Appendix 1

Studies and reviews demonstrating parallels between compulsive sexual behavior and the addiction model

STUDIES

Neuroscience studies (fMRI, MRI, EEG, Neuro-endocrine)

- **Brain Structure and Functional Connectivity Associated With Pornography Consumption: The Brain on Porn (2014)** – Kuhn & Gallinat 2014, a German study, found 3 significant addiction-related brain changes correlating with the amount of porn consumed. It also found that more porn use correlated with less reward circuit activation while viewing sexual photos. Researchers stated their findings indicated desensitization, and possibly tolerance, which is the increasing need for stimulation.

- **Neural Correlates of Sexual Cue Reactivity in Individuals with and without Compulsive Sexual Behaviours (2014)** – Voon et al., 2014 is the first in a series of Cambridge University studies. It found the same brain activity seen in drug addicts and alcoholics. It also found that porn addicts fit the accepted addiction model of wanting “it” more, but not liking “it” more. The researchers reported that 60% of subjects (average age: 25) had difficulty achieving erections/arousal with real partners, yet could achieve erections with porn.

- **Enhanced Attentional Bias towards Sexually Explicit Cues in Individuals with and without Compulsive Sexual Behaviours (2014)** – The second Cambridge University study. An excerpt: "Our findings of enhanced attentional bias... suggest possible overlaps with enhanced attentional bias observed in studies of drug cues in disorders of addictions. These findings converge with recent findings of neural reactivity to sexually explicit cues in [porn addicts] in a network similar to that implicated in drug-cue-reactivity studies and provide support for incentive motivation theories of addiction underlying the aberrant response to sexual cues in [porn addicts]."

- **Novelty, Conditioning and Attentional Bias to Sexual Rewards (2015)** – The third Cambridge study. Compared to controls, porn addicts preferred sexual novelty and conditioned cues associated porn. However, the brains of porn addicts habituated faster to sexual images. Since (sensation-seeking) novelty preference wasn’t pre-existing, porn addiction appears to drive novelty-seeking, as users attempt to overcome habituation and desensitization.

- **Neural Substrates of Sexual Desire in Individuals with Problematic Hypersexual Behavior (2015)** – This Korean fMRI study replicates other brain studies on porn users. Like the Cambridge University studies it found cue-induced brain activation patterns in sex addicts which mirrored the patterns of drug addicts. In line with several German studies it found alterations in the prefrontal cortex which match the changes observed in drug addicts.

- **Sexual Desire, not Hypersexuality, is Related to Neurophysiological Responses Elicited by Sexual Images (2013)** – This EEG study was touted in the media as evidence against the existence of porn addiction. However, this SPAN Lab study, like the next one, actually lends support to the existence of porn addiction. The study reported higher EEG readings (P300) when subjects were briefly exposed to pornographic photos. Studies consistently show that an elevated P300 occurs when addicts are exposed to cues (such as images) related to their addiction. However, due to methodological flaws the findings are uninterpretable: 1) subjects were heterogeneous (males, females, non-heterosexuals); 2) subjects were not screened for mental disorders or addictions; 3) study had no control group for comparison; 4) questionnaires were not validated for porn addiction. In line with the Cambridge University brain scan studies, this EEG study reported greater cue-reactivity to porn correlated with less desire for partnered sex. That is, individuals with more brain activation and cravings for porn would rather masturbate to porn than have sex with a real person. Study spokesman and former UCLA researcher Nicole Prause claimed that porn users merely had high libido, yet the results of the study say something quite different. Multiple peer-reviewed papers challenge Prause’s conclusions given her data.
• **Modulation of Late Positive Potentials by Sexual Images in Problem Users and Controls Inconsistent with "Porn Addiction" (2015)** – Another SPAN Lab EEG study comparing the 2013 subjects from the above study to an actual control group. Compared to controls, porn addicts had less response to photos of vanilla porn. Lead author Prause claims these results debunk porn addiction. However, these findings align perfectly with Kühn & Gallinat (2014), the first study above, which found that more porn use correlated with less brain activation in response to pictures of vanilla porn. Another EEG study ("Sex in the Brain: The Relationship between Event Related Potentials and Subjective Sexual Arousal") found that greater porn use in women correlated with less brain activation to porn. Put simply, frequent porn users were desensitized and needed greater stimulation to achieve aroused. Five peer-reviewed papers agree with this analysis of the study.

• **HPA axis dysregulation in men with hypersexual disorder (2015)** – The Hypothalamus-Pituitary-Adrenal (HPA) axis is the central player in the stress response. Addictions alter the brain’s stress circuits leading to a dysfunctional HPA axis. This study on sex addicts (hypersexuals) found altered stress responses that mirror drug addiction.

• **Can pornography be addictive? An fMRI study of men seeking treatment for problematic pornography use (2016)** – (in the press) Excerpts: Men with and without problematic porn use (PPU) differed in brain reactions to cues predicting erotic pictures, but not in reactions to erotic pictures themselves, consistent with the incentive salience theory of addictions. This brain activation was accompanied by increased behavioral motivation to view erotic images (higher ‘wanting’). Ventral striatal reactivity for cues predicting erotic pictures was significantly related to the severity of PPU, amount of pornography use per week and number of weekly masturbations. Our findings suggest that like in substance-use and gambling disorders the neural and behavioral mechanisms linked to anticipatory processing of cues relate importantly to clinically relevant features of PPU. These findings suggest that PPU may represent a behavioral addiction and that interventions helpful in targeting behavioral and substance addictions warrant consideration for adaptation and use in helping men with PPU.

• **Ventral striatum activity when watching preferred pornographic pictures is correlated with symptoms of Internet pornography addiction (2016)** – Another German study by a different group. Finding #1: Reward center activity (ventral striatum) was higher for preferred pornographic pictures. Finding #2: Ventral striatum reactivity correlated with the internet sex addiction score. Both findings indicate sensitization and align with the addiction model. The authors state that the “Neural basis of Internet pornography addiction is comparable to other addictions.”

• **Altered Appetitive Conditioning and Neural Connectivity in Subjects With Compulsive Sexual Behavior (2016)** – A third German fMRI study replicating two major findings from Voon et al., 2014 and Kuhn & Gallinat 2014. Compared to controls compulsive porn users had 1) greater conditioned cue-induced activity in the amygdala, while having 2) decreased coupling between the ventral striatum and the prefrontal cortex. Number 1 indicates sensitization, while number 2 indicates hypofronatality. In addition, 3 of the 20 compulsive porn users suffered from “orgasmic-erection disorder”.

**Neuro-Psychological Studies on Porn Users**

• **Watching Pornographic Pictures on the Internet: Role of Sexual Arousal Ratings and Psychological-Psychiatric Symptoms for Using Internet Sex Sites Excessively (2011)**

*Results indicate that self-reported problems in daily life linked to online sexual activities were predicted by subjective sexual arousal ratings of the pornographic material, global severity of psychological symptoms, and the number of sex applications used when being on Internet sex sites in daily life, while the time spent on Internet sex sites (minutes per day) did not significantly contribute to explanation of variance in IATsex score. We see some parallels between cognitive and brain mechanisms potentially contributing to the maintenance of excessive cybersex and those described for individuals with substance dependence.*

• **Pornographic picture processing interferes with working memory performance (2013)**
Some individuals report problems during and after Internet sex engagement, such as missing sleep and forgetting appointments, which are associated with negative life consequences. One mechanism potentially leading to these kinds of problems is that sexual arousal during Internet sex might interfere with working memory (WM) capacity, resulting in a neglect of relevant environmental information and therefore disadvantageous decision making. Results revealed worse WM performance in the pornographic picture condition of the 4-back task compared with the three remaining picture conditions. Findings are discussed with respect to Internet addiction because WM interference by addiction-related cues is well known from substance dependencies.

- **Sexual Picture Processing Interferes with Decision-Making Under Ambiguity (2013)**

  Decision-making performance was worse when sexual pictures were associated with disadvantageous card decks compared to performance when the sexual pictures were linked to the advantageous decks. Subjective sexual arousal moderated the relationship between task condition and decision-making performance. This study emphasized that sexual arousal interfered with decision-making, which may explain why some individuals experience negative consequences in the context of cybersex use.

- **Cybersex addiction: Experienced sexual arousal when watching pornography and not real-life sexual contacts makes the difference (2013)**

  The results show that indicators of sexual arousal and craving to Internet pornographic cues predicted tendencies towards cybersex addiction in the first study. Moreover, it was shown that problematic cybersex users report greater sexual arousal and craving reactions resulting from pornographic cue presentation. In both studies, the number and the quality with real-life sexual contacts were not associated to cybersex addiction. The results support the gratification hypothesis, which assumes reinforcement, learning mechanisms, and craving to be relevant processes in the development and maintenance of cybersex addiction. Poor or unsatisfying sexual real life contacts cannot sufficiently explain cybersex addiction.

- **Cybersex addiction in heterosexual female users of internet pornography can be explained by gratification hypothesis (2014)**

  Results indicated that Internet porn users rated pornographic pictures as more arousing and reported greater craving due to pornographic picture presentation compared with non-users. Moreover, craving, sexual arousal rating of pictures, sensitivity to sexual excitation, problematic sexual behavior, and severity of psychological symptoms predicted tendencies toward cybersex addiction in porn users. Being in a relationship, number of sexual contacts, satisfaction with sexual contacts, and use of interactive cybersex were not associated with cybersex addiction.

- **Empirical Evidence and Theoretical Considerations on Factors Contributing to Cybersex Addiction From a Cognitive Behavioral View (2014)**

  Previous work suggests that some individuals might be vulnerable to CA, while positive reinforcement and cue-reactivity are considered to be core mechanisms of CA development. In this study, 155 heterosexual males rated 100 pornographic pictures and indicated their increase of sexual arousal. Moreover, tendencies towards CA, sensitivity to sexual excitation, and dysfunctional use of sex in general were assessed. The results of the study show that there are factors of vulnerability to CA and provide evidence for the role of sexual gratification and dysfunctional coping in the development of CA.

- **Prefrontal control and internet addiction: a theoretical model and review of neuropsychological and neuroimaging findings (2015)**
Consistent with this, results from functional neuroimaging and other neuropsychological studies demonstrate that cue-reactivity, craving, and decision making are important concepts for understanding Internet addiction. The findings on reductions in executive control are consistent with other behavioral addictions, such as pathological gambling. They also emphasize the classification of the phenomenon as an addiction, because there are also several similarities with findings in substance dependency. Moreover, the results of the current study are comparable to findings from substance dependency research and emphasize analogies between cybersex addiction and substance dependencies or other behavioral addictions.

- **Implicit associations in cybersex addiction: Adoption of an Implicit Association Test with pornographic pictures. (2015)**

  Recent studies show similarities between cybersex addiction and substance dependencies and argue to classify cybersex addiction as a behavioral addiction. In substance dependency, implicit associations are known to play a crucial role. Results show positive relationships between implicit associations of pornographic pictures with positive emotions and tendencies towards cybersex addiction, problematic sexual behavior, sensitivity towards sexual excitation as well as subjective craving.

- **Symptoms of cybersex addiction can be linked to both approaching and avoiding pornographic stimuli: results from an analog sample of regular cybersex users (2015)**

  Results showed that individuals with tendencies toward cybersex addiction tended to either approach or avoid pornographic stimuli. Additionally, moderated regression analyses revealed that individuals with high sexual excitation and problematic sexual behavior who showed high approach/avoidance tendencies, reported higher symptoms of cybersex addiction. Analogous to substance dependencies, results suggest that both approach and avoidance tendencies might play a role in cybersex addiction.

- **Getting stuck with pornography? Overuse or neglect of cybersex cues in a multitasking situation is related to symptoms of cybersex addiction (2015)**

  Individuals with tendencies towards cybersex addiction seem to have either an inclination to avoid or to approach the pornographic material, as discussed in motivational models of addiction. The results of the current study point towards a role of executive control functions, i.e. functions mediated by the prefrontal cortex, for the development and maintenance of problematic cybersex use (as suggested by Brand et al., 2014). Particularly a reduced ability to monitor consumption and to switch between pornographic material and other contents in a goal adequate manner may be one mechanism in the development and maintenance of cybersex addiction.


  Study 1: Participants completed a pornography use questionnaire and a delay discounting task at Time 1 and then again four weeks later. Participants reporting higher initial pornography use demonstrated a higher delay discounting rate at Time 2, controlling for initial delay discounting. Study 2: Participants who abstained from pornography use demonstrated lower delay discounting than participants who abstained from their favorite food. The finding suggests that Internet pornography is a sexual reward that contributes to delay discounting differently than other natural rewards. It is therefore important to treat pornography as a unique stimulus in reward, impulsivity, and addiction studies and to apply this accordingly in individual as well as relational treatment.

- **Sexual Excitability and Dysfunctional Coping Determine Cybersex Addiction in Homosexual Males (2015)**
Recent findings have demonstrated an association between CyberSex Addiction (CA) severity and indicators of sexual excitability, and that coping by sexual behaviors mediated the relationship between sexual excitability and CA symptoms. The aim of this study was to test this mediation in a sample of homosexual males. Questionnaires assessed symptoms of CA, sensitivity to sexual excitation, pornography use motivation, problematic sexual behavior, psychological symptoms, and sexual behaviors in real life and online. Moreover, participants viewed pornographic videos and indicated their sexual arousal before and after the video presentation. Results showed strong correlations between CA symptoms and indicators of sexual arousal and sexual excitability, coping by sexual behaviors, and psychological symptoms. CA was not associated with offline sexual behaviors and weekly cybersex use time. Coping by sexual behaviors partially mediated the relationship between sexual excitability and CA. The results are comparable with those reported for heterosexual males and females in previous studies and are discussed against the background of theoretical assumptions of CA, which highlight the role of positive and negative reinforcement due to cybersex use.

- **Subjective Craving for Pornography and Associative Learning Predict Tendencies Towards Cybersex Addiction in a Sample of Regular Cybersex Users (2016)**

Some approaches [to cybersex addiction] postulate similarities to substance dependencies, for which associative learning is a crucial mechanism. In this study, 86 heterosexual males completed a Standard Pavlovian to Instrumental Transfer Task modified with pornographic pictures to investigate associative learning in cybersex addiction. Additionally, subjective craving due to watching pornographic pictures and tendencies towards cybersex addiction were assessed. Results showed an effect of subjective craving on tendencies towards cybersex addiction, moderated by associative learning. Overall, these findings point towards a crucial role of associative learning for the development of cybersex addiction, while providing further empirical evidence for similarities between substance dependencies and cybersex addiction.

**REVIEWS**

- **Neuroscience of Internet Pornography Addiction: A Review and Update (2015).** Thorough review of the neuroscience literature related to Internet addiction subtypes, with special focus on internet porn addiction. Excerpt: "The review leads to the conclusion that Internet pornography addiction fits into the addiction framework and shares similar basic mechanisms with substance addiction. Together with studies on Internet addiction and Internet Gaming Disorder we see strong evidence for considering addictive Internet behaviors as behavioral addiction."

- **Sex Addiction as a Disease: Evidence for Assessment, Diagnosis, and Response to Critics (2015)** Review provides a chart that takes on specific criticisms and offers citations that counter them.

- **Neurobiology of Compulsive Sexual Behavior: Emerging Science (2016) – Excerpt:** "Given some similarities between CSB and drug addictions, interventions effective for addictions may hold promise for CSB, thus providing insight into future research directions to investigate this possibility directly."

- **Should compulsive sexual behavior be considered an addiction? (2016) – Excerpt:** "Overlapping features exist between CSB and substance use disorders. Common neurotransmitter systems may contribute to CSB and substance use disorders, and recent neuroimaging studies highlight similarities relating to craving and attentional biases. Similar pharmacological and psychotherapeutic treatments may be applicable to CSB and substance addictions, although considerable gaps in knowledge currently exist."

- **Compulsive Sexual Behaviour as a Behavioural Addiction: The Impact of the Internet and Other Issues (2016).** Excerpts: “More emphasis is needed on the characteristics of the internet as these may facilitate problematic sexual behaviour.” And, “Clinical evidence from those who help and treat such individuals should be given greater credence by the psychiatric community.”

- **Neurobiological Basis of Hypersexuality (2016).** Excerpt: “Taken together, the evidence seems to imply that alterations in the frontal lobe, amygdala, hippocampus, hypothalamus, septum, and brain regions
that process reward play a prominent role in the emergence of hypersexuality. Genetic studies and neuropharmacological treatment approaches point at an involvement of the dopaminergic system.”

- **Cybersex Addiction (2015) Excerpts:** In recent articles, cybersex addiction is considered a specific type of Internet addiction. Some current studies investigated parallels between cybersex addiction and other behavioral addictions, such as Internet Gaming Disorder. Cue-reactivity and craving are considered to play a major role in cybersex addiction. Neuroimaging studies support the assumption of meaningful commonalities between cybersex addiction and other behavioral addictions as well as substance dependency.

- **Searching for clarity in muddy water: future considerations for classifying compulsive sexual behavior as an addiction (2016) – Excerpts:** We recently considered evidence for classifying compulsive sexual behavior (CSB) as a non-substance (behavioral) addiction. Our review found that CSB shared clinical, neurobiological and phenomenological parallels with substance-use disorders. Although the American Psychiatric Association rejected hypersexual disorder from DSM-5, a diagnosis of CSB (excessive sex drive) can be made using ICD-10. CSB is also being considered by ICD-11.

- **Is Internet Pornography Causing Sexual Dysfunctions? A Review with Clinical Reports (2016) - An extensive review of the literature related to porn-induced sexual problems. Involving US Navy doctors, the review provides the latest data revealing a tremendous rise in youthful sexual problems. It also reviews the neurological studies related to porn addiction and sexual conditioning via Internet porn. The doctors provide 3 clinical reports of men who developed porn-induced sexual dysfunctions.

- **Integrating psychological and neurobiological considerations regarding the development and maintenance of specific Internet-use disorders: An Interaction of Person-Affect-Cognition-Execution model (2016) – A review of the mechanisms underlying the development and maintenance of specific Internet-use disorders, including “Internet-pornography-viewing disorder”. The authors suggest that pornography addiction (and cybersex addiction) be classified as internet use disorders and placed with other behavioral addictions under substance-use disorders as addictive behaviors.**