden erhielten eine Rückmeldung zu ihren Reaktionszeiten und Fehlerzahlen in den Stroopaufgaben. Sie konnten Geschenkgutscheine gewinnen. Die Experimente wurden mit JavaScript (Version 1.8.5, Netscape, Mountain View, USA) programmiert. Die Reaktionszeiten wurden zunächst clientseitig gesammelt und am Ende des Stroops als Block übertragen, damit nicht Prozesse, welche mit dem Browser, der Internetverbindung oder unterschiedlichen Übertragungsprotokollen zusammenhingen, die Reaktionszeiten verzerrten. Der Suchtstroop in Studie A entsprach vom Aufbau her dem in der Laborstudie 1 und ebenso wurden die Wörter in einer randomisierten Reihenfolge gezeigt. Der Suchtstroop in Studie 3B hatte ein Blockdesign mit je zwei Blöcken aus ausschließlich neutralen und ausschließlich computerbezogenen Wörtern. Die Blöcke wurden in einer randomisierten Reihenfolge präsentiert. Im Unterschied zu Studie 1 gab es pro Kategorie in beiden Farbstroops 12 Wörter, die zweimal in vier Farben gezeigt wurden, woraus sich 192 Durchgänge ergaben. Der Farbstroop wies ebenfalls ein Blockdesign auf. Es gab zwei Blöcke mit Farbworten („rot", „blau", „grün" und „gelb"), die in viermal in den inkongruenten Schriftfarben dargestellt wurden (z. B. das Wort „rot" in blauer, grüner und gelber Schriftfarbe, aber nicht in roter Schriftfarbe). Zudem wurden vier numerische Wörter („null", „fünf", „neun" und „elf") dreimal in den vier Farben gezeigt, sodass es insgesamt 192 Durchgänge gab.

Ergebnisse. Das MMORPG World of Warcraft (Activision Blizzard, Santa Monica, USA) war das am meisten genutzte Spiel in beiden Studien. In Bezug auf Studie 3A zeigte sich, dass die pathologischen Internetspieler doppelt so viele Stunden pro Woche spielten (M = 22.9, SD = 15.6) wie die nicht-pathologischen (M = 11.2, SD = 7.1), $t(36.5) = 3.528$, $p < .001$, $d = 0.965$. Hinsichtlich des Suchtstroops ergab die 3x2 ANOVA bei gemischten Designs keinen Haupteffekt für die Gruppe, $F(2,78) = 2.86$, $p = .063$, die Wortart, $F(1,78) = 2.36$, $p = .129$, oder die Interaktion Gruppe x Wortart, $F(2,78) = 0.19$, $p = .828$. In Bezug auf Studie 3B zeigte die 3x2 ANOVA bei gemischten Designs für den Suchtstroop keinen Haupteffekt für die Gruppe, $F(2,84) = 0.10$, $p = .904$, die Wortart, $F(1,84) = 0.36$, $p = .548$, oder die Interaktion Gruppe x Wortart, $F(2,84) = 2.15$, $p = .123$. Beim Farbstroop ergab die 3x2 ANOVA bei gemischten Designs einen Haupteffekt für die Wortart, $F(1,84) = 41.34$, $p <.001$, $\eta^2 = .144$. Alle Probanden reagierten demnach im Durchschnitt langsamer auf die inkongruenten Farb- als auf die Zahlwörter. Es zeigte sich kein Haupteffekt für die Gruppe, $F(2,84) = 0.85$, $p = .431$, und auch keine Interaktion Gruppe x Wortart, $F(2,84) = 0.53$, $p = .593$.

Diskussion. Im ersten Suchtstroop mit einer randomisierten Wortfolge (Studie 3A) konnte kein Aufmerksamkeitsbias bei pathologischen Internetspielern demonstriert werden. Waters, Feyerabend, Paton und Petroskey (2000) fanden heraus, dass Personen mit einer Nikotinabhängigkeit einen Aufmerksamkeitsbias in einem Suchtstroop mit Blockdesign zeigten, aber nicht in einem Suchtstroop mit einer randomisierten Wortfolge. In Studie 3B wurde daher ein Suchtstroop mit einem Blockdesign eingesetzt. Dennoch zeigte sich erneut kein Aufmerksamkeitsbias bei Personen mit einer SSIS. Die Ergebnisse unterscheiden sich von denen aus der Laborstudie 1, obwohl dieselbe Stroop-Aufgabe verwendet wurde. Möglicherweise lag es am Experimentieren im Internet, dass sich kein Aufmerksamkeitsbias zeigte. Die Probanden reagierten im Mittel in den webbasierten Suchtstroops 28 und 31 ms langsamer als im Labor (Jeromin, Nyenhuis, et al., 2016). Dagegen spricht, dass sich im webbasierten Farbstroop ein typischer Interferenzeffekt zeigte. Eine weitere Möglichkeit ist, dass Personen mit einer SSIS keinen Aufmerksamkeitsbias aufweisen. Wenn dies so ist, unterscheidet sich die SSIS in dieser Hinsicht von Störungen durch Substanzkonsum und der Störung durch Glücksspielen.

Studie 4: Äquivalenztestung von Reaktionszeiten in einem Farbstroop im Labor und im Internet

Quelle. Jeromin, F., Gorbunova, A. & Barke, A. (2017). Are reaction times collected on the Internet equivalent to those measured in the laboratory? A comparison of a laboratory and three web-based settings using the Stroop task. Manuscript submitted for publication at *Psychological Methods*.

Hintergrund. Das Durchführen von Studien im Internet ist ökonomisch, praktisch für die Teilnehmenden und ermöglicht es, große Stichproben von Personen mit psychischen Störungen zu rekrutieren, welche kleine Prävalenzzahlen haben, wie beispielsweise die SSIS (Denissen et al., 2010; Gosling et al., 2000). Auf der anderen Seite können Reaktionszeitmessungen außerhalb des Labors störanfällig sein, wenn die Probanden zum Beispiel durch Hintergrundgeräusche abgelenkt werden oder mehrere Programme gleichzeitig geöffnet haben (Eichstaedt, 2002). Der Farbstroop ist eines der am meisten durchgeführten psychologischen Experimente und führt im Labor zu großen Effektstärken (MacLeod, 1991). Linnman, Carlbring, Åhman, Andersson und Andersson (2006) sowie Semmelmann und Weigelt (2016) verglichen ein im Labor durchgeführtes Stroopexperiment mit einem im Internet und fanden den Interferenzeffekt in beiden Bedingungen. In keiner der Studien wurde eine Äquivalenztestung durchgeführt, um zu prüfen, ob die Reaktionszeiten im Labor und im Internet äquivalent waren. Ziel dieser Studie war, vier Gruppen mit unterschiedlichen, häufig durchgeführten Rekrutierungsmethoden (Kothgassner, Felnhofer, Weber & Stetina, 2011; Rhodes, Bowie & Hergenrather, 2003) zu vergleichen und zu testen, ob sich im Labor und im Internet äquivalente Reaktionszeiten in einem Farbstroop zeigten.

Methode. Psychologiestudierende der Universität Marburg wurden mittels E-Mail rekrutiert und ins psychologische Institut eingeladen. Nachdem sie ihr Einverständnis zur Studienteilnahme gegeben hatten, wurde ausgelost, ob sie im Labor (PStud-Labor, n = 36) oder an einem Ort ihrer Wahl per Internet (PStud-Web, n = 34) teilnahmen. Studierende anderer Fachrichtungen und Universitäten wurden ebenfalls per E-Mail angeworben (GStud-Web, n = 62). Personen aus der Allgemeinbevölkerung wurden in Internetforen und per Schneeballsystem rekrutiert (GPop-Web, n = 59). Die letzten beiden Gruppen nahmen an einem Ort ihrer Wahl teil und gaben online ihr Einverständnis zur Studienteilnahme. Das Durchschnittsalter der Teilnehmenden lag bei 24.2 Jahren (*SD* = 5.2 Jahre, Altersbereich: 18 bis 52 Jahre). 36 Personen waren männlich (18.8%). Alle Probanden nahmen an der gleichen

Studie teil, welche auf der Umfrageplattform LimeSurvey (Hamburg, Germany) platziert wurde. Sie machten Angaben zu ihrem Alter, ihrem Geschlecht sowie zu dem von ihnen benutzten Browser und Betriebssystem. Mithilfe des Ishiharatests wurde ihre Farbsichtigkeit überprüft (Ishihara Farbtafel, 2009). Anschließend nahmen sie an einem Farbstroop mit inkongruenten Farbwörtern und neutralen Zahlwörtern teil, welcher jenem in Studie 3B entsprach. Die Gruppen PStud-Labor und PStud-Web bekamen Versuchspersonenstunden für ihre Teilnahme, die Gruppen GStud-Web und GPop-Web konnten Geschenkgutscheine gewinnen. Für die Äquivalenztestung wurde die Prozedur mit zwei einseitigen Testverfahren (TOST) genutzt (Schuirmann, 1987) mit einem Signifikanzniveau von $\alpha = .05$ und einem Konfidenzintervall von 90%. Basierend auf den Empfehlungen von Joinson (1999) wurde ein strenger Äquivalenzbereich δ definiert, welcher ± 5% der mittleren Reaktionszeit von PStud-Labor war, jeweils getrennt für die Zahl- und die Farbwörter.

Ergebnisse. In Hinblick auf den Farbstroop zeigte die 4x2 ANOVA bei gemischten Designs einen Haupteffekt für die Wortart $F(1,187) = 76.7$, $p < .001$, $\eta^2 = .053$, was bedeutet, dass alle Gruppen langsamer auf Farbwörter als auf Zahlwörter reagierten. Es gab keinen Haupteffekt für die Gruppe, $F(3,187) = 1.12$, $p = .341$, oder eine Interaktion Gruppe x Wortart, $F(3,187) = 0.11$, $p = .953$. Die Äquivalenztestung ergab, dass die Reaktionszeiten in Bezug auf die Zahl- und die Farbwörter von GStud-Web und GPop-Web jeweils äquivalent waren zu jenen von PStud-Labor. Die Reaktionszeiten bei beiden Worttypen von PStud-Web waren nicht äquivalent zu jenen von PStud-Labor.

Diskussion. Der Interferenzeffekt in einem Farbstroop wurde in allen vier Gruppen gefunden, obwohl diese unterschiedlich rekrutiert wurden und an verschiedenen Orten teilnahmen. Dennoch waren nicht alle im Internet erhobenen Reaktionszeiten äquivalent zu jenen im Labor. Die Reaktionszeiten bei beiden Worttypen von GStud-Web und GPop-Web waren äquivalent zu jenen von PStud-Labor, die Reaktionszeiten von PStud-Web hingegen nicht. Die Probanden in der Gruppe PStud-Web wurden ins psychologische Institut eingeladen und anschließend gebeten, von zu Hause aus teilzunehmen. Nach ihrer Partizipation mussten sie erneut ins Institut kommen, um ihre Versuchspersonenstunde zu erhalten und hatten einen Mehraufwand im Vergleich zu den anderen Gruppen. Möglicherweise wurde dadurch unabsichtlich ihre Motivation gemindert, ihr Bestes in der Stroopaufgabe zu geben. Ihre mittleren Reaktionszeiten waren langsamer als die der anderen drei Gruppen, die ANOVA zeigte jedoch keinen Haupteffekt für die

Zwischengruppenvariable. Aufschluss konnte hier die Äquivalenztestung geben, die keine Äquivalenz von PStud-Web zu PStud-Labor zeigte. Die Randomisierung der Probanden hätte bereits vor dem E-Mail-Kontakt stattfinden sollen, um zu verhindern, dass sie demotiviert wurden. Dennoch waren die Reaktionszeiten der anderen beiden Internetbedingungen in einer leichten Aufgabe (Zahlwörter) und einer schweren (Farbwörter) äquivalent zu denen im Labor, sodass geschlussfolgert werden kann, dass sich Reaktionszeiten im Internet valide erheben lassen.

Diskussion

In der vorliegenden Dissertation wurde untersucht, ob Personen mit einer SSIS einen Aufmerksamkeitsbias bei computerbezogenen Stimuli zeigen.

In Bezug auf die erste Fragestellung lässt sich sagen, dass der IGDQ die SSIS reliabel und valide erfasst. Der Fragebogen wies eine akzeptable Reliabilität auf (Kline, 2000) und korrelierte mit dem CIUS sowie dem zeitlichen Umfang, in welchem die Probanden wöchentlich Internetspiele nutzten.

Die zweite Fragestellung, ob Personen mit einer SSIS einen Aufmerksamkeitsbias bei computerbezogenen Stimuli zeigen, lässt sich nicht abschließend beantworten. In Studie 2 zeigten die pathologischen Internetspieler einen Aufmerksamkeitsbias in dem Suchtstroop, aber nicht in einer Visual Probe. In Studie 3A wurde kein Aufmerksamkeitsbias in einem Suchtstroop mit randomisierter Wortfolge gefunden, in Studie 3B ebenfalls kein Aufmerksamkeitsbias in einem Suchtstroop mit Blockdesign.

In Hinblick auf die dritte Fragestellung zeigte sich, dass Reaktionszeiten im Labor und im Internet weitgehend äquivalent erfasst werden konnten. In zwei von drei Internetbedingungen waren die Reaktionszeiten äquivalent zu jenen in der Laborbedingung.

Möglich ist, dass aufgrund der verwendeten Paradigmen kein Aufmerksamkeitsbias gefunden wurde. Ataya et al. (2012) untersuchten die Reliabilität von 14 Experimenten, in welchen ein Suchtstroop oder eine Visual Probe verwendet wurde. Die interne Konsistenz der Visual Probe-Aufgaben lag zwischen Cronbachs α = .00 und .50, die der Suchtstroops zwischen Cronbachs α = .53 und .98. Die zum Teil geringe Reliabilität kam durch methodische Einschränkungen der Studien zustande. In den vorliegenden Experimenten im Rahmen der Dissertation wurden daher die Empfehlungen von Cox et al. (2006) sowie von Field und Cox (2008) für die Durchführung von Experimenten zur Messung des Aufmerksamkeitsbias befolgt. Die computerbezogenen und neutralen Wörter im Suchtstroop unterschieden sich nicht in der Buchstaben- und Silbenanzahl oder hinsichtlich der Frequenz im deutschen Sprachgebrauch. So wurde sichergestellt, dass Unterschiede in den Reaktionszeiten bei den zwei Worttypen auf deren semantischen Gehalt zurückzuführen waren. Äquivalent dazu unterschieden sich die computerbezogenen und neutralen Bilder nicht im Kontrast, in der Helligkeit, in der Größe oder in der visuellen Komplexität. Andernfalls hätte dies die Aufmerksamkeitslenkung beeinflussen können (Egeth & Yantis, 1997).

Möglicherweise wurde kein Aufmerksamkeitsbias gefunden, da in den Suchtstroops und in der Visual Probe computerbezogene Stimuli verwendet wurden. Im Sinne der

Konditionierungstheorie (Field & Cox, 2008) und aus psychotherapeutischen Überlegungen heraus sind computerbezogene Stimuli relevanter als spielbezogene. In den bisherigen Studien, in welchen der Aufmerksamkeitsbias bei Personen mit einer SSIS untersucht wurde, wurden spielbezogene Stimuli verwendet (Lorenz et al., 2013; Metcalf & Pammer, 2011; van Holst et al., 2012; Zhang et al., 2016). Diese Stimuli sind den Spielern jedoch bekannter als den Nicht-Spielern und die spielbezogenen Wörter kommen in der Sprache seltener vor als die neutralen Wörter, was die Reaktionszeiten beeinflusst haben könnte (Cox et al., 2006). Van Holst et al. (2012) und Zhang et al. (2016) verwendeten spielbezogene Stimuli und fanden dennoch keinen Aufmerksamkeitsbias. Dies legt den Schluss nahe, dass die Ergebnisse der vorliegenden Experimente nicht auf die Auswahl der Stimuli zurückzuführen sind.

In den Studien 3A und 3B wurde erstmals im Internet der Aufmerksamkeitsbias bei Personen mit einer SSIS untersucht. Es ist möglich, dass das Experimentieren im Internet mit Störfaktoren einherging und Fehlervarianz produzierte, sodass aus diesem Grund keine Evidenz für den Aufmerksamkeitsbias gefunden wurde. Dagegen spricht, dass sich in Studie 3B der Interferenzeffekt in einem klassischen Farbstroop in allen Gruppen zeigte. Zudem wurde in Studie 4 die Äquivalenz von Reaktionszeitmessungen im Labor und im Internet weitgehend nachgewiesen. Lewis, Watson und White (2009) verglichen Ergebnisse eines Labor- und Internetexperiments zur Wirkung von unterschiedlichen Aufklärungsinformationen zum Autofahren unter Alkoholeinfluss. Sie fanden ebenfalls äquivalente Ergebnisse in beiden Bedingungen.

Die oben genannten Überlegungen legen den Schluss nahe, dass die Ergebnisse nicht durch experimentelle Limitationen zustande kamen, sondern dass Personen mit einer SSIS tatsächlich keinen Aufmerksamkeitsbias in Bezug auf Computerstimuli zeigen. Dies ist in Einklang mit den Studien von van Holst et al. (2012) und Zhang et al. (2016), in welchen ebenfalls kein Aufmerksamkeitsbias bei Personen mit einer SSIS gefunden wurde. Die SSIS unterscheidet sich in diesem Punkt von Störungen durch Substanzkonsum und der Störung durch Glücksspielen (Cox et al., 2006; Leeman et al., 2014; Robbins & Ehrman, 2004). Eine Bierflasche wird ausschließlich zum Biertrinken verwendet, ein Aschenbecher nur zum Rauchen. Der Computer wird von den Spielern vermutlich auch für zahlreiche andere Aktivitäten genutzt, beispielsweise zum Chatten, zum Arbeiten oder zum Ansehen von Filmen. Es kann daher sein, dass die Verbindung zwischen dem Computer und der Spielerfahrung nicht prädiktiv und exklusiv genug ist, damit der neutrale Stimulus Computer ein konditionierter Stimulus wird, welcher einen Aufmerksamkeitsbias auslöst. Zudem ist möglicherweise die belohnende Empfindung beim Spielen nicht so stark wie die beim

Drogenkonsum und kann daher einen neutralen Stimulus aus der Umgebung des Spiels nicht in einen konditionierten Stimulus verwandeln.

In Bezug auf die Ergebnisse der Dissertation ergibt sich die Frage nach verschiedenen Einschränkungen. In die Studien wurden ausschließlich Erwachsene eingeschlossen, sodass die Ergebnisse nicht auf andere Altersgruppen übertragen werden können. Van Holst et al. (2012) untersuchten 12- bis 17-jährige Kinder, die jedoch ebenfalls keinen Aufmerksamkeitsbias zeigten. Die Studien 1, 3A, 3B und 4 wurden im Internet durchgeführt und 22.2% bis 55.4% der Probanden beendeten ihre Teilnahme frühzeitig. Diese Zahlen sind vergleichbar mit anderen Internetstudien (Reips, 2000). Internetexperimente ohne Versuchsleiter machen es den Teilnehmenden leichter, eine Studie vorzeitig abzubrechen, da sie aufgrund der medienvermittelten Kommunikation weniger soziale Verpflichtung spüren (Musch & Reips, 2000; Taddicken, 2008). Dies ist jedoch in einem Messwiederholungsdesign unproblematisch, da es keine Manipulation der verschiedenen Gruppen gibt und Dropouts somit nicht systematisch die Ergebnisse einer Gruppe verzerren können (Reips, 2002).

Zu den Stärken der Dissertation zählt, dass insgesamt fünf Experimente durchgeführt wurden. Die Paradigmen für die Messung des Aufmerksamkeitsbias wurden sorgfältig geplant unter Beachtung der Empfehlungen von Cox und Kollegen (2006) sowie von Field und Cox (2008). Unterschiedliche Basiseigenschaften bei computerbezogenen und neutralen Stimuli wurden vermieden, was die Reaktionszeiten hätte beeinflussen können. Studie 1 war die erste, in welcher die Gütekriterien des IGDQ untersucht wurden. An den Studien 3A und 3B nahmen Personen aus der Allgemeinbevölkerung im Internet teil, sodass die Generalisierbarkeit der Ergebnisse verbessert wurde. Im Rahmen von Studie 4 wurde erstmalig eine statistische Äquivalenztestung durchgeführt, um die Vergleichbarkeit von Reaktionszeitmessungen im Internet und im Labor zu überprüfen.

Die SSIS ist eine vorläufige Forschungsdiagnose, für deren Absicherung empirische Evidenz notwendig ist (American Psychiatric Association, 2013). Die vorliegende Dissertation leistete einen wichtigen Beitrag dazu, die grundlegenden Mechanismen der Aufrechterhaltung der Störung experimentell zu untersuchen. Abschließend lässt sich nicht eindeutig sagen, ob Personen mit einer SSIS einen Aufmerksamkeitsbias bei computerbezogenen Stimuli zeigen. Es verdichten sich die Hinweise, dass es ihn nicht gibt, da er sich in drei von vier sorgfältig durchgeführten Experimenten im Rahmen dieser Dissertation nicht zeigte. Möglich ist jedoch, dass er sich mit Reaktionszeiten als indirektes Maß nicht abbilden lässt. Um abschließend zu klären, ob bei Personen mit einer SSIS ein

Aufmerksamkeitsbias vorliegt, sollten zukünftige Studien ihn mithilfe von direkten Maßen wie Blickbewegungsmessungen und Elektroenzephalographie untersuchen.

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Anhang

Studien

Jeromin, F., Rief, W. & Barke, A. (2016). Validation of the Internet Gaming Disorder Questionnaire in a sample of adult German-speaking Internet gamers. *Cyberppsychology, Behavior, and Social Networking*, *19*(7), 453–459. DOI: 10.1089/cyber.2016.016

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Validation of the Internet Gaming Disorder Questionnaire in a Sample of Adult German-Speaking Internet Gamers

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Abstract

With the inclusion of Internet Gaming Disorder (IGD) in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders comes the need for a reliable and valid questionnaire to assess the diagnosis. The Internet Gaming Disorder Questionnaire (IGDQ) is a short tool that measures IGD. Our study aimed at investigating its psychometric properties in a sample of German gamers. Eight hundred ninety-four Internet game players (mean age: 26.5 ± 8.5 years, range: 18–75 years, 87.36% male) completed an online version of the IGDQ and the Compulsive Internet Use Scale (CIUS) and provided information on their Internet and gaming use. Item and reliability analyses were computed. To investigate the component structure, the sample was randomly divided into two subsamples. A maximum likelihood factor analysis was conducted for one subsample and a confirmatory factor analysis (CFA) for the other subsample. The IGDQ had a Cronbach's alpha of 0.70. The IGDQ score correlated with the CIUS score ($r = 0.59$) and the time spent playing ($r = 0.24$). The maximum likelihood factor analysis extracted one component, explaining 30.26% of the variance, which was confirmed by the CFA. The correlation of the IGDQ score with the CIUS score is a first indicator that the IGDQ allows for valid interpretations. In all, 7.94% of the gamers met the criteria for IGD.

Introduction

In 2014, 1.78 billion people worldwide played computer games.[1] A small proportion sought psychotherapeutic treatment because of difficulties with controlling their gaming use and the resulting psychosocial problems.[2] Existing studies with computer game players used different criteria and questionnaires to assess pathological or addicted gaming.[3] Furthermore, most studies focused on Massively Multiplayer Online Role Playing Games (MMORPGs), and few focused on other types of games, such as First-person Shooter Games (FPS) or Multiplayer Online Battle Arenas (MOBAs). This has made comparisons difficult and has led to prevalence rates ranging from 0.2%[4] to 8.7%[5] in different countries. In addition, the methodical heterogeneity made it complicated to determine a threshold for problematic usage.

Internet Gaming Disorder (IGD) has been included in the appendix of the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5)[6] as a tentative diagnosis. The accompanying hope was that standardized criteria will lead to more consistency in studies researching symptoms, underlying mechanisms, comorbidities, and treatments of the condition. Ultimately, it may help to clarify whether IGD is an independent psychiatric disorder. Furthermore, it will enable practitioners to give a diagnosis to excessive Internet gamers seeking treatment.

IGD consists of nine criteria that have to be fulfilled for the duration of the last 12 months: preoccupation with gaming, withdrawal when unable to game, tolerance, failure to stop or to reduce the amount of gaming, giving up other hobbies or activities, continuing to play despite problems, deceiving others about the amount of gaming, gaming to escape adverse moods, and jeopardizing or losing an important relationship, one's occupation, or one's education because of gaming. Gamers have to fulfill at least five criteria to be diagnosed with the disorder.

The criteria are based on those for Substance Use Disorders and Gambling Disorder. Several studies point to similarities between IGD and the disorders it is modeled on.[7] However, there is an ongoing debate on whether classifying IGD as a behavioral addiction and whether basing its criteria on those for Substance Use Disorder and Gambling Disorder might lead to a depreciation of the concept of "addiction."[8]

Petry et al.[10] developed a questionnaire that provides one item for every criterion of IGD. The Internet Gaming Disorder Questionnaire (IGDQ) has been translated from English into Chinese, Dutch, French, German, Italian, Japanese, Korean, Portuguese, Spanish, and Turkish. The authors followed

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the World Health Organization's[9] recommendations for translating questionnaires. One native speaker translated the IGDQ into his or her respective language, and at least one additional native speaker, who was unfamiliar with the original English version, independently back-translated it into English.[10] Discrepancies were discussed before selecting the final wording. The psychometric properties of the IGDQ have not yet been evaluated.

Our aim was to investigate the factorial structure, reliability, and validity of the IGDQ in a broad sample of adult German-speaking gamers playing different types of Internet games. To explore the concurrent validity, we correlated it with the commonly used German version of the Compulsive Internet Use Scale (CIUS).[11] The scale was developed by Meerkerk et al.[12] and has good internal consistency.[11–13] The CIUS is a short tool and according to Brand,[14] conceptually sound.

Methods

Sampling

The local ethics committee approved the study. An invitation to participate in the study and a link to the web-based questionnaire (LimeSurvey, Hamburg, Germany) were placed in gaming forums and social network sites. On the first page of the survey, the participants were informed that their answers would be anonymous; by clicking on a button, they provided informed consent. The participants could discontinue the survey at any time by leaving the website. As an incentive, the participants had the chance to win one of ten gift vouchers for a popular online store (voucher value: 20 €). To ensure anonymity, at the end of the questionnaire, the participants received a link to a second, unrelated web-based survey to provide their e-mail addresses for the draw.

A total of 1,966 people provided informed consent. Of these, 630 (32.04%) failed to fulfill the inclusion criteria (337 were excluded because they did not play computer games for at least 30 minutes per week, 84 because their native language was not German, and 209 because they were younger than 18 years). Of the remaining 1,336, 437 (22.23% of the total sample) dropped out before finishing the survey. Another five (0.25%) were excluded because they failed to provide serious information (e.g., by stating that they played computer games for 168 hours a week).

Participants

The data from 894 gamers were analyzed. According to Bühner,[15] this is a very good sample size for conducting a factor analysis. Of those, 781 (87.36%) were male, 113 (12.64%) female. On average, the participants were 26.49 ± 8.46 years old, ranging from 18 to 75 years.

The participants played Internet games for 18.4 ± 16.1 hours per week, with individual gaming sessions lasting 2.9 ± 2.0 hours. In addition to their gaming, they spent 14.8 ± 18.3 hours every week privately on the Internet engaged in other activities, such as social networking, visiting forums, surfing websites, online shopping, or consuming online pornography. On average, they had played computer games for 13.6 ± 6.3 years.

Procedure

The participants filled in their demographic information (age, sex, native language) and information concerning their gaming and Internet use. In addition, they answered the German versions of the IGDQ[10] and the CIUS.[11]

Materials

Internet use and gaming. The participants were asked which game they played most, which additional games they played, the number of years they had played computer games, the number of hours per week they played Internet games, how long a typical gaming session lasted, and how many hours per week they spent doing other things online (e.g., social networking, visiting forums, surfing websites, online shopping, or consuming online pornography).

Internet Gaming Disorder Questionnaire. The German version of the IGDQ[10] consists of nine items, for example, "Do you lose interest in or reduce participation in other recreational activities (hobbies, meetings with friends) due to gaming?" The items reflect the nine DSM-5 criteria for IGD. The IGDQ has a dichotomous response format, with 0 (*no*) and 1 (*yes*). The cutoff for receiving a diagnosis of IGD, as defined in the appendix of the DSM-5, is five points.

Compulsive Internet Use Scale. The German version of the CIUS[11] measures excessive Internet use with 14 items, for example "Do you prefer to use the Internet instead of spending time with others (e.g., partner, children, parents)?" The participants were asked to refer to their Internet gaming when answering the questionnaire. The CIUS has very good internal consistency, with a Cronbach's alpha ranging from 0.86 to 0.90.[11–13] The scale has a unidimensional structure.[11,12] The items are rated on a five-point scale from 0 (*never*) to 4 (*very often*), with higher scores indicating more use. Participants were asked to refer to their gaming use when answering the questions.

Data analysis

SPSS and SPSS AMOS (version 21; IBM) were used for statistical calculations. A standard item analysis computing internal consistency (standardized Cronbach's α), item difficulties, and corrected item-total correlations of the IGDQ was conducted. To investigate the factor structure, exploratory and confirmatory factor analyses (CFAs) were used. For this purpose, the sample was randomly divided into two subsamples (A and B). Independent t-tests were computed to assess whether there were any differences in the two subsamples regarding age, weekly gaming time, duration of gaming sessions, IGDQ and CIUS scores, and additional recreational Internet use time. The number of men and women in both subsamples was compared using a χ^2 test.

Since the IGDQ has a dichotomous response format, tetrachoric correlations (cosine phi formula) were calculated as input for the factor analysis.[16] The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were calculated to test whether the data set was suitable for factor analysis.

A maximum likelihood (ML) factor analysis was conducted for subsample A. Velicer's Minimum Average Partial (MAP) Test[17] was used to determine the number of components to be extracted. For subsample B, a CFA was computed to test the fit of the component structure that resulted from the ML. As goodness of fit measures, the χ^2 test, root mean square error of approximation (RMSEA), standardized root mean

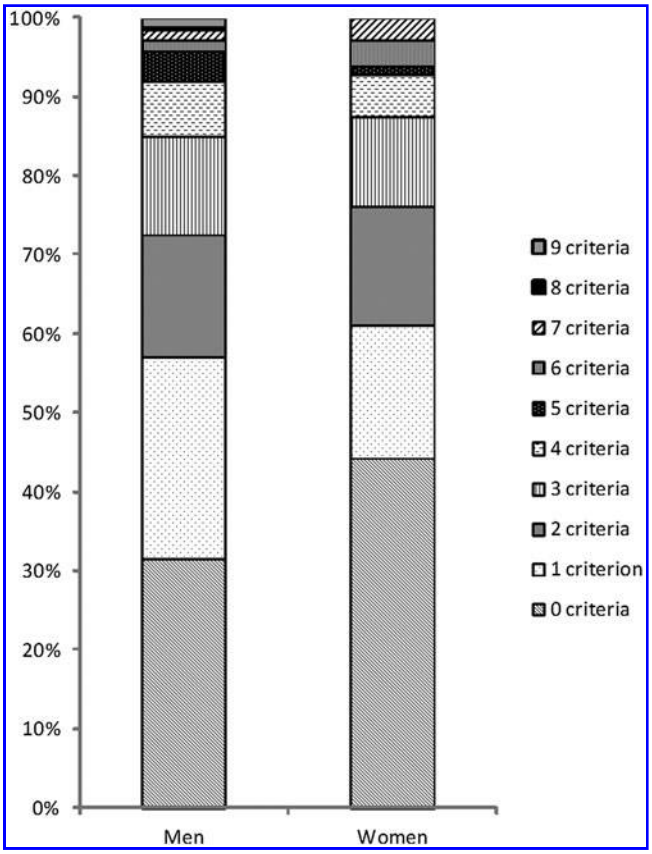

FIG. 1. Percentage of men and women fulfilling different numbers of Internet Gaming Disorder (IGD) criteria.

squared residual (SRMR), and comparative fit (CFI) are reported. According to Schreiber et al.,[18] the thresholds for an acceptable fit are a ratio of the χ^2 to the degrees of freedom of ≤ 2 or 3, a CFI of ≥ 0.95, an RMSEA of <0.06–0.08 (including confidence intervals), and an SRMR of ≤ 0.08.

Gender differences in IGDQ scores were tested using an independent *t*-test. Pearson correlations of the IGDQ and CIUS scores, the time spent playing computer games per week, and the time spent for each computer gaming session were calculated. Gamers with and without a diagnosis of IGD (as determined by IGDQ cutoff) were compared using independent *t*-tests with regard to age and overall weekly gaming time, their favorite game, the duration of individual gaming sessions and their recreational Internet use. The significance value was set at $p < 0.05$, and Cohen's d is reported as a measure of effect size where appropriate.

Results

Gaming and Internet use

The game genres that were played were MMORPGs (36.4%) such as World of Warcraft (Blizzard Entertainment, 2004), FPS (19.6%) such as Counter Strike (Sierra Studios, 2000), and MOBAs (9.2%) such as League of Legends (Riot Games, 2009), strategy games (7.8%) such as Age of Empires II: The African Kingdoms (Ensemble Studios, 2015), action adventure games (7.2%) such as The Legend of Zelda: Twilight Princess (Nintendo, 2016), sport games (4.9%) such as FIFA 16 (Electronic Arts, 2015), online skill and parlor games (3.6) such as Bubble Shooter (Absolutist LTD, 2002), simulation games (2.3%) such as The Sims 4 (Electronic Arts, 2016), Massively Multiplayer Online First-person Shooter Games (2.0%) such as Firefall (Red 5 Studios, 2014), adventure games (1.8%) such as Minecraft (Mojang, 2011), and others (5.2%) such as Trine 2 (Frozenbyte, 2011).

The mean IGDQ score across all participants was 1.70 ± 1.86. There was no significant difference in the IGDQ scores between men (1.7 ± 1.9) and women (1.4 ± 1.8), $t(892) = 1.339$, $p = 0.18$. A total of 71 participants (7.94%) fulfilled at least five IGD criteria (see Fig. 1 for details).

Internet Gaming Disorder Questionnaire

Item analysis and internal consistency. The IGDQ had an internal consistency of Cronbach's alpha = 0.70. The item with the highest endorsement was item 1 (324 people) and the item with the lowest endorsement was item 2 (57 people). The mean item difficulty was $p_i = 0.19$, with difficulties ranging from $p_i = 0.06$ (item 2) to $p_i = 0.36$ (item 1). Item 5 had the largest number of missing answers (8) and items 7 and 9 had the fewest (none). The corrected item-total correlations ranged

Table 1. Characteristics of the Two Subsamples Resulting from the Random Division of the Total Sample for the Purpose of the Exploratory and Confirmatory Factor Analyses

	Subsample 1 (n = 447)		*Subsample 2* (n = 427)				
	M	SD	M	SD	t	*df*	p
Age (years)	26.4	8.4	26.4	8.3	–0.024	872	n.s.
Years of gaming	13.6	6.3	13.7	6.2	–0.297	868	n.s.
Gaming hours per week	19.4	17.6	17.4	14.3	1.856	872	n.s.
Duration of gaming sessions (hours)	3.0	2.1	2.9	2.0	0.791	865	n.s.
Recreational time spent online apart from gaming (hours)	14.2	18.3	15.3	18.1	–0.862	868	n.s.
IGDQ score	1.6	1.8	1.7	1.9	–0.745	872	n.s.
CIUS score	15.9	8.2	16.2	9.4	–0.466	872	n.s.
	Men	*Women*	*Men*	*Women*	χ^2	df	*p*
Sex	386	61	381	46	1.679	1	n.s.

CIUS, Compulsive Internet Use Scale; IGDQ, Internet Gaming Disorder Questionnaire; n.s., not significant ($p > 0.05$).

TABLE 2. NUMBER OF PARTICIPANTS WHO AGREED ON EACH ITEM, NUMBER OF MISSING ANSWERS FOR EACH ITEM, FACTOR LOADINGS, ITEM DIFFICULTIES (P_I), CORRECTED ITEM-TOTAL CORRELATIONS (R_{ITC}), AND INTERNAL CONSISTENCIES WITHOUT EACH ITEM FOR THE INTERNET GAMING DISORDER QUESTIONNAIRE (N=894)

Item	*Endorsement*	*Missing answers*	*Factor loadings*	p_i	r_{itc}	*Cronbach's α without item*
1. Verbringen Sie viel Zeit damit, an Computerspiele zu denken, auch wenn Sie gerade nicht spielen, oder damit zu planen, wann Sie wieder spielen können? (Do you spend a lot of time thinking about games even when you are not playing or planning when you can play next?)	324	1	0.34	0.36	0.28	0.700
2. Fühlen Sie sich ruhelos, gereizt, launisch, wütend, ängstlich oder traurig, wenn Sie versuchen weniger oder gar nicht zu spielen oder wenn Sie keine Möglichkeit zum Spielen haben? (Do you feel restless, irritable, moody, angry, anxious, or sad when attempting to cut down or stop gaming, or when you are unable to play?)	57	5	0.42	0.06	0.38	0.678
3. Verspüren Sie ein Bedürfnis nach längeren Spielzeiten, aufregenderen Spielen, oder leistungsstärkeren Geräten, um das gleiche Ausmaß an Spannung wie üblich zu erreichen? (Do you feel the need to play for increasing amounts of time, play more exciting games, or use more powerful equipment to get the same amount of excitement you used to get?)	178	3	0.39	0.20	0.37	0.676
4. Haben Sie das Gefühl, dass Sie weniger spielen sollten, schaffen es aber nicht Ihre Spielzeiten zu verringern? (Do you feel that you should play less, but are unable to cut back on the amount of time you spend playing games?)	142	6	0.48	0.16	0.37	0.675
5. Verlieren Sie wegen Ihres Computerspielens Interesse an anderen Freizeitaktivitäten (Hobbys, Freunde) oder schränken Sie diese ein? (Do you lose interests in or reduce participation in other recreational activities (hobbies, meetings with friends) due to gaming?)	160	8	0.49	0.18	0.43	0.665
6. Setzen Sie das Spielen fort, obwohl Sie sich negativer Folgen bewusst sind, wie etwa Schlafmangel, Unpünktlichkeit in Schule/Arbeit, zu hohe Geldausgaben, Streitigkeiten mit anderen, oder Vernachlässigung wichtiger Pflichten? (Do you continue to play games even though you are aware of negative consequences, such as not getting enough sleep, being late to school/work, spending too much money, having arguments with others, or neglecting important duties?)	252	3	0.44	0.28	0.42	0.666
7. Belügen Sie Familienmitglieder, Freunde oder andere über das Ausmaß ihres Spielens, oder versuchen Sie ihre Spielzeiten vor Familienmitgliedern oder Freunden zu verheimlichen? (Do you lie to family, friends, or others about how much you game or try to keep your family or friends from knowing how much you game?)	93	0	0.51	0.10	0.42	0.670
8. Spielen Sie Computerspiele um persönlichen Problemen zu entkommen oder um diese zu vergessen, oder um unangenehme Gefühle wie Schuld, Angst, Hilflosigkeit oder Niedergeschlagenheit zu lindern? (Do you game to escape from or forget about personal problems or to relieve uncomfortable feelings such as guilt, anxiety, helplessness, or depression?)	199	6	0.42	0.22	0.32	0.686
9. Gefährden oder verspielen Sie wegen ihres Computerspielens wichtige Beziehungen oder Berufs-, Bildungs- oder Karrierechancen? (Do you risk or lose significant relationships, or job, educational, or career opportunities because of gaming?)	103	0	0.64	0.12	0.49	0.657

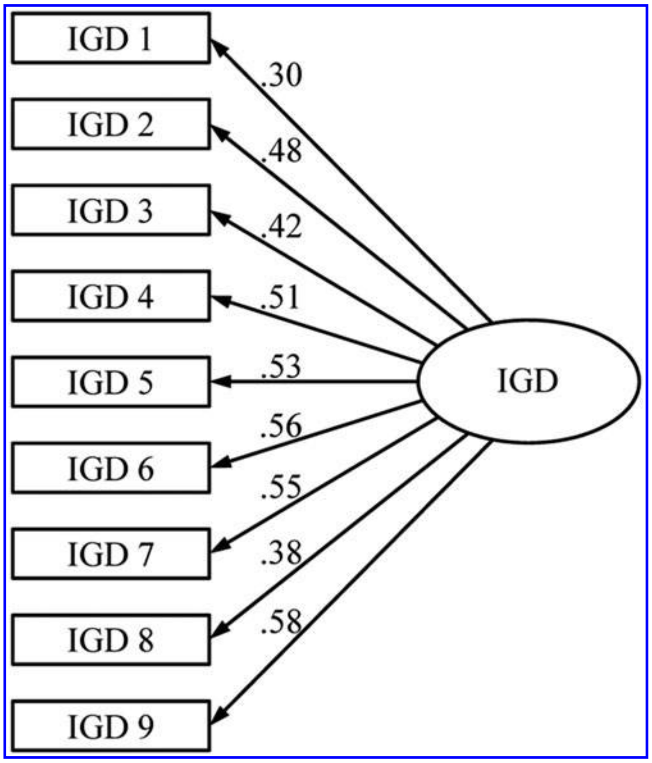

FIG. 2. Path diagram for the confirmatory factor analysis with the standardized path coefficients for subsample 2 ($n = 427$). All path coefficients are statistically significant at $p < 0.001$.

from $r_{itc} = 0.28$ (item 1) to $r_{itc} = 0.49$ (item 9), with a mean item-total correlation of $r_{itc} = 0.39$. See Table 2 for details.

Factor structure. The two subsamples A and B resulting from the random division of the sample for the purpose of the ML and the CFA did not differ regarding age, sex, years that the game had been played, gaming hours per week and per session, recreational Internet use apart from gaming, IGDQ scores, and CIUS scores. See Table 1 for details.

For subsample A, Bartlett's test of sphericity ($\chi^2 = 488.19$, $df = 36$, $p < 0.001$) indicated that correlations between the items were sufficiently large for an ML. The KMO criterion was 0.79, demonstrating good suitability of the data for the analysis. The ML extracted one component that was retained by Velicer's MAP Test.[17] It explained 30.26% of the variance. Factor loadings were between 0.34 (item 1) and 0.64 (item 9). See Table 2 for details. The CFA calculated on the basis of subsample B confirmed the extraction of one component (see Fig. 2 for the path diagram using standardized path coefficients). The χ^2 was significant, $\chi^2(27) = 70.193$, $p < 0.001$, and the χ^2/df ratio was 2.6. The CFI was 0.915, the RMSEA was 0.061 (0.044–0.079), and the SRMR was 0.047.

Correlation with CIUS scores and gaming time. IGDQ scores correlated with CIUS scores, $r = 0.59$, p (one tailed) <0.001. Furthermore, IGDQ scores correlated with the number of hours spent gaming per week, $r = 0.24$, p (one tailed) <0.001 and the duration of a gaming session, $r = 0.26$, p (one tailed) <0.001.

Comparison of persons fulfilling the diagnostic of IGD with persons not fulfilling the criteria. The gamers with IGD were younger compared to those without it and had played games for a shorter period of time. Their CIUS score was higher, they played more overall, and their playing sessions lasted longer. In addition to their gaming, they also spent more time online for other recreational purposes. See Table 3 for details.

Discussion

This study was the first to investigate the reliability and the validity of the German version of the IGDQ, a self-report questionnaire that uses the DSM-5 criteria to assess for IGD.

The IGDQ had a moderate-to-good internal consistency with a Cronbach's alpha of 0.70 that would not have benefitted from discarding any item. On average, the endorsement of the items was low. This is to be expected of a questionnaire whose items represent the criteria for IGD. The majority of gamers play recreationally and should not display the symptoms represented by the criteria; otherwise, there would be an overassessment of the diagnosis. Item 1 had the highest endorsement and item 2 had the lowest. Since the majority of players are very engaged in their gaming without being classified as addicted,[19] it is conceivable that many would confirm their preoccupation with gaming. Item 2 asks whether participants feel withdrawal when they are unable to game. In a broad sample of players, it is plausible to assume that only a few would experience withdrawal.

Table 3. Differences in Gamers with Internet Gaming Disorder and Those Without Regarding Their Age, Gaming, and Internet Use

	Gamers with IGD (n = *71*)		*Gamers without IGD* (n = *823*)				
	M	SD	M	SD	t	*df*	d
Age (years)	24.0	5.4	26.7	8.6	3.817*	104.25	–0.38
Years of gaming	11.8	5.3	13.8	6.3	2.638*	888	–0.34
Gaming hours per week	26.0	22.4	17.7	15.3	–3.048*	75.73	0.43
Duration of gaming sessions (hours)	4.2	2.8	2.8	1.9	–3.880**	75.67	0.59
Recreational time spent online apart from gaming (hours)	21.1	27.8	14.3	17.1	–2.033*	74.65	0.30
CIUS score	27.5	10.6	15.1	7.8	–9.609**	76.63	1.33

*$p < 0.01$, **$p < 0.001$.
IGD, Internet Gaming Disorder.

The corrected item-total correlations of the items were above the threshold of 0.30,[20] indicating moderate discriminatory power. The only exception was item 1 ($r_{itc} = 0.28$), which asks about preoccupation with the game when the person is not actually playing. It seems plausible that the discriminatory power of item 1 would be rather low because persons with and without IGD can be preoccupied with gaming—a preoccupation with gaming acquires meaning for IGD only if additional criteria are fulfilled. Kardefelt-Winther[21] argues that preoccupation is not a suitable criterion to diagnose IGD because gaming has become such a regular leisure activity for the majority of adolescents and that thinking about one's leisure activities is just a natural aspect of their importance.

However, one could object that nicotine and alcohol consumption are regular in adolescents as well and although preoccupation with the substance would not be *sufficient* to diagnose an abuse, in combination with other criteria, continuing preoccupation may well be regarded as an indication of a disorder. The preoccupation criterion needs to be investigated further with studies comparing the symptoms of gamers with and without IGD. Furthermore, qualitative and quantitative research could investigate the motives of gamers that lead to a preoccupation with gaming. Knowing about the motives behind the symptoms may prove especially helpful when it comes to the treatment of the disorder.

The ML extracted one component, which explained 30.26% of the variance. The CFA, using a second, independent sample, also confirmed the extraction of one component. The fit indices were all satisfactory, except for the CFI, which was slightly below the threshold for an acceptable fit of the model.[18] Overall, the results point to the extraction of one underlying component, namely IGD. The variance explained by this is comparably low because IGD is composed of nine criteria all belonging to one diagnosis but correspond to conceptually different problematic behaviors and symptoms.

IGDQ scores were compared to external criteria. According to Cohen,[22] they showed a large correlation with CIUS scores, a medium correlation with the hours spent gaming per week, and a medium correlation with the duration of a gaming session. Other studies also found medium correlations between pathological gaming and weekly gaming time.[12,13,23] As previously stated, players can be very engaged in their gaming and thus spend a lot of time playing, without displaying pathological behavior.[19] The correlation of the IGDQ score with the CIUS score is a first indicator that the IGDQ is a valid questionnaire for assessing IGD.

The differentiation between gamers with and without IGD according to the IGDQ seemed to yield reasonable results. The CIUS score of the participants with IGD was higher than was the CIUS score of the participants without it. On average, the participants with IGD played for 26 hours per week and those without it for 15.3 hours per week. This is comparable to what previous studies found.[24,25] In addition, playing sessions lasted longer for the gamers who met criteria for IGD.

This study is not without limitations. The study was restricted to adult German-speaking participants. Different results may occur for children and adolescents. Using online surveys has several advantages, such as providing large and heterogeneous samples and being economic to administer.[26] However, participants might feel freer to drop out before finishing an online survey. In this study, 22.23% of the participants fulfilling the inclusion criteria dropped out, which is below the average rate of 34% previously reported for Internet-based studies.[27] However, the influence of this dropout rate on the final results cannot be ruled out. Some gamers might have stopped filling in the questionnaire because they felt uneasy when asked about their problems with gaming.

In conclusion, the German version of the IGDQ can be used to assess IGD. Further studies should follow up on these findings by including participants from other countries, in addition to children and adolescents. Field trials and diagnostic interviews with excessive Internet gamers could further investigate the clinical validity of IGD and the practical utility of the IGDQ. In addition, it would be interesting to investigate the relationship of the IGDQ with a questionnaire that measures not only the IGD-criteria but also relevant constructs for cognitive behavioral therapy such as the *Generalized Problematic Internet Use Scale 2*.[28,29]

Author Disclosure Statement

Prior to their affiliation with Philipps-University, Marburg, F.J. and A.B. worked at Georg-August University, Goettingen, where the data were collected.

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Attentional bias in excessive Internet gamers: Experimental investigations using an addiction Stroop and a visual probe

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Background and aims: Internet Gaming Disorder is included in the *Diagnostic and statistical manual of mental disorders* (5th edition) as a disorder that merits further research. The diagnostic criteria are based on those for Substance Use Disorder and Gambling Disorder. Excessive gamblers and persons with Substance Use Disorder show attentional biases towards stimuli related to their addictions. We investigated whether excessive Internet gamers show a similar attentional bias, by using two established experimental paradigms. *Methods:* We measured reaction times of excessive Internet gamers and non-gamers ($N = 51$, 23.7 ± 2.7 years) by using an addiction Stroop with computer-related and neutral words, as well as a visual probe with computer-related and neutral pictures. Mixed design analyses of variance with the between-subjects factor group (gamer/non-gamer) and the within-subjects factor stimulus type (computer-related/neutral) were calculated for the reaction times as well as for valence and familiarity ratings of the stimulus material. *Results:* In the addiction Stroop, an interaction for group × word type was found: Only gamers showed longer reaction times to computer-related words compared to neutral words, thus exhibiting an attentional bias. In the visual probe, no differences in reaction time between computer-related and neutral pictures were found in either group, but the gamers were faster overall. *Conclusions:* An attentional bias towards computer-related stimuli was found in excessive Internet gamers, by using an addiction Stroop but not by using a visual probe. A possible explanation for the discrepancy could lie in the fact that the visual probe may have been too easy for the gamers.

Keywords: attentional bias, Internet Gaming Disorder, MMORPG, addiction Stroop, visual probe

INTRODUCTION

Excessive Internet gaming is associated with psychosocial problems such as decreasing academic or occupational performance (Chen & Tzeng, 2010; Chiu, Lee, & Huang, 2004; Griffiths, Davies, & Chappell, 2004; Hellström, Nilsson, Leppert, & Slund, 2012; Jeong & Kim, 2011; Liu & Peng, 2009; Peng & Liu, 2010; Rehbein, Kleimann, & Mössle, 2010; Skoric, Teo, & Neo, 2009; Van Rooij, Kuss, Griffiths, Shorter, & Van de Mheen, 2013), neglecting hobbies and relationships outside the game (Griffiths et al., 2004; Hellström et al., 2012; Liu & Peng, 2009; Lo, Wang, & Fang, 2005; Rehbein et al., 2010), interpersonal conflicts (Batthyány, Müller, Benker, & Wölfling, 2009; Hellström et al., 2012; Shen & Williams, 2011), loneliness (Lemmens, Valkenburg, & Peter, 2011; Shen & Williams, 2011; Van Rooij, Schoenmakers, Vermulst, Van den Eijnden, & Van de Mheen, 2011), and sleep deprivation (Achab et al., 2011; Griffiths et al., 2004; Hellström et al., 2012; Rehbein et al., 2010; Van Rooij et al., 2013).

Currently, 671 million people worldwide play computer games (Singh, 2013). *Massively multiplayer online role-playing games (MMORPGs)* account for a fourth of the worldwide revenue for computer games (Barnett & Coulson, 2010). MMORPGs are fantasy-based games in which thousands of players interact through their individual character, the avatar. In order to be successful, players have to cooperate (Cole & Griffiths, 2007) and invest successively more time (Van Rooij et al., 2011). MMORPGs have no end-point (such as a final battle) and are persistent; that is to say, the game continues, even if a player is not logged in (Barnett & Coulson, 2010). Players are reinforced intermittently through acquiring higher levels, abilities, virtual gold, or better equipment. The most popular MMORPG is *World of Warcraft (WoW)*, which has 10 million subscribers (Blizzard Entertainment, 2014). Because of their social nature, persistence, and intermittent reinforcement, MMORPGs bear a high risk for excessive use (Beutel, Hoch, Wölfling, & Müller, 2011). Smyth (2007) assigned students who previously did not play computer games to play one (solo, arcade, console, or MMORPG) for at least an hour per week. After one month, MMORPG-players reported playing more often than the other participants, worse physical health and sleep quality, and the game interfering more with their studies.

Internet Gaming Disorder has been included in the appendix of the *Diagnostic and statistical manual of mental disorders* (5th edition) to encourage further research (American Psychiatric Association, 2013). The diagnostic criteria are based on those for Substance Use Disorder and Gambling Disorder (Petry et al., 2014). The question arises

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whether Internet Gaming Disorder and these disorders share features in the development and maintenance of the disorder (e.g., conditioning and attentional processes).

An attentional bias is a robust finding in people with Substance Use Disorder (Cox, Fadardi, & Pothos, 2006; Robbins & Ehrman, 2004); it manifests itself in an increased attention towards stimuli that are associated with each respective addiction (Cox et al., 2006). Regarding Gambling Disorder, such a bias was demonstrated in four studies (Boyer & Dickerson, 2003; McCusker, Gettings, & Ireland, 1997; Molde et al., 2010; Vizcaino et al., 2013), whereas one study failed to find evidence for it (Atkins & Sharpe, 2006).

According to the theory of current concerns, a motivational state, or current concern, lies between the decision to pursue a goal and accomplishing or giving up the goal (Cox et al., 2006). People with Substance Use Disorder have the goal of using a substance. Stimuli that are related to it have a strong motivational value for them. Hence, they become the centre of attention and an attentional bias towards these stimuli develops. Over time, this can become implicit and automatic. During the course of a current concern, conditioning processes can develop. According to classical conditioning, a neutral stimulus (e.g., lighter) is repeatedly paired with an unconditioned stimulus (e.g., nicotine), and becomes a conditioned stimulus (CS) that causes arousal and craving (Field & Cox, 2008). Since the CS predicts the drug, it is more salient than other stimuli and the person shifts their attention towards it. Attentional biases play a role in the maintenance of addictions. If people with Substance Use Disorder notice drug-related stimuli more often, they experience craving (Field, Munafò, & Franken, 2009), which in turn may lead to renewed consumption and may make staying abstinent difficult (Cox, Hogan, Kristian, & Race, 2002). Alcohol-related attentional biases predicted the amount of future alcohol consumption (Janssen, Larsen, Vollebergh, & Wiers, 2015), and an attentional bias modification training improved abstinence (Schoenmakers et al., 2010).

Two commonly used measures for attentional bias are the addiction Stroop and the visual probe (Field & Cox, 2008). In the addiction Stroop, an addiction-related or a neutral word is presented in one of several colours (Field & Cox, 2008). Participants are instructed to indicate the colour, and reaction times are measured. An attentional bias manifests itself in a *slower* reaction to addiction-related words. The underlying mechanism is that the automatic processing of the semantic content of the more salient words interferes with naming the word's colour (Cox et al., 2006). In order to be able to attribute any differences in reaction time to the word type, it is important that the addiction-related and neutral words do not differ in basic characteristics such as number of letters, syllables, and frequency in the language; and, since the addiction words are from one category, so should the neutral words be (Cox et al., 2006). In the visual probe, an addiction-related and a neutral picture are presented side by side (Field & Cox, 2008). One of the pictures is then replaced by a target, and participants are instructed to indicate its position. Again, reaction times are measured. In general, people react faster to a stimulus when it appears in an attended region (Posner, Snyder, & Davidson, 1980). If people with Substance Use Disorder react faster to targets replacing addiction-related pictures than to neutral ones, it is inferred that they attended more to the addiction-related pictures (Field & Cox, 2008). In this case, an attentional bias manifests itself in *faster* reaction times to addiction-related material.

For excessive Internet gamers, attentional biases have been investigated only with regard to material directly related to the games. The results were heterogeneous. One addiction Stroop task (Metcalf & Pammer, 2011) and one dot-probe task (Lorenz et al., 2013) found an attentional bias towards MMORPG stimuli, one addiction Stroop and one visual probe failed to do so (Van Holst et al., 2012). It was our aim to extend these findings and to investigate the question whether excessive gamers show an attentional bias not only towards MMORPG stimuli but towards computer stimuli in general. Computers are regularly paired with the gaming experience and according to the model (Field & Cox, 2008) should themselves become the CS and give rise to an attentional bias. If so, this would be highly relevant to the maintenance and treatment of excessive Internet gaming.

Therefore, we tested the following hypotheses:

Excessive gamers would show an attentional bias such that they react slower to computer-related words compared to neutral words in an addiction Stroop.

Excessive gamers would show an attentional bias such that they react faster to targets presented in the position of a computer-related stimulus compared to targets presented in the position of a neutral picture in a visual probe.

METHODS

Participants

The sample size was computed *a priori* with G*Power (version 3.1.9.2, Kiel, Germany). With $\alpha = 0.05$, $f = 0.25$, and a power of 0.80 it yielded an overall sample size of 34 participants. Students were recruited via advertisements on bulletin boards at the University of Goettingen and in online forums. They were screened for their computer game usage. Students who played *WoW* were given a link to a web-based questionnaire (SurveyMonkey, Portland, USA), and filled in the German version of the *Compulsive Internet Use Scale for WoW (CIUS-WoW)* (Barke, Nyenhuis, Voigts, Gehrke, & Kröner-Herwig, 2013) at home. The CIUS-*WoW* measures excessive *WoW* usage with 14 items and has a good internal consistency (Cronbach's $\alpha = .86$) (Barke et al., 2013). The items are rated on a five-point scale from 0 *(never)* to 4 *(very often)*, with higher scores indicating more use. If *WoW* players had a mean CIUS-*WoW* score of at least 25 (highest 25% of all screened *WoW* players), they were classified as excessive gamers and were invited to participate. Students who did not play any computer games were invited directly to participate. Twenty-one gamers and 30 non-gamers participated. The gamers had a mean CIUS-*WoW* score of 29.0 ± 3.5. On average, they were playing *WoW* for 15.4 ± 11.3 hours per week. Two gamers and one non-gamer were excluded from the addiction Stroop because their inability to identify the numbers on the test plates of the Ishihara Test (Ishihara Farbtafel, 2009) indicated problems with colour vision. One gamer's reaction times could not be analysed, because the computer failed to save his log file.

Procedure and measures

The participants completed six test plates of the Ishihara Test (Ishihara Farbtafel, 2009). The test plates show dots in shades of green and red that form numbers. People with normal colour vision should be able to correctly identify the numbers. Testing the colour vision was necessary because the participants were required to indicate colours in the addiction Stroop. They answered questions concerning demographics and computer usage. They took part in the addiction Stroop and the visual probe tasks. The order of the tasks was balanced between participants to avoid sequence effects. Participants were tested individually in a darkened laboratory. They completed the tasks on a standard 17-inch computer monitor and used a regular keyboard, a chin-rest to ensure a constant distance of 62 cm to the screen, and earmuffs to block out ambient sound. After the experimental tasks, participants rated the valence and the familiarity of the words and the pictures used in the tasks on two 9-point scales, ranging from 1 *(very unpleasant)* to 9 *(very pleasant)* and 1 *(very unfamiliar)* to 9 *(very familiar)*. All participants received 10 euros for their participation.

Behavioural tasks. Both tasks were programmed with Presentation (version 14.8, Neurobehavioral Systems, Berkeley, USA). Reaction times, pressed keys, and missed targets were saved as log files and then imported into statistical software for further processing.

Addiction Stroop. The participants saw 20 neutral words belonging to the category office (e.g., telephone) and 20 computer-related words (e.g., keyboard). Neutral and computer-related words had equal frequencies in the German language (Institut für Deutsche Sprache, 2009) and the same number of letters and syllables. Each word was presented once in red, yellow, green, and blue, resulting in 160 stimuli for each block. Between the two blocks, participants had a five-minute break. Each trial lasted 1000 ms, in which subjects saw one word in the centre of the screen against a grey background. Each word was presented until a key was pressed. Once a key was pressed, a white fixation cross appeared for the remainder of the trial. After 1000 ms, the next word appeared automatically. The order of words and colours was randomised. The keys 'a', 's', 'k', and 'l' had stickers with the four colours on them. The participants placed four fingers on the keyboard and were instructed to press the corresponding key as quickly as possible. Prior to the experimental blocks, they familiarised themselves with the task in a practice run with 10 animal words (once in each colour, i.e., 40 stimuli).

Visual probe. Participants viewed 10 neutral (e.g., a radio) and 10 computer-related (e.g., a monitor) black and white pictures (300 × 300 pixels). A Fourier analysis ensured the picture categories did not differ in low-level characteristics, such as contrast and detail. A white fixation cross was visible in the middle of the grey screen for the whole duration of the experiment and participants were instructed to fixate throughout. For each trial, participants viewed one computer-related and one neutral picture side by side for a 150 or 450 ms [short or long stimulus onset asynchrony (SOA)] (see Figure 1). Short SOAs can be used to measure an initial shifting to a relevant stimulus, whereas long SOAs assess difficulties in disengaging from it (Cox et al., 2006). For 50 ms, the pictures were replaced by a blank screen, and then a target (a yellow square) appeared in place of one of the pictures for 200 ms. The participants were instructed to indicate the target position as quickly as possible with the key 'alt' (left targets) and the key 'alt gr' (right targets). Afterwards, a blank screen appeared for 1000 or 2000 ms (inter-trial interval). In trials with a short SOA, the blank screen was presented afterwards for 300 ms so that each trial lasted 1700 or 2700 ms. The participants familiarised themselves with the task in six practice trials with animal pictures and completed 200 experimental trials (100 short and 100 long SOAs). The SOA, the duration of the

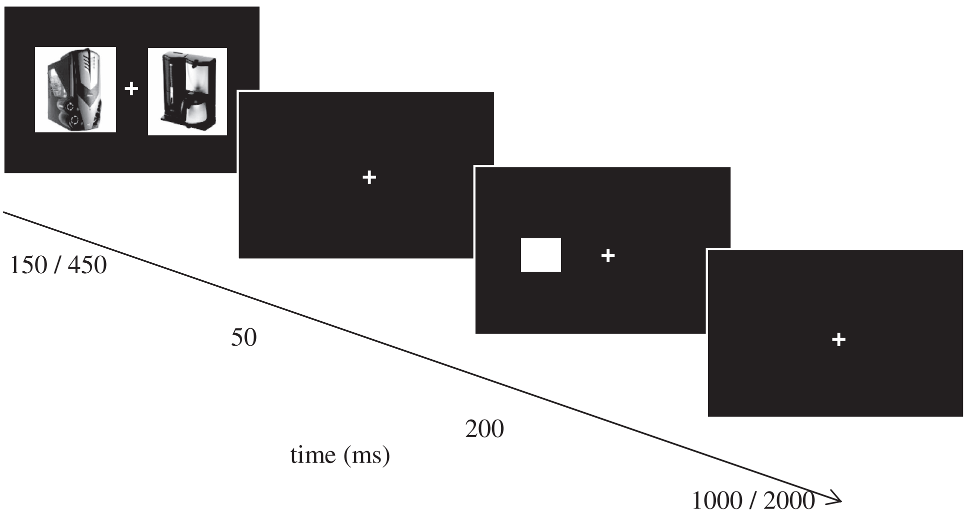

Figure 1. Sequence of one trial in the visual probe. A computer-related picture and a neutral picture appeared for 150 or 450 ms (short or long stimulus onset asynchronies), followed by a blank screen for 50 ms, a yellow square (here depicted in white) on the right or left side for 200 ms, and a blank screen for 1000 or 2000 ms (inter-trial interval). In trials with a short stimulus onset asynchrony, the blank screen was presented afterwards for 300 ms so that each trial lasted 1700 or 2700 ms

inter-stimulus interval, and the position of the pictures and targets were randomised.

Statistical analysis

Statistica (version 10, StatSoft, Tulsa, USA) and SPSS (version 22, IBM, Armonk, USA) were used for statistical calculations. Independent *t*-tests were conducted to compare age and private computer use and a χ^2 analysis to compare the sex distribution between the groups. The reaction times, the number of errors, and the number of missed responses in the addiction Stroop, as well as the valence and the familiarity of the stimuli, were analysed by using 2 × 2 mixed design analyses of variance (ANOVA) with the between-subjects factor group (gamers/non-gamers) and the within-subjects factor word/picture type (computer-related/neutral). The reaction times and number of errors in the visual probe were analysed by using a 2 × 2 × 2 mixed-design ANOVA with the between-subjects factor group (gamers/non-gamers) and the within-subjects factors SOA (150 ms/450 ms), and picture type (computer-related/neutral). Only correct responses were included in the analyses of the reaction times. In the addiction Stroop, 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). LSD 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 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 Georg-August University, Goettingen, approved the study, because the authors have worked there before and the experiments have been conducted there. All subjects were informed about the study and all provided informed consent.

RESULTS

Demographics

The groups did not differ significantly with regard to sex, $\chi^2(1) = 1.85, p > .10$ or age, $t(45) = -1.55, p > .10$, but the excessive gamers spent more time using their computer for recreational purposes than the non-gamers, $t(45) = 4.51$, $p < .001$, $d = 1.19$. See Table 1 for details.

Table 1. Descriptive statistics for the excessive Internet gamers and the non-gamers

	Excessive Internet gamers ($n = 21$)	Non-gamers ($n = 30$)
Sex (% male)	81.0	63.3
Age (years)	22.9 ± 2.1	24.5 ± 3.2
Private computer usage per day (h)	4.7 ± 2.9	2.0 ± 1.4

Addiction Stroop

The 2 × 2 ANOVA showed no main effect for group, $F(1,46) = 0.92$, $p = .34$, or word type, $F(1,46) = 0.03$, $p = .86$, but it did show an interaction for group × word type, $F(1,46) = 12.13$, $p = .001$, $\eta^2 = .01$. LSD post-hoc tests revealed that the gamers reacted more slowly to computer-related words (583.2 ± 42.2) than to neutral words (573.7 ± 41.2) and that the non-gamers reacted more slowly to neutral words (597.5 ± 57.9) than to computer-related words (587.0 ± 50.3). See Figure 2 for details.

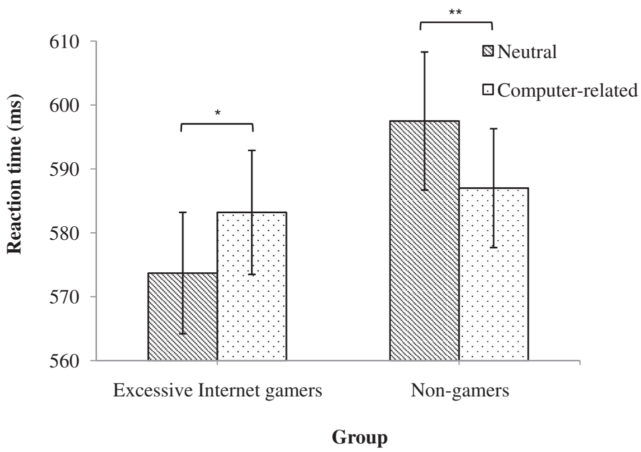

Figure 2. Mean reaction times (± SE) to neutral and computer-related words in the addiction Stroop. Brackets indicate significant post-hoc tests, $*p < .05$, $**p < .01$

The participants pressed the wrong key in 10.2% of all trials and missed a word in 6.2% of all trials. The participants' errors were analysed with a 2 × 2 mixed design ANOVA. It did not yield a main effect for group, $F(1,46) = 0.012$, $p = .92$, word type, $F(1,46) = 0.003$, $p = .96$, or an interaction group × word type $F(1,46) = 0.68$, $p = .41$ for the 2 × 2 ANOVA. The analysis of missed words with a 2 × 2 ANOVA did not yield a main effect for group, $F(1,46) = 3.01$, $p = .09$, word type, $F(1,46) = 0.25$, $p = .62$, or an interaction group × word type, $F(1,46) = 0.25$, $p = .62$.

Visual probe

The 2 × 2 × 2 ANOVA showed a main effect for group, $F(1,49) = 4.59$, $p = .037$, $\eta^2 = .06$ (the gamers reacted faster overall than the non-gamers) and a main effect for SOA, $F(1,49) = 51.34$, $p < .001$, $\eta^2 = .10$ (participants reacted faster after long SOAs than they did after short SOAs), but it showed no main effect for picture type, $F(1,49) = 1.22$, $p = .28$. There were no interactions for SOA × group, $F(1,49) = 0.51$, $p = .48$, picture type × group, $F(1,49) = 0.40$, $p = .84$, SOA × picture type, $F(1,49) = 3.11$, $p = .08$, or SOA × picture type × group, $F(1,49) = 1.32$, $p = .26$. See Table 2 and Figure 3 for details.

The participants pressed the wrong key in 1.8% of trials. The participants' errors were again analysed with a 2 × 2 × 2 mixed design ANOVA. This analysis did not show a main effect for group, $F(1,49) = 1.15$, $p = .29$, picture type, $F(1,49) = 2.56$, $p = .12$, or SOA, $F(1,49) = 0.05$, $p = .83$,

Table 2. Reaction times (ms) to neutral and computer-related words with short and long stimulus onset asynchronies in the visual probe

		Short stimulus onset asynchrony				Long stimulus onset asynchrony			
		Neutral		Computer-related		Neutral		Computer-related	
Group	*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Excessive Internet gamers	30	331.2	31.9	336.1	31.8	319.5	30.2	317.9	25.9
Non-gamers	21	353.4	42.4	355.2	43.2	341.8	39.1	342.3	40.9

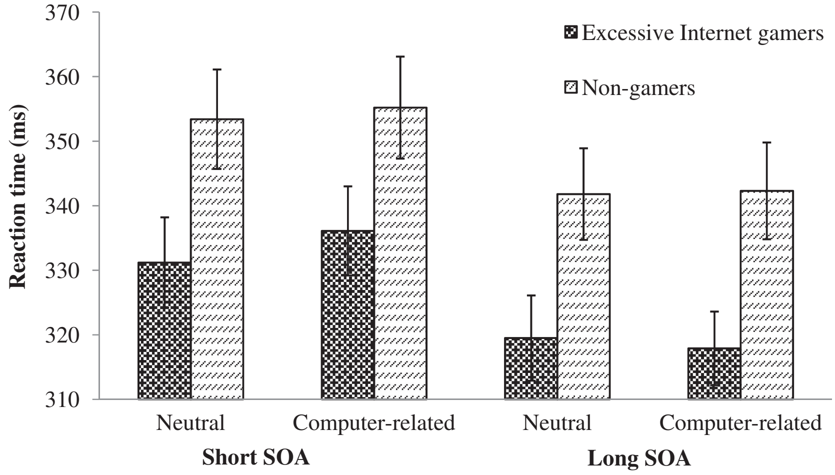

Figure 3. Mean reaction times (± SE) to neutral and computer-related pictures with short and long stimulus onset asynchronies (SOA) in the visual probe

but it did show an interaction group × picture type, $F(1,49) = 4.79$, $p = .033$, $\eta^2 = .01$. LSD post-hoc tests revealed that the gamers made more errors with computer-related pictures (4.7 ± 3.7) than with neutral pictures (3.4 ± 2.5). The non-gamers did not differ in the number of errors with neutral pictures (3.4 ± 2.7) and computer-related pictures (3.2 ± 2.3). There were no interactions for group × SOA, $F(1,49) = 2.20$, $p = .14$, picture type × SOA, $F(1,49) = 0.002$, $p = .96$, or group × picture type × SOA, $F(1,49) = 0.65$, $p = .42$. Participants did not miss any targets.

Valence and familiarity

Words. Regarding valence, the 2 × 2 ANOVA showed a main effect for word type, $F(1,46) = 11.60$, $p = .001$, $\eta^2 = .07$ and an interaction group × word type, $F(1,46) = 30.81$, $p < .001$, $\eta^2 = .19$. LSD post-hoc tests revealed that the gamers rated computer-related words (6.4 ± 1.3) as more positive than neutral words (5.2 ± 0.7). The non-gamers' valence ratings did not differ for neutral (5.6 ± 0.8) and computer-related words (5.3 ± 0.9). There was no main effect for group, $F(1,46) = 1.52$, $p = .22$. See Figure 4a for details.

Regarding familiarity, the 2 × 2 ANOVA showed a main effect for group, $F(1,46) = 4.38$, $p = .04$, $\eta^2 = .05$ and a group × word type interaction, $F(1,46) = 13.79$, $p = .001$, $\eta^2 = .09$. LSD post-hoc tests revealed that the gamers were more familiar with computer-related words (7.9 ± 0.9) than with neutral words (7.1 ± 1.3); the reverse was true for the non-gamers (neutral words: 7.1 ± 1.3; computer-related words: 6.6 ± 1.4). There was no main effect for word type, $F(1,46) = 0.89$, $p = .35$. See Figure 4c for details.

Pictures. Regarding valence, there were no main effects for group, $F(1,49) = 1.79$, $p = .19$ or picture type, $F(1,49) = 2.59$, $p = .11$ for the 2 × 2 ANOVA, but an interaction was found, $F(1,49) = 23.43$, $p < .001$, $\eta^2 = .07$. LSD post-hoc tests showed that the gamers rated computer-related pictures (6.5 ± 1.5) as more positive than neutral pictures (5.8 ± 1.4) and that the non-gamers rated neutral pictures (5.9 ± 1.3) as more positive than computer-related ones (5.5 ± 1.2). See Figure 4b for details.

Regarding familiarity, the 2 × 2 ANOVA showed a main effect for picture type, $F(1,49) = 12.65$, $p = .001$, $\eta^2 = .06$ and a group × picture type interaction, $F(1,49) = 10.21$, $p = .002$, $\eta^2 = .05$. LSD post-hoc tests revealed that the gamers were more familiar with computer-related pictures (7.3 + 1.1) than with neutral pictures (6.3 + 1.3). The familiarity ratings of the non-gamers did not differ between neutral pictures (6.2 + 1.0) and computer-related pictures (6.3 + 1.3). There was no main effect for group, $F(1,49) = 2.85$, $p = .10$. See Figure 4d for details.

DISCUSSION AND CONCLUSIONS

We used an addiction Stroop and a visual probe to examine whether excessive Internet gamers show an attentional bias towards computer-related stimuli. Supporting our first hypothesis, the gamers reacted more slowly to computer-related compared to neutral words in an addiction Stroop. However, their reaction times did not differ between targets

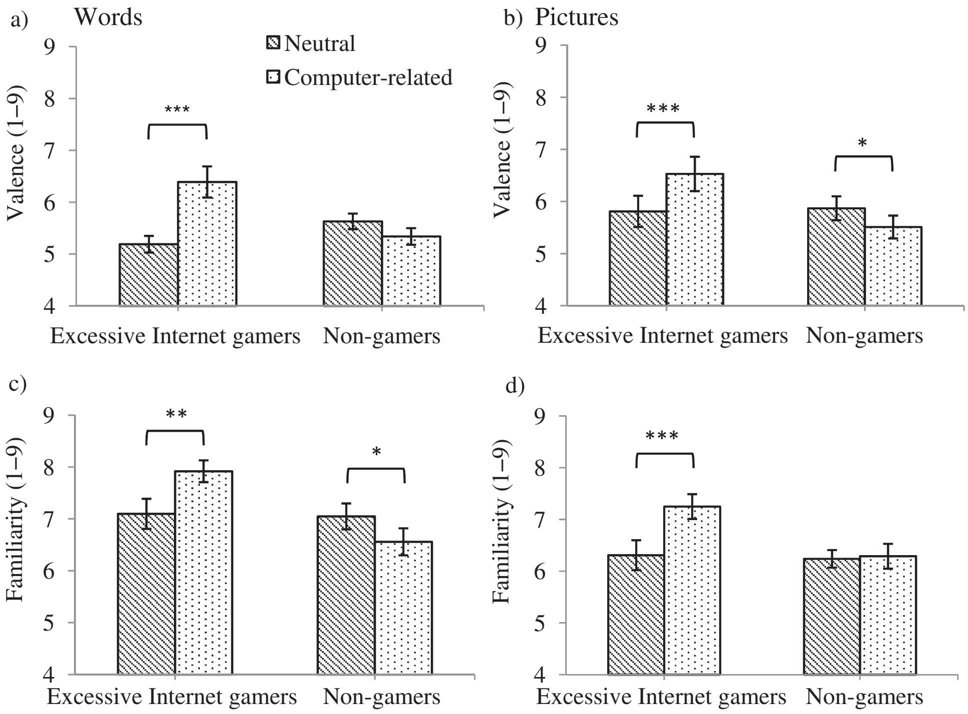

Figure 4. Mean valence and familiarity (± SE) of neutral and computer-related words (left) and pictures (right) in the addiction Stroop and the visual probe. Brackets indicate significant post-hoc tests, $*p < .05$, $**p < .01$ $***p < .001$

following computer-related and neutral pictures in a visual probe. Thus, our second hypothesis was not supported.

The finding that excessive gamers show an attentional bias in an addiction Stroop extends the results from Metcalf and Pammer (2011). Not only MMORPG words but also words related to computers in general, such as *monitor*, drew the attention of excessive Internet gamers and caused an interference with a behavioural task. This is in agreement with the model according to which the attentional bias is caused by classical conditioning in that stimuli that are related to the context, rather than the content, of the gaming experience become the CS. Moreover, according to the theory of current concerns (Cox et al., 2006), computers have a strong motivational value for people who pursue the goal of gaming. Contrary to our results, Van Holst et al. (2012) did not find a reaction time difference between gaming and neutral words. A possible explanation for the discrepancy could be that they investigated a less homogenous sample and used more heterogenic stimulus material: their participants played different types of games and the words that the participants viewed stemmed from these different games so that they might not have been of equal relevance for all gamers.

Similar to Van Holst et al. (2012) we did not demonstrate an attentional bias in the reaction times in a visual probe, but we found that only the excessive Internet gamers made significantly more errors with targets following computer-related pictures compared to neutral pictures. This might indicate that seeing computer-related pictures led to a preoccupation with computer games that interfered with correctly locating the target. Nonetheless, since the participants made so few errors in general, this result needs to be interpreted with caution. Contrary to our study, Lorenz et al. (2013) found an attentional bias in excessive *WoW* gamers towards *WoW*-related pictures in a dot-probe. Conceivably, *WoW*-related pictures are more attention-grabbing than computer-related pictures.

A review by Dye, Green, and Bavelier (2009) came to the result that playing action video games improves reaction times. This might be the reason why the gamers were faster overall than the non-gamers in the visual probe. However, gamers were not faster in the addiction Stroop. Possibly, reacting to a target that is in one location or another is more similar to their regular gaming experience than indicating the colour of a word. Moreover, the mechanisms that underlie the tasks differ: in the addiction Stroop, processing the semantic meaning of the computer-related word *interferes* with naming the word's colour, whereas in the visual probe, allocating the attention towards a computer-related picture *facilitates* detecting a target following it.

The excessive Internet gamers but not the non-gamers rated computer-related words and pictures more positive than neutral ones and were more familiar with them, showing a pattern to be expected and supporting the stimulus selection.

Since the results of the experiments are conflicting, further studies are needed to explore the attentional bias in excessive Internet gamers. We lean towards the conclusion that gamers show an attentional bias, which is in line with the results from studies with people with Substance Use Disorder (Cox et al., 2006; Robbins & Ehrman, 2004) and Gambling Disorder (Boyer & Dickerson, 2003; McCusker et al., 1997; Molde et al., 2010; Vizcaino et al., 2013), as well as our addiction Stroop. One reason for the absence of an effect in the visual probe might be that the task was too easy for the gamers to detect a bias. The excessive gamers in our study had mean reaction times of 326 ms to all targets. Compared to this, people with Substance Use

Disorder show reaction times between 361 and 643 ms (Bradley, Field, Mogg, & De Houwer, 2004; Bradley, Mogg, Wright, & Field, 2003; Ehrman et al., 2002; Field & Cox, 2008; Field, Eastwood, Bradley, & Mogg, 2006; Field, Mogg, & Bradley, 2004; Field, Mogg, Zetteler, & Bradley, 2004; Lubman, Peters, Mogg, Bradley, & Deakin, 2000; Mogg, Bradley, Field, & De Houwer, 2003). It is possible that even if gamers paid more attention to the computer-related stimuli, this still may not have facilitated detecting targets following those stimuli, because perhaps reacting to the targets was so easy that facilitation could not improve the reaction time further. Eye tracking could be used to find out whether excessive Internet gamers allocate their attention towards computer-related pictures. Marks et al. (2014) combined a visual probe with eye tracking when investigating people addicted to cocaine. The authors found no difference in the reaction times, but the eye-tracking showed that people addicted to cocaine fixated longer on addiction-related pictures than on neutral ones.

The results of our study should be interpreted in the light of its limitations: The sample consisted of university students, thus limiting the generalisability. Possibly the visual probe was too easy for the participants, and thus, future studies should use a more challenging paradigm. Among the methodical strengths of the present study should be counted that Cox et al.'s (2006) requirements for a valid addiction Stroop were fulfilled and in general low-level differences between computer-related and neutral stimuli were avoided, which might influence reaction times.

In conclusion, the addiction Stroop, but not the visual probe, provided evidence for the existence of an attentional bias in excessive Internet gamers. Further studies should follow this up by employing direct measures of attentional biases, such as eye tracking.

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Authors' contribution: NN and AB designed the study. FJ 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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Using two web-based addiction Stroops to measure the attentional bias in adults with Internet Gaming Disorder

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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.

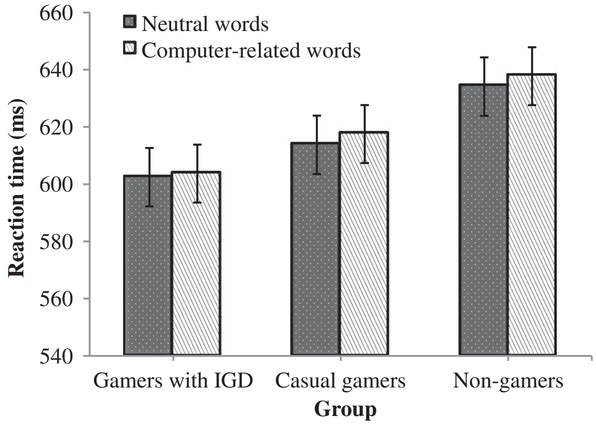

Figure 1. Mean reaction times (±SE) to neutral and computer-related words in the addiction Stroop in Study 1

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).

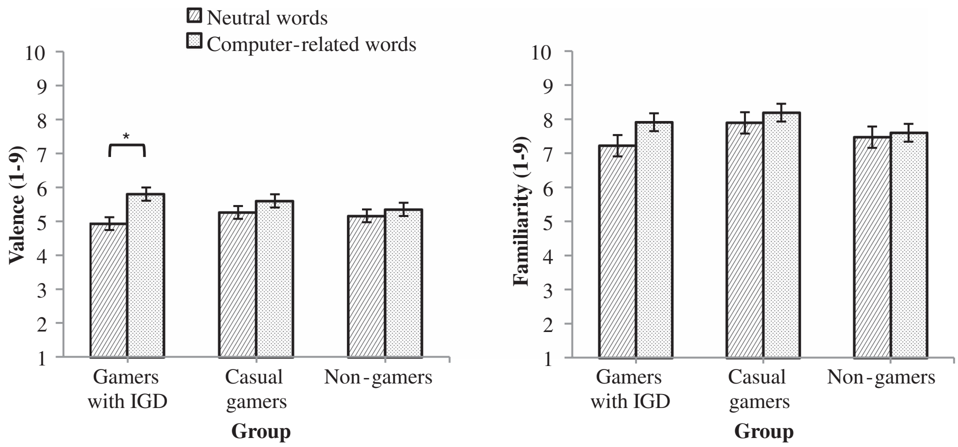

Figure 2. Valence and familiarity ratings (±SE) of neutral and computer-related words in the addiction Stroop in Study 1. Brackets indicate significant post-hoc tests, *$p < .001$

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.

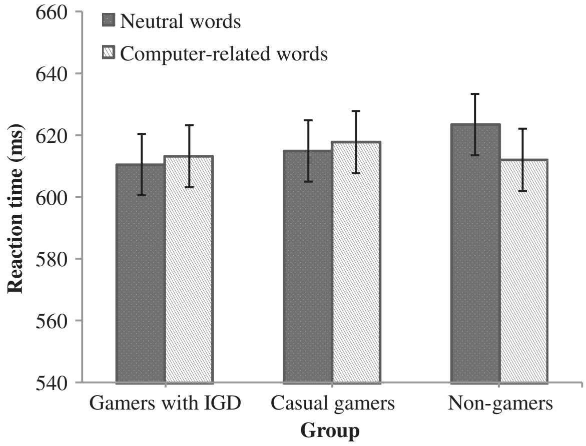

Figure 3. Mean reaction times (±SE) to neutral and computer-related words in the addiction Stroop in Study 2

$p = .424$. 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.

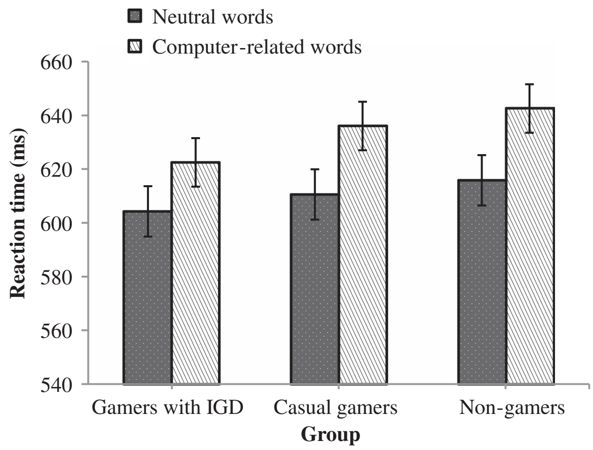

Figure 5. Mean reaction times (±SE) to neutral and computer-related words in the classical Stroop in Study 2

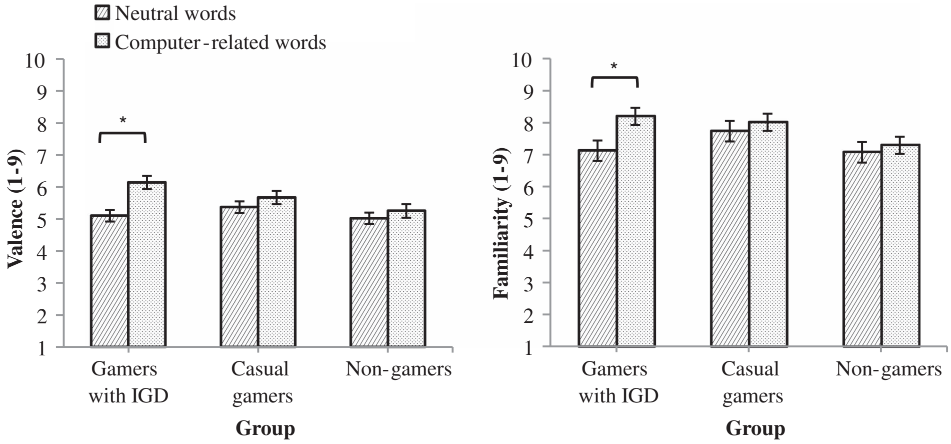

Figure 4. Valence and familiarity ratings (±SE) of neutral and computer-related words in the addiction Stroop in Study 2. Brackets indicate significant post-hoc tests, *$p < .001$

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.

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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.

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Are reaction times collected on the Internet equivalent to those measured in the laboratory? A comparison of a laboratory and three web-based settings using the Stroop task

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Abstract

Web-experiments are convenient and economical. However, reaction-time measurements online can be interference-prone. Our study tested the equivalence of the reaction times obtained from a laboratory and three web-based settings. There were four groups (N=191, 24.2±5.2 years): Students from our university were randomly assigned to complete the experiment in our laboratory (PStud-lab) or at home (PStud-web). Students from other universities (GStud-web) were asked to take part through mailing lists, and people from the general population were recruited in online forums (GPop-web). Both groups participated online. All participants completed a Stroop task with colour and neutral words. They indicated the font colour. Their reaction times were measured. The 4x2 mixed-design-ANOVA yielded a main effect for word type (all groups reacted more slowly to colour words). Equivalence testing showed that the reaction times to both word types of GStud-web and GPop-web were equivalent to those of PStud-lab, those of PStud-web were not. A Stroop effect was found in all groups, despite the different sampling methods and experimental environments. However, only the reaction times obtained from two web-based settings proved equivalent to those from the laboratory. Reaction times of PStud-web were slower and their results not equivalent; the most likely explanation cites motivational reasons.

Are reaction times collected on the Internet equivalent to those measured in the laboratory? A comparison of a laboratory and three web-based settings using the Stroop task

Web-based experiments have several advantages: they are economical because they require less lab space and personnel, and several people can participate at the same time (Denissen, Neumann, & van Zalk, 2010; Reips, 2002). The experimenter's absence also prevents unwanted experimenter effects (Rosenthal, 1966). Participants can take part from their homes at their convenience. The Internet makes it easier to gather data from demographically diverse samples (Gosling, Vazire, Srivastava, & John, 2000), instead of the usual psychology students who participate for course credit (Hewson, Vogel, & Laurent, 2016; Peterson, 2014), and it is possible to recruit large samples of people with a rare condition or trait (Mangan & Reips, 2007). Due to the enhanced anonymity, people are more likely to disclose sensitive information that they might be uncomfortable to talk about in person (Kays, Gathercoal, & Buhrow, 2012), there is less social desirability in the responses (Joinson, 1999; Richman, Kiesler, Weisband, & Drasgow, 1999), and people with social anxiety feel more comfortable to participate (Prizant-Passal, Shechner, & Aderka, 2016). Overall, Internet experiments may increase external validity in a number of ways.

However, there are several challenges of Internet research outside of the laboratory, possibly leading to a decrease in internal validity. People can terminate the study prematurely without having to explain themselves to the experimenter, which can lead to higher or selective dropout rates (Reips, 2002). If there is no experimenter present, they cannot intervene if the participants do not understand the task or carry it out incorrectly. Furthermore, reaction time measurements may be interference-prone due to distractions of the participants (other people talking, listening to the radio) or technical reasons (using different browsers and operating systems, having several programs open at once) (Eichstaedt, 2001).

In 1935, Stroop discovered that participants take, on average, 47 seconds longer to name ink colours of incongruent colour words (e.g. the word "red" printed in blue) compared to naming the colour of squares (Stroop, 1935). The explanation for this effect is that reading is a highly automatic process, which is hard to suppress. Reading the name of a colour interferes with naming a different font colour verbally. Nowadays, the Stroop task is commonly carried out as a computerized version, where one incongruent colour word or neutral word appears on a computer screen at a time, and participants indicate the font colour with a keypress (MacLeod, 1991). The Stroop task is one the most frequently conducted experiments and yields robust effects in a laboratory.

So far, several sophisticated cognitive experiments were carried out online (Dandurand, Shultz, & Onishi, 2008; Germine et al., 2012). However, few studies measured reaction times. Hilbig (2015) compared a laboratory and an online setting regarding a lexical decision task. The word frequency effect was found in both environments, but there were slower reaction times on the Internet. Two studies have compared the Stroop experiment conducted in a laboratory setting with one carried out on the Internet (Linnman, Carlbring, Åhman, Andersson, & Andersson, 2006; Semmelmann & Weigelt, 2016). Both found a Stroop interference effect in the two environments, but slower reaction times overall for the web-based version. None of the three studies used equivalence testing to show whether the different settings yielded equivalent reaction times. Classical two-sided hypothesis-testing cannot show that there is no difference between conditions (Barker, Luman, McCauley, & Chu, 2002) because it is designed to test the alternative hypothesis that there is a difference between groups and discard the null hypothesis that there is no difference (Bortz, 2005). If the data show that one cannot accept the alternative hypothesis, this does not permit the conclusion that the null hypothesis is true, and, hence, that there is no difference, but only that there is not enough evidence to accept the alternative hypothesis. Therefore, it is necessary to carry out equivalence testing to show that results from an experiment conducted in a laboratory and via the Internet can be considered equivalent (Weigold, Weigold, & Russell, 2013). Equivalence testing enables ascertainment of whether a difference between groups is smaller than a tolerable value (Barker et al., 2002). To do so, one defines an equivalence margin, δ, that demarcates a range within which the results should fall so as to be considered equal (Walker & Nowacki, 2011), and tests, with two one-sided *t*-tests, whether the actual value lies within the predetermined margin.

We were interested in whether different study environments, such as the laboratory and the Internet, had an influence on the results obtained from a classical Stroop task. Furthermore, we implemented recruiting strategies commonly employed in web-based studies, such as invitations via mailing lists, posts in online forums, and snowball sampling (Kothgassner, Felnhofer, Weber, & Stetina, 2011; Rhodes, Bowie, & Hergenrather, 2003). We used equivalence testing to investigate whether all four groups showed equivalent reaction times obtained from a Stroop task:

(1) local psychology students from our university who were recruited via mailing lists and were randomized to take part at the laboratory (PStud-lab),

(2) local psychology students from our university who were recruited via mailing lists and were randomized to take part via the Internet (PStud-web),

(3) general students from other universities who were recruited via mailing lists and participated via the Internet (GStud-web), and

(4) participants from the general population who were recruited in online forums and participated via the Internet (GPop-web).

Method

Sampling and Procedure

The study was carried out in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Philipps University Marburg. All participants were informed about the study and provided informed consent.

Psychology students from our university were recruited via a mailing list and invited to come to our laboratory. Upon arrival, they provided informed consent and then entered into a draw that determined whether they would participate in the laboratory or at home. Those who were to participate in the laboratory started the experiment right away. The others received a link to the Internet experiment and were asked to participate at a place of their choice during the following week. Persons studying different subjects at other universities were invited via mailing lists, while participants from the general population were recruited in online forums and in a snowball procedure. Both of these groups received a link to the Internet experiment. The same online platform (LimeSurvey, Hamburg, Germany) was used for all four groups. On the first page of the survey, the participants were informed that their answers would be anonymous and they provided informed consent. They answered questions about age, sex, education, and native language, as well as the operating system and browser they used while participating in the study. In addition, they completed the Ishihara Test (Ishihara Farbtafel, 2009) and took part in the Stroop task. Afterwards, they provided information on how concentrated they felt during the task on a 6-point scale, ranging from 1 (*not at all concentrated*) to 6 (*very concentrated*). They indicated whether something distracted them during the task with a dichotomous response format, with 0 (*no*) and 1 (*yes*), and whether they did something simultaneously to the study (e.g., eating/drinking, talking to someone, texting, reading, watching TV/videos, listening to music/the radio, reading, gaming). Finally, the participants received personal feedback regarding their reaction times and number of errors in the Stroop task. By following a link that ensured anonymity, they could provide their e-mail addresses to take part in a draw for one of three gift vouchers

(2x15, 1x20 euros) for an online store. Students from our university received course credit for taking part in the study.

Measures

Ishihara Test. The Ishihara Test (Ishihara Farbtafel, 2009) was used to assess colour vision prior to the Stroop task. It consists of three test plates, which show green and red dots forming numbers. People with normal colour vision are able to identify the numbers correctly.

Stroop task. The task was programmed with JavaScript (version 1.8.5, Netscape, Mountain View, USA) to be executed client-side. This means that all experimental data were collected by JavaScript and only uploaded to the Lime Survey server as a set once the experimental blocks were complete. The advantage of client-side collection of data is that differing internet connection speeds do not confound the reaction times (Birnbaum, 2004). In the end, reaction times, pressed keys, and missed targets were saved as log files and imported into statistical software. Prior to the experiment, the participants familiarised themselves with the task and the buttons used in a practice with 40 animal words printed in different colours. For the experiment, subjects saw two blocks with colour words ('red', 'blue', 'green', and 'yellow') and two blocks with numeral words ("zero", "five", "nine", and "eleven). The colour words were shown four times in three incongruent colours 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 colours 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). The order of words and colours within the blocks was fully randomised. The words were presented in the centre of the screen against a grey background. Each trial lasted 1000ms, thereafter, the next word appeared automatically. The participants were instructed to place four fingers on the keys 'a', 's', 'k', and 'l' and to press the key corresponding to the colour 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.

Participants

Table 1 shows the number of participants for each group who provided informed consent and those who failed to fulfil the inclusion criteria, because their native language was not German, the Ishihara test indicated that they did not see colours properly, and/or they were younger than 18 years. Furthermore, it shows the number of those who terminated before finishing the study and those who were excluded from the analysis because they pressed the wrong key and/or missed more than 30% of all trials in the Stroop task. We assumed that the latter failed to understand the task correctly. The remaining sample consisted of 36 psychology students from our university who took part in the study at the laboratory (PStud-lab), 34 psychology students from our university who participated on the Internet (PStud-web), 62 persons studying different subjects at other universities who participated on the Internet (GStud-web), and 59 participants from the general population who were recruited in online forums and via snowball sampling, and participated on the Internet outside the laboratory (GPop-web). More participants were recruited for groups GStud-web and GPop-web than for the other two groups in case of higher dropout rates. O’Neil, Penrod, & Bornstein (2003) reported that people recruited on the Internet were more likely to terminate their study prematurely than undergraduate students from their university.

Table 1

Number and percentages of participants of each group who provided informed consent, failed to fulfil the inclusion criteria, terminated prematurely, failed to understand the task correctly, and final participants.

Group	Provided informed consent	Failed to fulfil inclusion criteria	Terminated prematurely	Failed to understand task	Remaining sample
PStud-lab	48	6(12.5%)	0(0%)	6(12.5%)	36(75%)
PStud-web	46	7(15.2%)	0(0%)	5(10.9%)	34(73.9%)
GStud-web	102	9(8.8%)	24(23.5%)	7(6.9%)	62(60.8%)
GPop-web	141	29(20.6%)	42(29.8%)	11(7.8%)	59(41.8%)
All	337	51(15.1%)	66(19.6%)	29(8.6%)	191(56.7%)

Statistical Analysis

Statistica (version 12, StatSoft, Tulsa, USA) and SPSS (version 22, IBM, Armonk, USA) were used for the analysis. Only correct responses were included in the analyses of the reaction times. 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).

Comparative analysis. X^2 analyses were used to compare the sex and college degree distribution between the four groups and to test whether the groups differed regarding whether something distracted them during the Stroop task. Age and concentration during the study were analysed with one-way analyses of variance (ANOVAs). If the assumption of homogeneity of variances was violated, Welch's *F* was reported. The reaction times, the number of errors, and the number of missed responses in the Stroop task were analysed by using 4x2 mixed design ANOVAs with the between-subjects factor group (PStud-lab, PStud-web, GStud-web, GPop-web) and the within-subjects factor word type (numeral words, colour words). Hochberg's GT2 post-hoc tests were calculated for all significant effects in the ANOVAs, unless population variances were unequal, in which case Games Howell post-hoc tests were used. The significance level was set to $\alpha = .05$, and η^2 is reported as measure of effect size (Levine & Hullett, 2002).

Equivalence analysis. The equivalence of the four groups (PStud-lab, PStud-web, GStud-web, GPop-web) was tested separately regarding the reaction times to numeral words and colour words in the Stroop task. The two one-sided test procedure (TOST) (Schuirmann, 1987) was used, with a significance level of $\alpha = .05$ and a 90% confidence interval. The confidence interval was calculated with the formula (1 - 2α) * 100% (Walker & Nowacki, 2011). The equivalence margin δ for the numeral words was defined as ±5% (Julious, 2004) of the mean reaction times to numeral words of PStud-lab, and, correspondingly, the equivalence margin δ for the colour words was defined as ±5% of the mean reaction times to colour words of PStud-lab.

Results

Demographics

The groups did not differ significantly with regard to sex, $X^2(3) = 2.36$, $p = .508$, or number of participants who had a college degree, $X^2(3) = 2.12$, $p = .555$. Regarding age, the one-way ANOVA yielded a main effect for group, Welch's $F(3, 100.62) = 7.35$, $p < .001$, $\eta^2 = .089$. Games Howell post-hoc tests showed that the participants in GStud-web were older than those in PStud-web, and the participants in GPop-web were older than those in PStud-lab and PStud-web. The other groups did not differ with regard to age. The participants from GPop-web were younger than 44.3 years which is the mean age of the German population

(Bundesinstitut fuer Bevoelkerungsforschung, 2017). This is possibly due to younger people using Internet forums more often. See Table 2 for details.

Table 2

Distribution of sexes and participants with college degrees in the groups, as well as mean age (± SD) and range.

Group	n	Sex		College degree	Age		
		Female	Male		*M*	*SD*	Range
PStud-lab	36	28(77.8%)	8(22.2%)	13(36.1%)	22.9	3.2	19-35
PStud-web	34	25(73.5%)	9(26.5%)	10(29.4%)	22.1	2.3	18-27
GStud-web	62	52(83.9%)	10(16.1%)	25(40.3%)	24.2	4.7	18-45
GPop-web	59	50(84.7%)	9(15.3%)	26(44.1%)	26.3	7.0	18-52
All	191	155(81.2%)	36(18.8%)	74(38.7%)	24.2	5.2	18-52

Operating System and Browser

Table 3 shows that the most commonly used operating system was Windows (Microsoft, Redmond, USA) and the most commonly used browser was Mozilla Firefox (Mozilla Corporation, Mountain View, USA) in all four groups. Since PStud-lab took part in the laboratory, the operating system and browser they used were identical for all participants.

Table 3

Operating systems and browsers used by the participants.

		PStud-lab (n = 36)	PStud-web (n = 34)	GStud-web (n = 62)	GPop-web (n = 59)	All (N = 191)
Operating system	Linux	0(0%)	1(2.9%)	4(6.5%)	1(1.7%)	6(3.1%)
	OS X/macOS	0(0%)	7(20.6%)	11(17.7%)	8(13.6%)	26(13.6%)
	Windows	36(100%)	22(64.7%)	46(74.2%)	41(69.5%)	145(75.9%)
	Unknown	0(0%)	4(11.8%)	1(1.6%)	9(15.3%)	14(7.3%)
Browser	Google Chrome	0(0%)	6(17.6%)	18(29%)	14(23.7%)	38(19.9%)
	Internet Explorer	0(0%)	1(2.9%)	1(1.6%)	7(11.9%)	9(4.7%)
	Mozilla Firefox	36(100%)	18(52.9%)	36(58.1%)	30(50.8%)	120(62.8%)
	Opera	0(0%)	2(5.9%)	0(0%)	2(3.4%)	4(2.1%)
	Safari	0(0%)	7(20.6%)	7(11.3%)	5(8.5%)	19(9.9%)
	Unknown	0(0%)	0(0%)	0(0%)	1(1.7%)	1(0.5%)

Note. OS X/macOS (Apple Inc., Cupertino, USA), Windows (Microsoft, Redmond, USA), Google Chrome (Google, Mountain View, USA), Internet Explorer Microsoft, Redmond, USA), Mozilla Firefox (Mozilla Corporation, Mountain View, USA), Opera (Opera Software, Oslo, Norway), Safari (Apple Inc., Cupertino, USA).

Stroop Task

Regarding the reaction times, the 4x2 mixed design ANOVA yielded a main effect for word type, $F(1,187) = 76.7$, $p < .001$, $\eta^2 = .053$, indicating that all groups reacted more slowly to incongruent colour words compared to numeral words. There was no main effect for group, $F(3,187) = 1.12$, $p = .341$, $\eta^2 = .014$, or an interaction, $F(3,187) = 0.11$, $p = .953$, $\eta^2 < .001$. See Figure 1 for details.

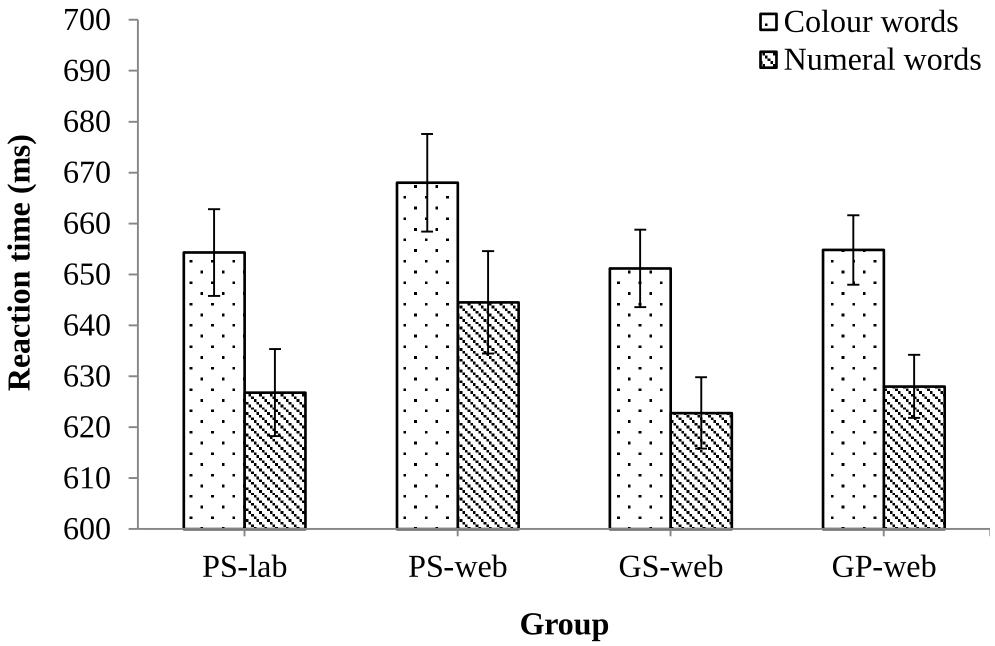

Figure 1. Mean reaction times (± *SE*) to colour and numeral words in the Stroop task.

Overall, the participants pressed the wrong key in 10.3% of all trials and missed a word in 9.7% of them. With regard to errors, the 4x2 mixed design ANOVA yielded a main effect for word type, $F(1,187) = 7.92$, $p = .005$, $\eta^2 = .011$, indicating that all groups made more errors with incongruent colour words than numeral words. There was no main effect for group, $F(3,187) = 0.63$, $p = .598$, $\eta^2 = .007$, or an interaction, $F(3,187) = 0.72$, $p = .544$, $\eta^2 = .003$. See Figure 2 for details.

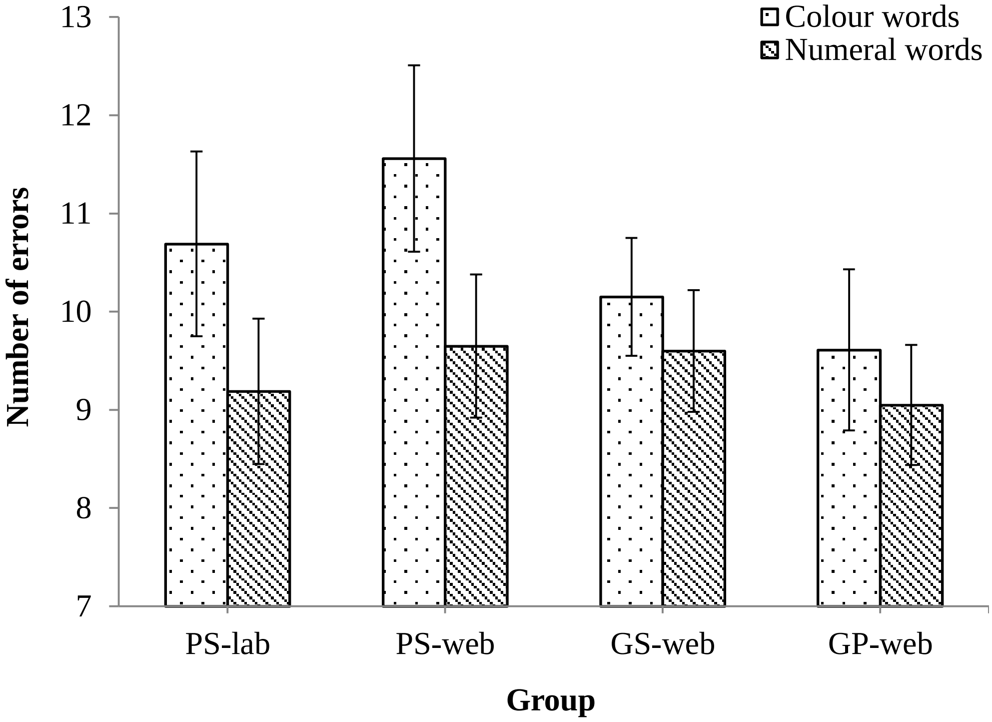

Figure 2. Mean number of errors (± *SE*) to colour and numeral words in the Stroop task.

The analysis of missed words with a 4x2 ANOVA showed a main effect for word type, $F(1,187) = 143.59$, $p < .001$, $\eta^2 = .110$, indicating that all groups missed more incongruent colour words than numeral words. There was no main effect for group, $F(3,187) = 1.26$, $p = .289$, $\eta^2 = .015$, or an interaction, $F(3,187) = 0.80$, $p = .493$, $\eta^2 = .002$.

Regarding how concentrated participants felt they were during the Stroop task, the one-way ANOVA did not show a main effect for group, $F(3,181) = 2.48$, $p = .062$, $\eta^2 = .040$. The groups did not differ significantly with regard to whether something distracted them during the task, $X^2(3) = 6.71$, $p = .081$. Figure 3 shows the percentages of the participants that did something simultaneously to the study.

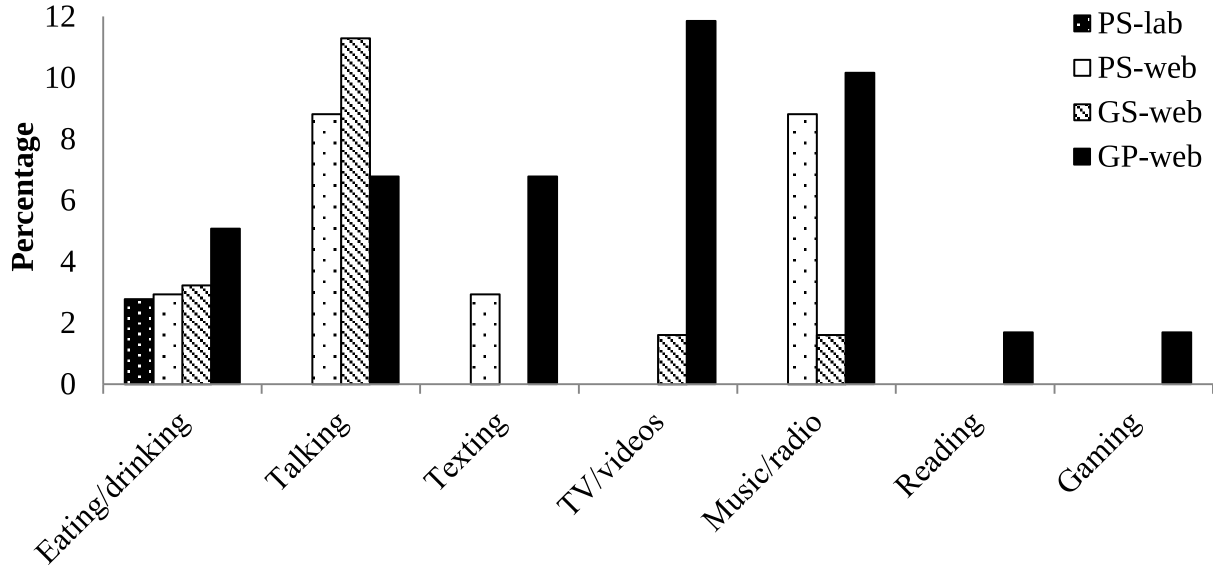

Figure 3. Percentages of the participants in the four groups that carried out other activities simultaneously to the study.

Equivalence of reaction times

Regarding the reaction times to numeral words in the Stroop task, equivalence testing revealed that GStud-web and GPop-web were equivalent to PStud-lab. PStud-web was not equivalent to PStud-lab. Regarding the reaction times to colour words in the Stroop task, equivalence testing revealed that GStud-web and GPop-web were equivalent to PStud-lab. PStud-web was not equivalent to PStud-lab. See Table 4 for details.

Table 4

Equivalence tests for the reaction times to numeral and colour words in a Stroop task

	δ	90% CI for the difference PStud-lab and PStud-web		90% CI for the difference PStud-lab and GStud-web		90% CI for the difference PStud-lab and GPop-web	
		Lower	Upper	Lower	Upper	Lower	Upper
Neutral words	±32.71	-35.65	8.15	-16.16[e]	22.22[e]	-19.88[e]	18.85[e]
Colour words	±31.34	-38.58	3.2	-14.31[e]	22.30[e]	-19.61[e]	17.34[e]

Note. δ is based on the mean reaction times in the Stroop task of PStud-lab. [e] = equivalent at 5%. CI = confidence interval.

Discussion

This study was the first to test the equivalence of reaction times obtained from a Stroop task conducted in a laboratory and on the Internet. The four groups with different sampling methods and experimental environments all showed the Stroop interference effect and reacted slower to incongruent colour words than to neutral words. This is in line with the results from Linnman et al. (2006) as well as Semmelmann and Weigelt (2016). However, not all Internet groups had equivalent reaction times to the laboratory condition. The reaction times to both word types of GStud-web and GPop-web were equivalent to those of PStud-lab. The reaction times of PStud-web could not be considered equivalent.

PStud-lab and PStud-web were invited to come to our university and then were randomly assigned to either participate in the laboratory right away or at home during the next week. The randomization may have inadvertently lowered the motivation of the students asked to participate from home, because having scheduled time for the experiment, they expected to complete it and earn course credit right away. However, after finishing the study at home, they had to return to the university to receive their compensation, exposing them to an additional inconvenience that was absent in the other groups. This might have lowered their motivation to give their best during the Stroop experiment. Their mean reaction times were higher than those of the other three groups. However, the ANOVA did not yield a significant main effect for the between-subjects variable. In this case, equivalence testing gave valuable insights. With a strict equivalence margin of 5% of the mean reaction times of PStud-lab, the reaction times of PStud-web were not equivalent to PStud-lab. Thus, randomising students to take part at the university or at home is not a useful strategy. Nevertheless, the reaction times of GStud-web and GPop-web in an easy task (indicating the font colour of numeral words) and a difficult one (indicating the font colour of incongruent colour words) proved to be equivalent to those of PStud-lab. This shows that experimenting online in those cases led to valid results even when using interference prone measures, such as reaction times, and a difficult assignment, such as the Stroop task.

The participants in the web-conditions completed the study in a place of their own choice and used miscellaneous operating systems and browsers. In the laboratory, a few of the participants drank or ate during the study, but mainly did nothing else, while, in the other three groups, some participants talked to other people, watched TV, or listened to music while participating in the study. Nevertheless, the groups did not differ significantly regarding their reaction times, number of errors, number of missed words in the Stroop task, or how concentrated they felt during the study. Even though there were fewer disturbances in the laboratory environment, it did not seem to be superior to other environments regarding the reaction times or the Stroop effect.

Those who participated outside the laboratory were unable to ask an experimenter for help if they did not understand the instructions. Between 6.9% and 10.9% of the people in those three groups had to be excluded because they failed to understand the task, compared to 12.5% of the persons who took part in the laboratory. Hence, the presence of an experimenter did not seem to improve the results. This is in line with results from Ollesch, Heineken, and Schulte (2006). The authors did not find differences regarding response latencies or recall rates when comparing settings with no experimenter present, an experimenter present but not involved, and an actively involved experimenter.

However, the presence of an experimenter and receiving a definitive compensation for participating might have positively influenced the dropout rate. None of the participants from our university (who we had personal contact with and who received course credit) terminated the study early. Comparable numbers of people dropped out from the group that was recruited in online forums and in a snowball procedure (29.8%) and from the group that was asked to participate via mailing lists of other universities (23.5%). The mean dropout rate from other Internet studies was 34% (Reips, 2000). The participants in those two groups might have felt less obligated to finish the study because there was no experimenter present (Reips, 2002). They were able to leave the website without having to explain themselves, making it easier for them to abandon the experiment. Moreover, they only had a chance to win a voucher and did not receive course credit, which could have lowered their motivation to finish the study. On the other hand, we only had to expend minimal resources (time and incentive) to recruit them, since we did not need a lab room with a computer and several people could participate at the same time. Furthermore, people who really wanted to participate voluntarily took part and not only those who had to earn course credit.

To summarize, this study contributed to clarifying whether results from web-based experiments can be considered equivalent to those obtained in a laboratory. We showed that two web-based settings produced valid reaction times in a Stroop experiment that were equivalent to those measured in a laboratory.

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Lebenslauf

[Der Lebenslauf ist nicht Teil der Veröffentlichung.]

Eidesstattliche Erklärung

Ich versichere, dass ich meine Dissertation „Aufmerksamkeitsbias bei Personen mit einer Störung durch Spielen von Internetspielen“ selbstständig ohne unerlaubte Hilfe angefertigt und mich dabei keiner anderen als der von mir ausdrücklich bezeichneten Quellen und Hilfen bedient habe. Die Dissertation wurde in der jetzigen oder einer ähnlichen Form noch bei keiner anderen Hochschule eingereicht und hat noch keinen sonstigen Prüfungszwecken gedient.

Marburg, April 2017 Franziska Jeromin