# Screen Addiction Disorder:

## EEG-based Diagnostics and Trends In Therapeutics

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### Introduction

Since childhood, most of us have been told that watching too much television is not healthy and that **excessive screen time** can have serious repercussions on our general health. However, when asked about the nature of damage that spending long hours in front a screen can cause in the short to the long term, most people (and mental health professionals!) find it hard to offer the actual evidence for it.

In line with popular beliefs, epidemiological studies indicate that excessive screen time is an important and **independent risk factor for general health**, with adult morbidity and mortality [1]. Also, there is evidence that the number of hours of viewing proportionally increases the risk for experiencing socio-emotional problems [2]. These are some of the main reasons why reducing the average screen time in the adult population has been one of the national health improvement priorities and main strategies of disease prevention in the USA for at least a decade now [3].

One of the main concerns about screen viewing is it that can cause addiction. The term **"screen addiction"** is used to indicate that the engagement with multiple screen activities becomes a significant proportion of an individual's daily life and that discontinuation is associated to cravings. Activities that have been found to induce screen addition are those that simply involve a display, including video gaming, messaging and social networking, watching pornography or simply watching television series [4, 5]. Importantly, many studies have reported that **a range of psychiatric disorders may coexist with internet addiction** [6-8], which is supported by correlations found with depression [9, 10], anxiety [11], attention deficit hyperactivity disorder (ADHD) [12, 13], psychosis [14] and obsessive-compulsive disorder (OCD) [15].

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## 1. Using electroencephalography to detect screen addiction and comorbid disorders

A growing number of research studies have evidenced that **persons with screen addiction exhibit brain activity anomalies** as detected by electroencephalography (EEG). For example Choi et al. [16] found that individuals with internet addiction had **decreased absolute beta power at rest,** and that the decrease was proportional to symptom severity and impulsivity. Importantly, there is evidence that comorbid depression affects the EEG changes associated to internet addiction. In particular, **quantitative EEG (qEEG)** findings indicate that persons with **internet addiction and comorbid** depression may exhibit increased absolute delta power relative to patients with internet addiction without depression, and increased relative theta power relative to patients with internet addiction without depression or healthy controls [17]. Other qEEG research found that, when compared to healthy controls, persons with **internet gaming disorder (IGD)** exhibited decreased absolute beta power and increased absolute gamma power [16], and that greater absolute gamma power was significantly correlated with IGD symptom severity [18]. Another study found that **adolescents with ADHD and IGD** showed lower relative delta band power and greater relative beta band power values in temporal regions compared to an ADHD-only group [19].

Other data that deserve mention derive from research that employed the recording of **Event Related Potentials (ERP)** during performance of cognitive tasks. In particular, there is evidence for increased impulsivity as well as poorer attention and learning associated with **excessive internet use**, as measured by the **P3 component** (a positive going deflection appearing in the EEG after the presentation of an attention demanding stimulus) and by activity perturbation in the **gamma frequency band** in response to attention demanding stimuli [20]. Similarly, a recent ERP study in persons with **addiction to cybersex** found impaired cognitive activity as well as greater impulsivity as measured by reaction times and by the N2 (200-300 ms) and P3 (300-500 ms) components, respectively [21].

Altogether, EEG and ERP research suggests that **it is possible to identify persons with screen addiction using EEG signals**, although comorbidities with other disorders (e.g., ADHD and affective disorders) may complicate the overall profile. Utilizing well established biomarkers of cognitive and emotion regulation processes, it is possible to determine discrepancies from normative values in view of targeted interventions aimed at normalizing or at least reducing the anomalies detected.

## 2. Treatment of addictive behavior related to the use of internet-based technology

### *2.1 Pharmacotherapy and psychotherapy*

Given the detrimental effects that the uncontrolled use of internet-based applications can have on our wellbeing, the research on targeted interventions has been steadily growing over the last few decades [22]. However, the research on the addictive exposure to technology is still in its infancy [23] and the research on potential treatments still needs to culminate in the design of evidence-based, well organized treatment plans.


It has been proposed that the neurobiological changes that take place in the brain of persons with behavioral addictions (e.g., gambling) are comparable to those exhibited by people addicted to substances [24]. Similarly, there could be shared psychological and behavioral characteristics in persons with behavioral addictions and persons who engage in substance abuse [25]. As a result, it is possible that treatments for substance abuse may have comparable effects in persons with of non-substance-related addictive behaviors, including those addicted to the use of internet-related technology [26].

Treatments explored mainly include **psychotropic medications** [22] and **cognitive behavioral therapy (CBT)** [27]. However, the efficacy of psychopharmacological treatments still has to be demonstrated in the context of technology addiction as more research needs to be carried out on greater population samples. So far, a number of exploratory case studies support the use of selective serotonin reuptake inhibitors (SSRIs) and naltrexone (i.e., Vivitrol) [28]. This is particularly interesting as naltrexone is typically used to treat alcohol or opioid abuse [29]. Also, bupropion (i.e., Wellbutrin) and methylphenidate (i.e., Ritalin) have been employed for treatment of gaming disorder with conflicting results. In one study, no differences were found between persons treated with psychotropics versus behavioral therapy [30]. Instead, other researchers [31] found not only improvements in mood but also significant reductions in the amount of time spent playing video games. While these contradictory results could certainly be linked to methodological limitations, the paucity of studies conducted up to this point [28] or to the small and heterogeneous patient sample sizes [22], it could be argued that the population recruited is still not well known. Without clear, objectively defined and consistent criteria used to assess the different types of technology used, choosing the most appropriate treatment for those with addiction may be challenging [26]. In this context, other therapeutic avenues have also been sought but with similar limitations. For example, some evidence [32] suggests that **narrative therapy** might be effective in the treatment of excessive video game use and other studies support cognitive CBT as a treatment for internet addiction [27, 33].

*2.2 Targeting impulsivity to reduce addiction behavior*

Clinical studies suggest that impulsive behavior is highly linked to substance abuse [34-38] and there is evidence that greater impulsivity is associated with poor clinical outcomes [39, 40] and relapse, even after long withdrawal periods [41, 42]. While impulsive decision making and impulsive behavior appear to be strongly linked to cognitive processes [43-45], greater physiological arousal and emotional states such as anxiety, anger, sadness, or joy may also be associated with impulsivity [46, 47].

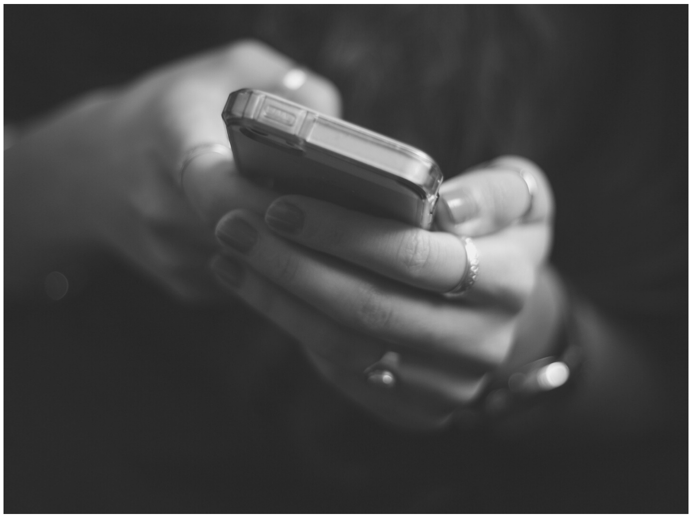
Interestingly, depression and impulsivity share **common neurobiological correlatesin the brain,** including the prefrontal cortex [48-52] and, as these anomalies reflect altered EEG [53-56], **EEG-based interventions** for addiction have been explored in research studies.

One of the avenues used to lower impulsivity in persons with substance abuse is **EEG-neurofeedback training,** a form of biofeedback known to facilitate self-regulation of EEG activity in the brain [57, 58]. Importantly, EEG-neurofeedback training has been shown to be effective in the treatment of drug addiction, lowering impulsivity, increasing abstinence rates [59], and lowering reactivity to drug-related stimuli [60]. Other neurofeedback studies [61] also indicate that neurofeedback reduced both impulsivity, anxiety and depression symptoms in long-term abstinent addicts (Fig.1), which lowered the likelihood for relapse [62-64].

While more research should determine the effects of EEG-neurofeedback training on screen addiction, it is reasonable to suggest that training protocols similar to those used with drug addiction patients are likely to yield positive clinical outcomes. In any case, the ability to selectively guide interventions targeting specific EEG imbalances is certainly of great advantage given the high level of behavioral heterogeneity exhibited by this clinical population.

## Conclusions

Excessive screen time can have detrimental effects on general health, increasing the risk for socio-emotional problems and negatively impacting quality of life.Persons who are regularly exposed to phones and computers are more at risk to developing addiction to screen watching while the efficacy of currently available treatments still needs to be determined in well conducted research. In particular, while pharmacotherapy and psychotherapy have been shown to have some beneficial effects, other EEG-based interventions i.e. neurofeedback training allow to reduce functional imbalances in the brain targeting specific non-normative activity.



## References


1. Sigman, A., Virtually addicted: why general practice must now confront screen dependency. Br J Gen Pract, 2014. **64**(629): p. 610-1.
2. England, P.H., Impact of digital culture, 2014.
3. US Department of Health and Human Services Healthy People 2020. Objective PA8. 2020; Available from: https://www.healthypeople.gov/2020/topics-objectives/topic/physical-activity/objectives.
4. Berry, S.D., M.L. McGowen, and S.J. Davis, A Brief Review of Addictive Tendencies Related to Technology Use: Conceptualization, Treatment, and Future Directions. IAFOR Journal of Psychology & the Behavioral Sciences, 2019. **5**(1).
5. Balhara, Y.P.S., K. Verma, and R. Bhargava, Screen time and screen addiction: Beyond gaming, social media and pornography- A case report. Asian J Psychiatr, 2018. **35**: p. 77-78.
6. Ha, J.H., et al., Depression and Internet addiction in adolescents. Psychopathology, 2007. **40**(6): p. 424-30.
7. Kim, K., et al., Internet addiction in Korean adolescents and its relation to depression and suicidal ideation: a questionnaire survey. Int J Nurs Stud, 2006. **43**(2): p. 185-92.
8. YOUNG, K.S. and R.C. ROGERS, The Relationship Between Depression and Internet Addiction. CyberPsychology & Behavior 2009. **1**(1).
9. Morrison, C.M. and H. Gore, The relationship between excessive Internet use and depression: a questionnaire-based study of 1,319 young people and adults. Psychopathology, 2010. **43**(2): p. 121-6.
10. Tsai, C.C. and S.S. Lin, Internet addiction of adolescents in Taiwan: an interview study. Cyberpsychol Behav, 2003. **6**(6): p. 649-52.
11. Bernardi, S. and S. Pallanti, Internet addiction: a descriptive clinical study focusing on comorbidities and dissociative symptoms. Compr Psychiatry, 2009. **50**(6): p. 510-6.
12. Ko, C.H., et al., Psychiatric comorbidity of internet addiction in college students: an interview study. CNS Spectr, 2008. **13**(2): p. 147-53.
13. Yoo, H.J., et al., Attention deficit hyperactivity symptoms and internet addiction. Psychiatry Clin Neurosci, 2004. **58**(5): p. 487-94.
14. Gibbs, P.L., Reality in cyberspace: analysands' use of the Internet and ordinary everyday psychosis. Psychoanal Rev, 2007. **94**(1): p. 11-38.
15. Zhang, L., C. Amos, and W.C. McDowell, A comparative study of Internet addiction between the United States and China. Cyberpsychol Behav, 2008. **11**(6): p. 727-9.
16. Choi, J.S., et al., Resting-state beta and gamma activity in Internet addiction. Int J Psychophysiol, 2013. **89**(3): p. 328-33.
17. Lee, J., et al., Differential resting-state EEG patterns associated with comorbid depression in Internet addiction. Prog Neuropsychopharmacol Biol Psychiatry, 2014. **50**: p. 21-6.
18. Son, K.L., et al., Neurophysiological features of Internet gaming disorder and alcohol use disorder: a resting-state EEG study. Transl Psychiatry, 2015. **5**: p. e628.
19. Park, J.H., et al., Comparison of QEEG Findings between Adolescents with Attention Deficit Hyperactivity Disorder (ADHD) without Comorbidity and ADHD Comorbid with Internet Gaming Disorder. J Korean Med Sci, 2017. **32**(3): p. 514-521.
20. Yu, H., et al., Effect of excessive Internet use on the time–frequency characteristic of EEG. Progress in Natural Science, 2009. **19**(10): p. 1383-1387.
21. Wang, J. and B. Dai, Event-related potentials in a two-choice oddball task of impaired behavioral inhibitory control among males with tendencies towards cybersex addiction. J Behav Addict, 2020. **9**(3): p. 785-796.
22. King, D., P.H. Delfabbro, and M.D. Griffiths, Clinical interventions for technologybased problems: Excessive Internet and video game use. Journal of Cognitive Psychotherapy, 2012. **26**: p. 43–56.
23. Griffiths, M.D., Technological Addictions. Clinical Psychology Forum, 1995. **76**, : p. 14-19.
24. Kuss, D.J. and J. Billieux, Technological addictions: Conceptualization, measurement, etiology and treatment. Addictive Behaviors, , 2014. **64**: p. 231–233.
25. Nakken, C., The addictive personality: Understanding the addictive process and compulsive behavior. 2nd ed. 1996, Center City, MN: Hazelden Publishing.
26. Kuss, D.J. and J. lBillieux, Technological addictions: Conceptualisation, measurement, etiology and treatment. Addictive Behaviors, 2017. **64.**
27. Young, K.S., Cognitive behavior therapy with Internet addicts: treatment outcomes and implications. Cyberpsychol Behav, 2007. **10**(5): p. 671-9.
28. Huang, X.Q., M.C. Li, and R. Tao, Treatment of internet addiction. Curr Psychiatry Rep, 2010. **12**(5): p. 462-70.
29. Administration, S.A.a.M.H.S., Naltrexone. 2016.
30. King, D.L. and P.H. Delfabbro, Internet gaming disorder treatment: a review of definitions of diagnosis and treatment outcome. J Clin Psychol, 2014. **70**(10): p. 942-55.
31. Weinstein, A. and M. Lejoyeux, New developments on the neurobiological and pharmaco-genetic mechanisms underlying internet and videogame addiction. Am J Addict, 2015. **24**(2): p. 117-125.
32. Graham, M., Narrative Therapy for Treating Video Game Addiction. Int J Ment Health Addiction, 2014. **12**: p. 701–707.
33. Young, K.S., Treatment outcomes using CBT-IA with Internet-addicted patients. J Behav Addict, 2013. **2**(4): p. 209-15.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## References


34. Moeller, F.G., et al., Increased impulsivity in cocaine dependent subjects independent of antisocial personality disorder and aggression. Drug Alcohol Depend, 2002. **68**(1): p. 105-11.
35. Ortal, S., et al., The Role of Different Aspects of Impulsivity as Independent Risk Factors for Substance Use Disorders in Patients with ADHD: A Review. Curr Drug Abuse Rev, 2015. **8**(2): p. 119-33.
36. Rodriguez-Cintas, L., et al., Impulsivity and addiction severity in cocaine and opioid dependent patients. Addict Behav, 2016. **58**: p. 104-9.
37. Roncero, C., et al., Cocaine-induced psychosis and impulsivity in cocaine-dependent patients. J Addict Dis, 2013. **32**(3): p. 263-73.
38. Valero, S., et al., Neuroticism and impulsivity: their hierarchical organization in the personality characterization of drug-dependent patients from a decision tree learning perspective. Compr Psychiatry, 2014. **55**(5): p. 1227-33.
39. Coffey, S.F., et al., Impulsivity and rapid discounting of delayed hypothetical rewards in cocaine-dependent individuals. Exp Clin Psychopharmacol, 2003. **11**(1): p. 18-25.
40. Poling, J., T.R. Kosten, and M. Sofuoglu, Treatment outcome predictors for cocaine dependence. Am J Drug Alcohol Abuse, 2007. **33**(2): p. 191-206.
41. Laudet, A.B., What does recovery mean to you? Lessons from the recovery experience for research and practice. J Subst Abuse Treat, 2007. **33**(3): p. 243-56.
42. Winhusen, T., et al., Impulsivity is associated with treatment non-completion in cocaine- and methamphetamine-dependent patients but differs in nature as a function of stimulant-dependence diagnosis. J Subst Abuse Treat, 2013. **44**(5): p. 541-7.
43. Patton, J.H., M.S. Stanford, and E.S. Barratt, Factor structure of the Barratt impulsiveness scale. J Clin Psychol, 1995. **51**(6): p. 768-74.
44. Winstanley, C.A., D.M. Eagle, and T.W. Robbins, Behavioral models of impulsivity in relation to ADHD: translation between clinical and preclinical studies. Clin Psychol Rev, 2006. **26**(4): p. 379-95.
45. Winstanley, C.A., et al., Insight into the relationship between impulsivity and substance abuse from studies using animal models. Alcohol Clin Exp Res, 2010. **34**(8): p. 1306-18.
46. Chester, D.S., et al., How do negative emotions impair self-control? A neural model of negative urgency. Neuroimage, 2016. **132**: p. 43-50.
47. Kreibig, S.D., Autonomic nervous system activity in emotion: a review. Biol Psychol, 2010. **84**(3): p. 394-421.
48. Tanabe, J., et al., Medial orbitofrontal cortex gray matter is reduced in abstinent substance-dependent individuals. Biol Psychiatry, 2009. **65**(2): p. 160-4.
49. London, E.D., et al., Orbitofrontal cortex and human drug abuse: functional imaging. Cereb Cortex, 2000. **10**(3): p. 334-42.
50. Stapleton, J.M., et al., Cerebral glucose utilization in polysubstance abuse. Neuropsychopharmacology, 1995. **13**(1): p. 21-31.
51. Volkow, N.D. and J.S. Fowler, Addiction, a disease of compulsion and drive: involvement of the orbitofrontal cortex. Cereb Cortex, 2000. **10**(3): p. 318-25.
52. Volkow, N.D., et al., Long-term frontal brain metabolic changes in cocaine abusers. Synapse, 1992. **11**(3): p. 184-90.
53. Fingelkurts, A.A., et al., Increased local and decreased remote functional connectivity at EEG alpha and beta frequency bands in opioid-dependent patients. Psychopharmacology (Berl), 2006. **188**(1): p. 42-52.
54. Franken, I.H., et al., Electroencephalographic power and coherence analyses suggest altered brain function in abstinent male heroin-dependent patients. Neuropsychobiology, 2004. **49**(2): p. 105-10.
55. Prichep, L.S., et al., Quantitative electroencephalographic characteristics of crack cocaine dependence. Biol Psychiatry, 1996. **40**(10): p. 986-93.
56. Roemer, R.A., et al., Quantitative electroencephalographic analyses in cocaine-preferring polysubstance abusers during abstinence. Psychiatry Res, 1995. **58**(3): p. 247-57.
57. Hammond, D.C., Neurofeedback with anxiety and affective disorders. Child Adolesc Psychiatr Clin N Am, 2005. **14**(1): p. 105-23, vii.
58. Johnstone, J., J. Gunkelman, and J. Lunt, Clinical database development: characterization of EEG phenotypes. Clin EEG Neurosci, 2005. **36**(2): p. 99-107.
59. Scott, W.C., et al., Effects of an EEG biofeedback protocol on a mixed substance abusing population. Am J Drug Alcohol Abuse, 2005. **31**(3): p. 455-69.
60. Horrell, T., et al., Neurofeedback Effects on Evoked and Induced EEG Gamma Band Reactivity to Drug-related Cues in Cocaine Addiction. J Neurother, 2010. **14**(3): p. 195-216.
61. Corominas-Roso, M., et al., Benefits of EEG-Neurofeedback on the Modulation of Impulsivity in a Sample of Cocaine and Heroin Long-Term Abstinent Inmates: A Pilot Study. Int J Offender Ther Comp Criminol, 2020: p. 306624X20904704.
62. Corominas, M., C. Roncero, and M. Casas, Corticotropin releasing factor and neuroplasticity in cocaine addiction. Life Sci, 2010. **86**(1-2): p. 1-9.
63. DiGirolamo, G.J., et al., Increased Depression and Anxiety Symptoms are Associated with More Breakdowns in Cognitive Control to Cocaine Cues in Veterans with Cocaine Use Disorder. J Dual Diagn, 2017. **13**(4): p. 298-304.
64. Hasin, D., et al., Effects of major depression on remission and relapse of substance dependence. Arch Gen Psychiatry, 2002. **59**(4): p. 375-80.


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