*Editorial*

# Neurobiology of Pornography Addiction

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'Pornography addiction' is a recent diagnostic label which is used to define patients with a propensity and tendency to view pornography images and videos frequently and regularly and also experiencing distress when not allowed to do so [1]. This falls under the broader rubric of 'sex addiction' or as a subtype of 'internet addiction behaviour' [2]. There is a mixed viewpoint on whether pornography is actually an addiction or whether it must be categorized as a sexual compulsivity or as a subset of hypersexual behaviour [3]. Even current literature is not clear on diagnostic criteria for the disorder while it remains a fact that clinicians are seeing more patients with this problem over the past few years [4].

**Role of the reward areas of the brain**

In an early study using fMRI scans, researchers showed cocaine addicted patient's preconscious sexually related visual cues (erotic images). They found activation of the same limbic system/reward circuitry in subjects shown sexual cues as when shown drug related cues [5]. Neurobiological reviews on sexual behaviour and drug addiction have confirmed that the networks involved in sexual behaviour are similar to those involved in processing other rewards including addictions [6]. The overlap of classic reward brain areas involved in sexual arousal, love and attachment has been elucidated with the ventral tegmental area, nucleus accumbens, amygdala, basal ganglia, prefrontal cortex and orbitofrontal cortex being the common substrate [7]. A model termed the 'reward deficiency syndrome' (RDS) model has been implicated in pornography addiction [8]. It implies a brain reward genetic dissatisfaction or impairment that results in aberrant pleasure-seeking behaviour that includes drugs, excessive food, sexuality gaming, gambling and other behaviours [9].

**Dopamine, neuroplasticity and its role**

It has been stated that the continued release of dopamine into the reward system when an individual compulsively and chronically watches pornography stimulates neuroplastic changes that reinforce the experience. These neuroplastic changes build brain maps for sexual excitement [10]. In the brain of the user, previously established brain maps for normal sexuality cannot match up to newly developed and continuously reinforced maps generated by watching pornography, and the addicted individual progresses to more explicit and graphic pornography use to maintain the higher level of excitement [11]. Changes in dopamine receptor density as a result with permanent changes in the reward system have been implicated in this condition [12].

**Cue reactivity**

In a landmark study on compulsive sexual behaviour, an experiment was conducted designed to measure the subjective experience of cue-reactivity, as well as the neurobiological markers and correlates. The subjects were shown the videos both inside and outside of the fMRI scanner. Compared to the healthy control subjects, the compulsive sexual behaviour subjects reported higher desire ratings to the sexually explicit videos, but not to the erotic clips while they reported higher liking rating to the erotic clips, but not to the explicit cues. These results indicated a divide between liking and yearning by compulsive sexual behaviour subjects when watching sexually explicit videos [13].

**Structural MRI findings**

In an MRI study on 64 healthy male subjects, the researchers correlated hours of online viewing of explicit material per week and years of use with dorsal striatal structure and connectivity. The longer duration and more hours per week of use correlated with lower grey matter volume in the right caudate nucleus. More years and more hours per week of use correlated with lower left putamen activity in response to brief, still sexual images. Gray matter volume of the brain was measured by voxel-based morphometry and resting state functional connectivity was measured on 3-T magnetic resonance imaging scans. They found a significant negative association between reported pornography hours per week and grey matter volume in the right caudate as well as with functional activity during a sexual cue–reactivity paradigm in the left putamen. Functional connectivity of the right caudate to the left dorsolateral prefrontal cortex was negatively associated with hours of pornography consumption [14]. fMRI studies have confirmed that the putamen is activated during sexual arousal and pleasure. The subjective symptom severity was also the only significant predictor in a regression analysis with ventral striatum response as dependent variable and subjective symptoms of Internet pornography addiction, general sexual excitability, hypersexual behaviour, depression, interpersonal sensitivity, and sexual behaviour in the last days as predictors [15]. The clinical implication of the findings are that there are brain related changes in pornography addiction. The greater the intensity and severity of the brain findings, the longer is the patient probably going to take to show treatment response and recovery. Further studies using multiple imaging modalities are needed to get a better perspective one exact neurobiological correlates of pornography addiction.

**Pornography viewing and higher cognitive function**

Multiple studies have also been conducted on the impact of pornography viewing on cognitive functions. Changes in neural structures such as the orbitofrontal cortex (OFC) and subcortical structures have been linked to neurochemical changes in serotonin and serotonin/dopamine ratios. Subjects with excessive pornography viewing have shown impairments on executive functioning thought to involve the DLPFC [16]. Greater self-reported executive dysfunction in a sample of hypersexual patients have been reported using neuropsychological tests [17]. Several studies reported an interference of the processing of sexual cues and sexual arousal with executive function [18]. Sexual arousal induced by sexual images impaired working memory performance in a study as well as switching and monitoring performance in an executive multitasking paradigm. The finding of an attentional bias towards sexually explicit cues has been replicated in many studies [19].

**Neuroimaging and visual sexual stimuli studies**

There is an increasing number of neuroimaging studies using visual sexual stimuli (VSS), especially within the emerging field of research on compulsive sexual behaviour [20]. A central question in this field is whether behaviours such as excessive pornography consumption share common brain mechanisms with widely studied substance and behavioural addictions. Depending on how VSS are conceptualized, different predictions can be formulated within the frameworks of 'reinforcement learning' or 'incentive salience theory' [21]. In most laboratory settings, VSS play a role of a reward, as evidenced by the (1) experience of pleasure while watching VSS, possibly accompanied by genital reactions, (2) reward-related brain activity correlated with these pleasurable feelings in response to VSS, (3) a willingness to exert effort to view VSS similarly as for other rewarding stimuli such as money and (4) conditioning for cues predictive of VSS. These studies on VSS serve as a means to provide common grounds for theories of the neurobiology of pornography addiction and other behavioural addictions [22].

**Emerging areas of research and new findings**

**Neuroplasticity:** The brain's ability to adapt and change in response to experiences, known as neuroplasticity, is a key area of study. Prolonged exposure to pornography has been suggested to influence neural circuits related to reward processing and habit formation [23].

**Similarities to Substance Addiction:** Some studies have explored similarities between pornography addiction and substance addiction in terms of brain activity and changes. However, it's crucial to recognize

that the concept of behavioural addiction, including pornography addiction, is still debated within the scientific community [24].

**Pre-existing Factors:** Individual differences, such as personality traits, pre-existing mental health conditions, and life experiences, may influence susceptibility to developing problematic patterns of pornography use. Understanding the interplay between these factors and neurobiological mechanisms is an active area of research.

**Neurotransmitters:** There have been multiple neurotransmitters that have been implicated in addictions that range from dopamine to serotonin and now a role for glutamate and dynorphin has been elucidated [25]. The same has not yet been elucidated in research of pornography addiction. Further studies in this direction are warranted. Evidence regarding neurotransmitter activity in pornography addictions and substance use disorders has tended to be complementary. Neurochemical findings suggest differential serotonergic function, compared with control subjects, among people with behavioural addictions and clinical results with dopamine antagonists and medications targeting serotonin (primarily SSRIs) have demonstrated negative or mixed findings in people with pornography addiction [26].

## Conclusions

The neurobiology of pornography addiction is one which is nascent, and needs substantiate research to consolidate the findings already done. Researchers need to converge these findings of various studies and come up with an integrated neurobiological model of pornography addiction. There is a need for further larger neuroimaging, biomarker and genetic studies in the area to help determine a biological trajectory for pornography addiction. It is the next decade of research in this area shall pave the way ahead for things to come.

## REFERENCES


1. Ley D, Prause N, Finn P. The emperor has no clothes: a review of the 'pornography addiction' model. Curr Sexual Health Rep 2014;6(2):94-105.
2. Sabina C, Wolak J, Finkelhor D. The nature and dynamics of Internet pornography exposure for youth. Cyberpsychol Behav 2006;11(6):691-3.
3. Wilson G. Your brain on porn: Internet pornography and the emerging science of addiction. Richmond, VA: Commonwealth Publishing: USA; 2014.
4. Maltz W, Maltz L. The porn trap: The essential guide to overcoming problems caused by pornography. Harper Collins: USA; 2009.
5. Childress AR, Ehrman RN, Wang Z, Li Y, Sciortino N, Hakun J, Jens W, Suh J, Listerud J, Marquez K, Franklin T. Prelude to passion: limbic activation by "unseen" drug and sexual cues. PLoS One 2008;3(1):e1506.
6. Demos KE, Heatherton TF, Kelley WM. Individual differences in nucleus accumbens activity to food and sexual images predict weight gain and sexual behavior. J Neurosci 2012;32(16):5549-52.
7. Hilton Jr DL, Watts C. Pornography addiction: A neuroscience perspective. Surg Neurol Int 2001;2:9-14.
8. Comings DE, Blum K. Reward deficiency syndrome: genetic aspects of behavioral disorders. Progr Brain Res 2000;126:325-41.
9. Blum K, Gardner E, Oscar-Berman M, Gold M. "Liking" and "wanting" linked to Reward Deficiency Syndrome (RDS): hypothesizing differential responsivity in brain reward circuitry. Curr Pharmaceut Design 2012;18(1):113-8.
10. Love T, Laier C, Brand M, Hatch L, Hajela R. Neuroscience of internet pornography addiction: a review and update. Behav Sci 2016;5(3):388-433.
11. Hilton Jr DL. Pornography addiction–a supranormal stimulus considered in the context of neuroplasticity. Socio-affective Neurosci Psychol 2015;3(1):20767.
12. Kühn S, Gallinat J. Brain structure and functional connectivity associated with pornography consumption: the brain on porn. JAMA Psychiatry 2014;71(7):827-34.
13. Laier C, Pawlikowski M, Pekal J, Schulte FP, Brand M. Cybersex addiction: experienced sexual arousal when watching pornography and not real-life sexual contacts makes the difference. J Behav Addict 2008;2(2):100-7.
14. Gola M, Miyakoshi M, Sescousse G. Sex, impulsivity, and anxiety: interplay between ventral striatum and amygdala reactivity in sexual behaviors. J Neurosci 2015;35(46):15227-9.
15. Sacher J, Neumann J, Okon-Singer H, Gotowiec S, Villringer A. Sexual dimorphism in the human brain: evidence from neuroimaging. Magnetic Resonance Imaging 2013;31(3):366-75.
16. Ko CH, Liu GC, Hsiao S, Yen JY, Yang MJ, Lin WC, Yen CH, Chen CS. Brain activities associated with gaming urge of online gaming addiction. J Psychiatr Res 2009;43(7):739-47.

17. Verdejo-García A, Bechara A, Recknor EC, Perez-Garcia M. Executive dysfunction in substance dependent individuals during drug use and abstinence: an examination of the behavioral, cognitive and emotional correlates of addiction. J Int Neuropsychol Soc 2010;12(3):405-15.
18. Crews F, He J, Hodge C. Adolescent cortical development: a critical period of vulnerability for addiction. Pharmacol Biochem Behav 2010;86(2):189-99.
19. Bickel WK, Yi R, Landes RD, Hill PF, Baxter C. Remember the future: working memory training decreases delay discounting among stimulant addicts. Biol Psychiatry 2011;69(3):260-5.
20. Brand M, Laier C, Pawlikowski M, Schächtle U, Schöler T, Altstötter-Gleich C. Watching pornographic pictures on the Internet: Role of sexual arousal ratings and psychological–psychiatric symptoms for using Internet sex sites excessively. Cyberpsychol Behav Soc Network 2009;14(6):371-7.
21. Paul T, Schiffer B, Zwarg T, Krüger TH, Karama S, Schedlowski M, Forsting M, Gizewski ER. Brain response to visual sexual stimuli in heterosexual and homosexual males. Human Brain Mapping 2008;29(6): 726-35.
22. Schiffer B, Krueger T, Paul T, de Greiff A, Forsting M, Leygraf N, Schedlowski M, Gizewski E. Brain response to visual sexual stimuli in homosexual pedophiles. J Psychiatry Neurosci 2008;33(1):23-8.
23. Kalivas PW, Volkow ND. The neural basis of addiction: a pathology of motivation and choice. Am J Psychiatry 2005;162(8):1403-13.
24. Grant JE, Brewer JA, Potenza MN. The neurobiology of substances and behavioral addictions. CNS Spectrums 2006;11(12):924-30.
25. Olive MF, Cleva RM, Kalivas PW, Malcolm RJ. Glutamatergic medications for the treatment of drug and behavioral addictions. Pharmacol Biochem Behavior 2012;100(4):801-10.
26. Malandain L, Blanc JV, Ferreri F, Thibaut F. Pharmacotherapy of sexual addiction. Curr Psychiatry Rep 2020;22:1-8.

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