

Addiction Research Unit: Affective and cognitive mechanisms of specific Internet-use disorders

Matthias Brand^{1,2} | Astrid Müller³ | Rudolf Stark^{4,5,6} |
 Sabine Steins-Loeber⁷ | Tim Klucken⁸ | Christian Montag⁹ |
 Martin Diers¹⁰ | Oliver T. Wolf¹¹ | Hans-Jürgen Rumpf¹² |
 Klaus Wölfling¹³ | Elisa Wegmann¹

¹General Psychology: Cognition and Center for Behavioral Addiction Research (CeBAR), University of Duisburg-Essen, Duisburg, Germany

²Erwin L. Hahn Institute for Magnetic Resonance Imaging, Essen, Germany

³Department of Psychosomatic Medicine and Psychotherapy, Hannover Medical School, Hannover, Germany

⁴Department of Psychotherapy and Systems Neuroscience, Justus Liebig University of Giessen, Giessen, Germany

⁵Bender Institute of Neuroimaging, Justus Liebig University of Giessen, Giessen, Germany

⁶Center of Mind, Brain and Behavior, Universities of Marburg and Giessen, Giessen, Germany

⁷Clinical Psychology and Psychotherapy, University of Bamberg, Bamberg, Germany

⁸Clinical Psychology and Psychotherapy, University of Siegen, Siegen, Germany

⁹Department of Molecular Psychology, Institute of Psychology and Education, Ulm University, Ulm, Germany

¹⁰Department of Psychosomatic Medicine and Psychotherapy, LWL University Hospital, Ruhr University Bochum, Bochum, Germany

¹¹Cognitive Psychology, Ruhr University Bochum, Bochum, Germany

¹²Department of Psychiatry and Psychotherapy, Research Group S:TEP (Substance use and related disorders: Treatment, Epidemiology, and Prevention), University of Lübeck, Lübeck, Germany

¹³Outpatient Clinic for Behavioral Addiction, Department of Psychosomatic Medicine and Psychotherapy, University Medical Center,

Abstract

In the eleventh International Classification of Diseases (ICD-11) of the World Health Organization, gambling disorder and gaming disorder are included in the category ‘disorders due to addictive behaviours’, which can be specified further as occurring either predominantly offline or predominantly online. Other specific problematic behaviours may be considered for the category ‘other specified disorders due to addictive behaviours’. The Research Unit FOR 2974, funded by the German Research Foundation (*Deutsche Forschungsgemeinschaft*, DFG), focuses on the most prominent online addictive behaviours: gaming, pornography use, buying-shopping and social-networks use. The main goal of the Research Unit is to contribute to a better understanding of the common and differential psychological as well as neurobiological mechanisms involved in these specific types of Internet-use disorders. We aim to investigate theoretically argued (bio)psychological processes with a focus on concepts coming from research of substance-use disorders, for example, cue reactivity and craving, executive functions and specific inhibitory control, coping, implicit cognitions, and decision making. One central characteristic of the Research Unit is that we will investigate all participants using a comprehensive core battery of experimental paradigms, neuropsychological tasks, questionnaires, biomarkers, ambulatory assessment, and a 6-month follow-up survey. Beyond the anticipated contributions to the scientific understanding of the mechanisms involved in the development and maintenance of respective online addictive behaviours, we also expect contributions to clinical practice by showing which affective and cognitive mechanisms may be addressed more intensively to optimize treatment.

KEYWORDS

buying-shopping disorder, cue-reactivity, gaming disorder, inhibitory control, problematic pornography use, problematic social-networks use

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

© 2021 The Authors. *Addiction Biology* published by John Wiley & Sons Ltd on behalf of Society for the Study of Addiction.

Johannes Gutenberg University Mainz, Mainz, Germany

Correspondence

Matthias Brand, General Psychology: Cognition and Center for Behavioral Addiction Research (CeBAR) and Erwin L. Hahn Institute for Magnetic Resonance Imaging, University of Duisburg-Essen, Forsthausweg 2, 47057 Duisburg, Germany.
Email: matthias.brand@uni-due.de

Funding information

Deutsche Forschungsgemeinschaft (DFG, German Research Foundation), Grant/Award Number: 411232260

1 | INTRODUCTION

The German Research Foundation (*Deutsche Forschungsgemeinschaft*, DFG) has decided to fund our transregional Research Unit, 'Affective and cognitive mechanisms of specific Internet-use disorders (ACSID)' (FOR 2974) in September 2020. The Research Unit consists of 11 principal investigators (PIs) of several sites of Germany representing various disciplines: Cognitive Psychology/Neuropsychology, Clinical Psychology/Psychosomatic Medicine, and Personality and Molecular Psychology. We will receive substantial funding for our research programme for up to 6 years (first funding period is 3 years). Establishing this Research Unit gives us the unique opportunity to contribute in a broader and comprehensive way to a better scientific understanding of the potential psychological mechanisms and underlying neurobiological correlates of relatively new types of addictive behaviours. The insights will hopefully inspire both research and clinical practice.

2 | MOTIVATION

Over the last decades, there have been controversial debates regarding whether behavioural addictions should be acknowledged as mental disorders and if so, whether they should be classified along with substance-related disorders. These controversies have abated in 2018, when the World Health Organization has decided to classify gambling disorder and gaming disorder as 'disorders due to addictive behaviours' in the ICD-11, which are considered as occurring either predominantly offline (without using the Internet) or predominantly online (on the Internet).¹ Other problematic behaviours may be considered for the ICD-11 category 'other specified disorders due to addictive behaviours'. In particular, we consider problematic online pornography use (although this may also be considered a subtype of compulsive sexual behaviour disorder in the ICD-11), problematic online buying-shopping, and problematic use of social networks as potential disorders belonging to this category.² For gaming disorder and the other relatively new and predominantly online-related disorders, which we subsume under the umbrella term Internet-use disorders (IUD), theoretical

frameworks considering the psychological processes of symptom development and maintenance have been recently proposed.³⁻⁵ Studies addressing the (bio-)psychological processes involved in different types of the aforementioned predominantly online addictive behaviours are needed in order to improve prevention and treatment. The Research Unit focuses on the most prominent predominantly online addictive behaviours: gaming, pornography use, buying-shopping and social-networks use.² We will also include groups with other addictive behaviours (gambling disorder) and substance-related disorders (alcohol and tobacco).

Based on a comprehensive theoretical model, namely, the Interaction of Person-Affect-Cognition-Execution (I-PACE) model,⁴ which has been updated and specified very recently,⁵ we aim to investigate the involvement of the theoretically argued (bio-)psychological processes, in particular affective and cognitive mechanisms, involved in the development and maintenance of predominantly online addictive behaviours.

3 | THEORETICAL AND EMPIRICAL BACKGROUND: A CONSOLIDATED SUMMARY

The I-PACE model (and its update) is based upon theoretical assumptions, which are well-known in research on substance-use disorders. Important theoretical constructs that are integrated in the model are craving and cue reactivity,^{6,7} and the role of (associative) learning mechanisms, in particular conditioning processes,⁷⁻⁹ which are the main basis for cue reactivity and craving.^{10,11} The idea that attentional biases, executive functions, and disadvantageous decision making as well as reductions in inhibitory control make an important contribution to the development and maintenance of a specific IUD is based on dual-process theories as well as other (neuroscientific) theories of addictions.¹²⁻²³ The main interactions considered important in the I-PACE model are those between a person's core characteristics (e.g., personality and psychopathology) and affective aspects (e.g., craving and motivation to experience pleasure or to reduce negative mood), cognitive aspects (e.g., reward expectancies, coping style and implicit cognitions), executive functions, and decision making

in the course of the development and maintenance of a specific IUD. The core constructs within the I-PACE model, which are also central to the Research Unit's main goals and aims, are summarized in Table 1. The I-PACE model also considers conditioning processes that lead to a generalization of situational features and thus trigger cue reactivity and craving. This may be the main reason why the addictive behaviour becomes habitual and/or compulsive in the course of the addiction process.^{30–32}

Several studies on predisposing variables, affective and cognitive correlates and executive functions exist for the different types of IUD, as described in several review articles and meta-analysis.^{33–37} The majority of previous studies, however, were limited to the investigation of a very specific aspect related to a particular type of IUD, without considering systematic interactions (moderating and mediating effects) among a comprehensive set of variables. Consequently, no previous studies have systematically and comprehensively investigated common and distinct interactions between general and specific predisposing variables, affective and cognitive processes, and behavioural mechanisms potentially underlying different types of IUD.

TABLE 1 Summary and definitions of the core constructs used in theories and research on substance-use disorders, which are integrated in the I-PACE model and focused upon in the Research Unit

Construct	Definition/description and typical pattern in the context of substance-use disorders
Cue reactivity	Physiological, emotional and cognitive responses to conditioned addiction-related stimuli ^{7,11}
Craving	Intense and urgent desire, subjective experience of desiring drug intake, potentially a result of cue reactivity, and reward craving and relief craving ²⁴
Attentional bias	Automatic cognitive processes (including implicit associations) underlying the effect that drug abusers become easily aware of addiction-related stimuli in their environment ^{25–27}
Approach-avoidance-tendency	Competing action-tendency states depending on subjective experiences; approach tendencies are closely related to cue reactivity and craving ^{6,28}
Use expectancies	Explicit expectancies about the effects of drug intake, including positive effects and relief expectancies ²⁹
Inhibitory control and executive functions	Diminished ability to control and regulate craving and addiction-related urges; top-down control of behavior ^{19,20}
Decision making	Choice of immediate reward; preference for short-term rewarding behaviours despite negative long-term consequences ^{14,20}

Abbreviation: I-PACE, Interaction of Person-Affect-Cognition-Execution.

4 | CHALLENGES AND GOALS OF THE RESEARCH UNIT

Based on the updated I-PACE model,⁵ the overall goal of the Research Unit is to contribute to a better understanding of the common and differential psychological and neurobiological processes underlying different types of IUD. We will focus on the affective and cognitive mechanisms, because these processes are considered to be central to the development and maintenance of specific IUDs in most of the existing theoretical frameworks. By testing the assumptions of this model systematically, we will also be able to contribute to theory improvement, because the results should show which of the theoretical assumptions of the model are valid for which specific type of IUD and dependent upon which stage of the addiction process, that is, at the beginning of the disorder (early stage) or during its manifestation (later stage).

The overall hypotheses that guide all projects are as follows. (1) The mechanisms summarized in the theoretical model, that is, the assumed interactions between predisposing variables and moderators and mediators, can significantly explain the severity of specific types of IUD. (2) There are common and differential predictors and moderators/mediators across the different types of IUD. (3) The interactions develop in a specific manner depending upon the stage of the disorder process.

By investigating these overall hypotheses, we will not only contribute to a better scientific understanding of the psychological processes but also be able to contribute to clinical applications. For instance, showing which mechanisms should be addressed more intensively in prevention and treatment can have a valuable impact on clinical practice. We aim at revealing how current techniques of cognitive-behavioural therapy might be extended in the future by considering specific techniques tapping into particular affective-cognitive mechanisms.

5 | METHODOLOGICAL APPROACHES AND COMPOSITION OF THE RESEARCH PROJECTS

We will use the same core battery of experimental paradigms (including tasks with different addiction-related stimuli), cognitive tasks, assessment of biomarkers and questionnaires in the laboratory and online surveys in the research projects (Figure 1). By applying a core battery of the same tests to every participant, it will be possible to analyse the data among projects and to test the central hypotheses as well as the overall theoretical model of the Research Unit for all types of IUD in comparison with gambling disorder, alcohol-use disorder, and tobacco-use disorder. Furthermore, the data from the core battery will enable a comparison of addicted individuals with both risky users (who may describe initial symptoms, but do not yet meet all the criteria for diagnosing a disorder) and recreational/nonproblematic users. All participants will be additionally examined with an end-of-day ambulatory assessment for 14 days after the

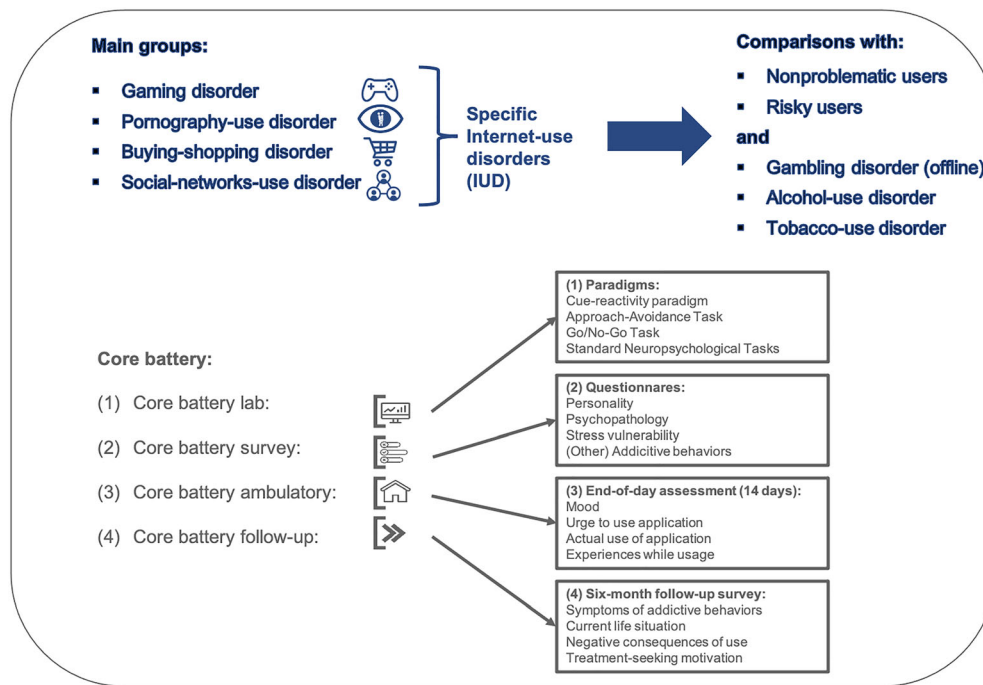


FIGURE 1 Main groups of interest in the Research Unit, comparison groups and summary of the core battery, which will be applied to all participants. All participants will undergo a comprehensive diagnostic interview, supplemented by questionnaires, before starting with the core battery

investigation in the laboratory. A 6-month follow-up investigation (online survey) will also be conducted with all participants. A cross-sectional comparison of individuals with recreational/nonproblematic use, risky use, and pathological use of specific Internet applications together with a follow-up investigation will allow for the identification of concomitants of a predominantly online addictive behaviour. We will be able to have a 4 (types of IUD) \times 3 (stages of addiction process) complete matrix within the Research Unit. In addition, some more groups will be included, enabling the IUD groups to be contrasted with another recognized behavioural addiction (gambling disorder) and substance-use disorder (alcohol-use disorder and tobacco-use disorder).

The data of the core battery, the ambulatory assessment, and the follow-up investigation will be analysed in the research project of PI Brand, which has the character of an umbrella project by compelling all data and testing comprehensively the overall hypotheses. All projects will contribute to testing and revising/specifying the theoretical model, but also have their own additional specific connections with other projects and their own specific aims and hypotheses. The project of PI Steins-Loeber and PI Müller will address the aspect of appetitive conditioning and automatized habitual responding in combination with stress induction in individuals with risky use of games and buying-shopping, respectively. In the project of PI Klucken and PI Stark, potential deficits in appetitive extinction learning will be studied experimentally and with functional magnetic resonance imaging (fMRI) in participants with gaming disorder and pornography-use disorder. These will be compared with participants with risky use of games or pornography and participants with nonproblematic use of games or pornography. The project of PI Brand, PI Wolf, and PI Diers will investigate the interaction of cue reactivity and craving (behaviourally and with fMRI) with executive functions/specific inhibitory control,

decision making, and effects of acute stress in individuals with gaming disorder and those with pornography-use disorder. These will be compared with risky users and nonproblematic users of games and pornography, respectively. PI Müller, PI Wegmann, and PI Wolf will investigate the effects of acute stress on cue-reactivity and implicit cognitions in buying-shopping disorder and social-networks-use disorder in their project. In the project of PI Wölfling and PI Steins-Loeber, the effects of implicit associations and cue-induced impulse control in individuals with gaming disorder compared with individuals with gambling disorder and individuals with alcohol-use disorder will be investigated. The project of PI Rumpf, PI Wegmann, and PI Montag will address the effects of reinforcement experiences in individuals with social-networks-use disorder and individuals with tobacco-use disorder, compared with individuals with risky use and individuals with nonproblematic use of social networks and individuals with nonproblematic tobacco use.

There are several synergies between the projects. One major benefit is expected from the investigation of individuals at different stages of disorder, even if the studies are cross-sectional in the first funding period with a brief 6-month longitudinal assessment. Buying-shopping disorder, for example, will be examined in two projects (PIs Steins-Loeber/Müller and PIs Müller/Wegmann/Wolf), of which one project will include individuals with risky use of shopping applications and the other project will include individuals with pathological use. In both projects, participants will perform a cue-reactivity paradigm and the same standardized laboratory stress induction. This approach offers the unique opportunity to learn more about the trajectories of cue-reactivity, craving, and psychological and neurobiological stress reactivity from early to later stages of buying-shopping disorder. Other examples for synergies are the projects in which recreational, risky, and pathological gaming and pornography use will be

investigated. In this context, one project (PIs Klucken/Stark) will examine neural correlates of extinction of cue-reactivity in the aforementioned groups using fMRI. Another project (PIs Brand/Wolf/Diers) will investigate potential differences in neural responses (fMRI) to distal versus proximal cues related to gaming and pornography. Risky use of social networks will be investigated in the project of PI Rumpf, PI Wegmann, and PI Montag, whereas pathological use of social networks will be examined in the project of PI Müller, PI Wegmann and PI Wolf. In summary, we will have synergies across the projects on different levels: common constructs that are in the focus of specific projects and methods that will be applied. The systematically designed synergies are summarized in Figure 2.

The psychological and neuroscientific approaches in the projects cover a wide range of methods: experimental paradigms with addiction-related cues, standard neurocognitive tasks, fMRI, neuroendocrinological measures (salivary cortisol and hair cortisol), genetic markers, eye-tracking and skin conductance responses.

Several sites of the Research Unit belong to Departments of Psychosomatic Medicine/Clinical Psychology/Psychiatry, including cognitive behavioural outpatient clinics, or they collaborate with treatment facilities, which will serve as referral sources for participants who need treatment. The participants with pathological use of specific Internet applications will be recruited mainly at these treatment facilities and will be offered treatment after the investigation if needed.

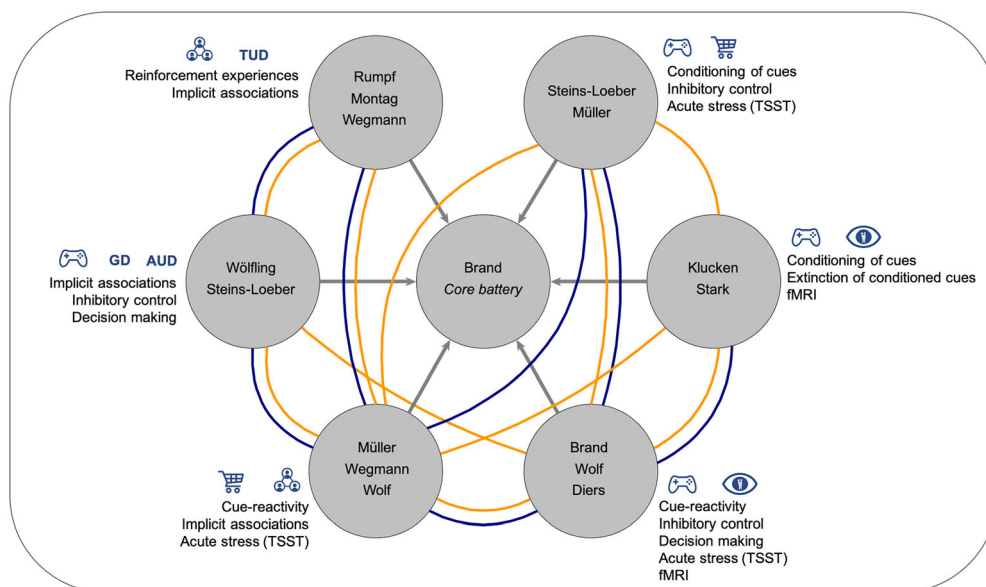
6 | OUTLOOK

Our vision is to continue contributing to theory building on two levels: (1) reducing complexity by examining the most relevant mechanisms, which are valid for all types of addictive behaviours, resulting in an update of the model, and (2) defining disorder-specific mechanisms, which may then also specify environmental/product features in disorder-specific models.

We will concentrate on the four specific IUDs in the first funding period. The main reason is that we aim at setting a clear focus within the Research Unit. Therefore, we have decided to consider gaming disorder first, given that gaming disorder has been included in DSM-5 (section III) and ICD-11 and can therefore be regarded as a prototype of IUDs. We then have considered the recent literature on clinical relevance of other online-related behaviours, and we have concentrated on those behaviours which are currently discussed as potential addictive behaviours, but for which the empirical evidence regarding affective and cognitive processes is scarce. Besides a clear focus, this allows for a synergistic choreography of the projects and having larger samples of the combined groups per specific IUD. As a consequence, gambling disorder, which is a very prevalent and recognized behavioural addiction, is included as a comparison group in one project, only. Alcohol-use and tobacco-use disorders are also included as examples of substance-use disorders as comparison groups. Including more groups/individuals with substance-use disorders would go beyond the current scope of the Research Unit in terms of the time for realization within the 3-year funding and the limited number of projects. However, we will compare our findings with those from the gambling disorder and substance-use disorder field in joint analyses with colleagues studying gambling disorder and substance-use disorders on the level of meta-analysis or even mega-analysis. Based on the results from the first funding period, we may consider inclusion of more diverse behavioural addictions as comparison groups in the proposal for the second funding period.

We are convinced that the findings of our Research Unit will make important contributions. It is important not to overpathologize everyday-life behaviour while concurrently not to trivialize conditions that are of clinical relevance and that deserve public health considerations. The results of our projects will hopefully be transferred into clinical applications and may inspire how treatments may be optimized by targeting more specifically affective and cognitive mechanisms involved in online-related addictive behaviours. The current psychotherapy for gaming disorder, pornography-use disorder and buying-

FIGURE 2 Synergies across the projects regarding data exchange (grey arrows), shared constructs (orange lines) and shared methods (blue lines). AUD, alcohol-use disorder; GD, gambling disorder, fMRI, functional magnetic resonance imaging; TSST, Trier Social Stress Test; TUD, tobacco-use disorder



shopping disorder is based on treatment manuals, which were developed and validated by certain PIs of the Research Unit.^{38–40} There is, however, currently no comprehensive and nationwide health care service for patients with IUDs in Germany. Treatment options exist primarily in special outpatient clinics of university hospitals, and some of those are included in the Research Unit. However, most patients are treated by local psychotherapist. Potential proof-of-concept studies within the Research Unit may include cognitive-bias modification, in particular avoidance-training, inhibition training as well as cue-exposure and craving regulation techniques. However, considering these approaches requires a better understanding of the mechanisms involved in specific IUDs, which we will be addressing in the Research Unit. One further goal of the Research Unit, beyond contributing to a better scientific understanding of IUDs, is to disseminate the current knowledge about mechanisms involved in the development and maintenance of IUDs to raise awareness in society and clinical practice about the potentially problematic behaviours in the context of Internet usage.

ACKNOWLEDGEMENTS

The Research Unit ACSID (FOR2974) is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) (411232260). Parts of this manuscript have been taken from the proposal (Coordination project and overall description) of the Research Unit. We thank Annika Brandtner for her extremely valuable support of our work on the Research Unit's proposal.

Open Access funding enabled and organized by Projekt DEAL.

AUTHOR CONTRIBUTIONS

Matthias Brand and Elisa Wegmann generated the draft of the manuscript. All co-authors made suggestions for edits. All authors approved the final version of the manuscript.

DATA AVAILABILITY STATEMENT

n/a

ORCID

Matthias Brand  <https://orcid.org/0000-0002-4831-9542>

Astrid Müller  <https://orcid.org/0000-0001-6176-2947>

Rudolf Stark  <https://orcid.org/0000-0003-4299-5280>

Sabine Steins-Loeber  <https://orcid.org/0000-0002-7651-0627>

Tim Klucken  <https://orcid.org/0000-0003-2433-6652>

Christian Montag  <https://orcid.org/0000-0001-8112-0837>

Martin Diers  <https://orcid.org/0000-0002-3257-7299>

Oliver T. Wolf  <https://orcid.org/0000-0002-9320-2124>

Hans-Jürgen Rumpf  <https://orcid.org/0000-0001-6848-920X>

Elisa Wegmann  <https://orcid.org/0000-0002-9373-979X>

REFERENCES

- World-Health-Organization ICD-11 for mortality and morbidity statistics. 2019(06/17).
- Brand M, Rumpf H-J, Demetrovics Z, et al. Which conditions should be considered as disorders in the International Classification of Diseases (ICD-11) designation of “other specified disorders due to addictive behaviors”? *J Behav Addict*. 2020. [Epub ahead of print]
- Dong G, Potenza MN. A cognitive-behavioral model of Internet gaming disorder: theoretical underpinnings and clinical implications. *J Psychiatr Res*. 2014;58:7-11.
- Brand M, Young KS, Laier C, Wöfling K, Potenza MN. Integrating psychological and neurobiological considerations regarding the development and maintenance of specific Internet-use disorders: an Interaction of Person-Affect-Cognition-Execution (I-PACE) model. *Neurosci Biobehav Rev*. 2016;71:252-266.
- Brand M, Wegmann E, Stark R, et al. The Interaction of Person-Affect-Cognition-Execution (I-PACE) model for addictive behaviors: update, generalization to addictive behaviors beyond Internet-use disorders, and specification of the process character of addictive behaviors. *Neurosci Biobehav Rev*. 2019;104:1-10.
- Breiner MJ, Stritzke WGK, Lang AR. Approaching avoidance. A step essential to the understanding of craving. *Alcohol Res Health*. 1999; 23(3):197-206.
- Carter BL, Tiffany ST. Meta-analysis of cue-reactivity in addiction research. *Addiction*. 1999;94(3):327-340.
- Tiffany ST, Carter BL, Singleton EG. Challenges in the manipulation, assessment and interpretation of craving relevant variables. *Addiction*. 2000;95(8):177-187.
- Loeber S, Duka T. Acute alcohol impairs conditioning of a behavioural reward-seeking response and inhibitory control processes—implications for addictive disorders. *Addiction*. 2009;104(12):2013-2022.
- Robinson TE, Berridge KC. The neural basis of drug craving: an incentive-sensitization theory of addiction. *Brain Res Brain Res Rev*. 1993;18(3):247-291.
- Robinson TE, Berridge KC. The psychology and neurobiology of addiction: an incentive-sensitization view. *Addiction*. 2000;95: 91-117.
- Goldstein RZ, Craig AD, Bechara A, et al. The neurocircuitry of impaired insight in drug addiction. *Trends Cogn Sci*. 2009;13(9):372-380.
- Goldstein RZ, Volkow ND. Drug addiction and its underlying neurobiological basis: neuroimaging evidence for the involvement of the frontal cortex. *Am J Psychiatry*. 2002;159(10):1642-1652.
- Goldstein RZ, Volkow ND. Dysfunction of the prefrontal cortex in addiction: neuroimaging findings and clinical implications. *Nat Rev Neurosci*. 2011;12(11):652-669.
- Kalivas PW, Volkow ND. The neural basis of addiction: a pathology of motivation and choice. *Am J Psychiatry*. 2005;162(8):1403-1413.
- Koob GF, Volkow ND. Neurocircuitry of addiction. *Neuropsychopharmacology*. 2010;35(1):217-238.
- Volkow ND, Fowler JS. Addiction, a disease of compulsion and drive: involvement of the orbitofrontal cortex. *Cereb Cortex*. 2000;10(3): 318-325.
- Volkow ND, Fowler JS, Wang GJ, Goldstein RZ. Role of dopamine, the frontal cortex and memory circuits in drug addiction: insight from imaging studies. *Neurobiol Learn Mem*. 2002;78(3):610-624.
- Volkow ND, Wang GJ, Fowler JS, Tomasi D. Addiction circuitry in the human brain. *Annu Rev Pharmacol Toxicol*. 2012;52(1):321-336.
- Bechara A. Decision making, impulse control and loss of willpower to resist drugs: a neurocognitive perspective. *Nat Neurosci*. 2005;8(11): 1458-1463.
- Evans JSBT, Coventry K. A dual process approach to behavioural addiction: the case of gambling. In: Wiers RW, Stacy AW, eds. *Handbook of Implicit Cognition and Addiction*. Thousand Oaks, CA: Sage; 2006:29-43.
- Stacy AW, Wiers RW. Implicit cognition and addiction: a tool for explaining paradoxical behavior. *Annu Rev Clin Psychol*. 2010;6(1): 551-575.
- Strack F, Deutsch R. Reflective and impulsive determinants of social behavior. *Pers Soc Psychol Rev*. 2004;8(3):220-247.

24. Tiffany ST, Wray JM. The clinical significance of drug craving. *Ann N Y Acad Sci.* 2012;1248(1):1-17.
25. Cox WM, Fadardi JS, Pothos EM. The Addiction–Stroop Test: theoretical considerations and procedural recommendations. *Psychol Bull.* 2006;132(3):443-476.
26. Field M, Cox WM. Attentional bias in addictive behaviors: a review of its development, causes, and consequences. *Drug Alcohol Depend.* 2008;97(1-2):1-20.
27. Wiers RW, Stacy AW. Implicit cognition and addiction. *Curr Dir Psychol Sci.* 2006;15(6):292-296.
28. Cousijn J, Goudriaan AE, Ridderinkhof KR, Van Den Brink W, Veltman DJ, Wiers RW. Approach-bias predicts development of cannabis problem severity in heavy cannabis users: results from a prospective fMRI study. *PLoS One.* 2012;7(9):e42394.
29. Goldman MS. The alcohol expectancy concept: applications to assessment, prevention, and treatment of alcohol abuse. *Appl Prev Psychol.* 1994;3(3):131-144.
30. Everitt BJ. Neural and psychological mechanisms underlying compulsive drug seeking habits and drug memories—indications for novel treatments of addiction. *Eur J Neurosci.* 2014;40(1):2163-2182.
31. Everitt BJ, Robbins TW. Neural systems of reinforcement for drug addiction: from actions to habits to compulsion. *Nat Neurosci.* 2005; 8(11):1481-1489.
32. Everitt BJ, Robbins TW. Drug addiction: updating actions to habits to compulsions ten years on. *Annu Rev Psychol.* 2016;67(1):23-50.
33. Ioannidis K, Hook R, Goudriaan AE, et al. Cognitive deficits in problematic Internet use: a meta-analysis of 40 studies. *Br J Psychiatry.* 2019;215(5):639-646.
34. Antons S, Brand M, Potenza MN. Neurobiology of cue-reactivity, craving, and inhibitory control in nonsubstance addictive behaviors. *J Neurol Sci.* 2020;415:116952.
35. Yao Y-W, Zhang J-T, Fang X-Y, Liu L, Potenza MN. Reward-related decision-making deficits in Internet gaming disorder: a systematic review and meta-analysis. *Addiction.* 2021. [Epub ahead of print]
36. Brand M, Rumpf H-J, Demetrovics Z, King DL, Potenza MN, Wegmann E. Gaming disorder is a disorder due to addictive behaviors: evidence from behavioral and neuroscientific studies addressing cue reactivity and craving, executive functions, and decision-making. *Curr Addiction Rep.* 2019;6(3):296-302.
37. Müller A, Brand M, Claes L, et al. Buying-shopping disorder—is there enough evidence to support its inclusion in ICD-11? *CNS Spectr.* 2019;24(4):374-379.
38. Wölfling K, Müller KW, Dreier M, et al. Efficacy of short-term treatment of internet and computer game addiction: a randomized clinical trial. *JAMA Psychiat.* 2019;76(10):1018-1025.
39. Müller A, Arikian A, de Zwaan M, Mitchell JE. Cognitive-behavioural group therapy versus guided self-help for compulsive buying disorder: a preliminary study. *Clin Psychol Psychother.* 2013;20(1):28-35.
40. Stark R, Wehrum-Osinsky S. *Sexuelle Sucht.* Hogrefe; 2016.

How to cite this article: Brand M, Müller A, Stark R, et al. Addiction Research Unit: Affective and cognitive mechanisms of specific Internet-use disorders. *Addiction Biology.* 2021; e13087. <https://doi.org/10.1111/adb.13087>