

Association Between Internet Addiction and Substance Abuse: A Literature Survey for Early Detection and Treatment

YUE QIU, KUN LIU and YUANZHE LI

ABSTRACT

As a newly proposed term, Internet addiction is derived from DSM-IV criteria from impulsive control disorders. The addictive element may be the active search for stimulation through the Internet and the presence of typical addictive features of substance abuse including tolerance and withdrawal, cognitive preoccupation and craving, activation in dorsal lateral prefrontal cortex (DLPFC) suggests a pre-existing mechanism for Internet addiction. Therefore, it was hypothesized that Internet addiction might be an interchangeable form of substance use disorder. Though there is a great number of findings supporting the relationship between Internet and substance addiction, the common features are debated in the study of addiction. This literature survey aims to investigate the association between Internet and substance addiction and develop potential early detection and treatments for Internet addiction.

INTRODUCTION

“Caught up in a virtual world he became less active, so easily done. Hours fly by when absorbed by the screen.” June 3rd 2020, Louis O’Neill, a healthy football coach who was 24, has died from deep vein thrombosis, after spending most of his time playing video games and not going outside. On August 31st 2020, India TV also reported after playing PUBG (Player Unknown’s Battlegrounds) continuously for several days, a 16-year-old teenager died from severe dehydration because he wasn’t taking any food or water. Similarly, on March 13th, 2007, a Chinese man dropped dead after a three-day consecutive internet session. Researchers who investigated Internet abuse have also found 5.9% to 13.0% of internet users showing disrupted behaviors on the Internet and this number is still increasing (Schumacher & Morahan-Martin, 2001). Despite the convenience and progress which has been brought to our day-to-day lives by the Internet,

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multiple cases of illnesses and deaths caused by excessive Internet use has been reported within the past two decades, yet little attention is devoted to such an alarming phenomenon.

After fast diffusion of the internet from specific groups of scientists, mathematicians, and IT professionals into the public, researches are stated to investigate the area of excessive Internet and over hundreds of clinics for specialized treatment in pathological Internet use were constructed in many countries, including South Korea and the People's Republic of China (Morahan-Martin, 2006). Plus, the Online Internet Addiction Disorder Support Group was also funded, which is later widely used by self-reported Internet addicts, despite it was created by Ivan Goldberg as a joke (Suler, 2004). The concept of Internet addiction emerged in the 1990s and excessive internet use is reported to be pathological and addictive from both scientific research and media press. The term "Internet addiction" has been proposed as a representation of this uncontrollable, damaging use of the Internet. It is regarded as a subset of non-chemical (behavioral) addictions, usually consists inducing and reinforcing features for the development of addiction (Griffiths, 1998). Due to the overlapping characteristics, symptoms of pathological Internet use are compared to the criteria used for diagnosing other addictions, particularly substance-based addictions, suggesting shared cognitive mechanisms.

Thus, this literature survey reviews what is known from the empirical literature on "internet addiction" and its derivatives (including internet addiction disorder, pathological internet use, and internet abuse, etc.) while assessing to what extent it is related to substance use disorders and evaluate whether internet addiction or internet abuse is an interchangeable form of substance use disorder.

KEY FEATURES FOR SUBSTANCE USE DISORDERS (SUD)

With a long history since around 1864, substance use disorder or substance abuse has been a common and representative form of addiction and underwent countless research. According to DSM-V criteria, substance use disorder (SUD) is the continuous use of a substance despite significant substance-related problems, including cocaine, phencyclidine, caffeine, tobacco, and alcohol, etc. The essential features for SUD are classified into behavioral, psychological, and cognitive aspects.

On the behavioral aspect, tolerance and withdrawal symptoms are usually regarded as core features, and addicts may experience relapse and remission during treatment. SUD results in impairment over substance use control after a prolonged period of use. Addicts also express a persistent desire of regulating substance use which might result in multiple unsuccessful efforts for decreasing intake. Other associated behavioral patterns may also be presented for SUD, including social dysfunction, risky use, and somatic complaints (Hasin et al., 2013).

Psychologically, substance addicts exhibit mood modification and often experiencing depression and anxiety during the process of withdrawal. Repeated use also leads to

sensitization of drug craving when the blood or tissue concentration of a substance decline in an individual (Robinson & Berridge, 1993). Therefore, the reduction of craving is often considered as an indicator of both the diagnosis and treatment of SUD.

The neurochemical basis of SUD involves activation of the reward system from a substance and normal activities may be neglected. Naturally, the reward system is responsible for the desired survival-related activities. When natural rewards such as food, novelty, and social stimuli are presented, neural circuitry is attributed to the nucleus accumbens (NA) following the reward pathway, and dopamine (DA) input is received in the ventral tegmental area (VTA) from DA cell bodies. DA is also projected to other related parts includes the amygdala, hippocampus, prefrontal cortex, and dorsal striatum, etc. Substances that have rewarding effects (i.e. cocaine, tobacco, etc.) directly activate the brain reward pathways and result in high-intensity DA projection, producing feelings of pleasure. Due to the prolonged and repeated exposure to drug stimulants, SUD results in a persistent change in reward-related brain regions. PET studies found cocaine addiction is related to alternation in dopamine receptors and causing 11% to 15% reduction in D2/3 receptor availability and reduction of dopamine neurotransmission in the striatum, while the healthy control remains unaffected. This detrimental effect is also observed in other SUD including heroin, alcohol, and methamphetamine abuse, and is still present after rescanning 3 months after detoxication. (Martinez, Kim, Krystal, & Abi-Dargham, 2007).

KEY FEATURES FOR INTERNET ADDICTION (IA)

Unlike the long history of studies for substance-related addictions since the mid-19th, Internet addiction (IA) is a relatively new area that started in the 21st century. Regarding the benefits of this robust technological progression to society including the emergence of online services, severe Internet-related problems are also created as some vulnerable populations (i.e. teenagers, young adults) started to abuse internet.

The concept of IA was initially proposed as a behavioral addiction involving active human-machine interaction, contains inducing and reinforcing features (Griffiths, 1998). Internet Addiction Test (IAT) and Young Internet Addiction Scale (YIAS) were developed as a common measurement for IA by Young (1996), using modified questionnaires from other behavioral addictions such as pathological gambling disorder. Later, Anderson (1998) also suggested the severity of IA is indicated by Internet using time and when the total time spent on internet activities reaches 400min per week, users are classified as Internet addicts, regardless of the type of usage (academic or entertainment). This continuous change in the definition of IA has not been stopped. To avoid confusion, in this survey, IA is considered a broad term describing compulsive use of all Internet-enabled digital technologies, including pathological internet use, cell-phone abuse, plus disturbed using patterns on other interactive online activities (Internet gaming and online relationship) to the point of detrimental consequences. Since some core psychometric components of substance abuse are also discovered in IA addicts,

similar categories of SUD are applied for IA diagnosis, including behavioral, emotional, and neurochemical features.

On the behavioral aspect, excessive and prolonged use of Internet is commonly observed in Internet dependents, causing dysfunction for normal activities. In Young's study, it was found the time Internet dependents spent online is approximately 8 times more than normal users. This excessive use resulted in moderate to severe problems in many areas of Internet addicts' lives, including health, family relationships, social lives, and work, while normal users reported little negative effects (Bruce & Young, 1986). Other associated negative impacts such as insomnia are also reported. Similar to substance addicts, Internet dependents also exhibit tolerance and withdrawal symptoms and experience conflict and relapse.

Apart from the behavioral factors, the essential cognitive factors also play a role in the negative consequences of IA. Excessive users often show emotional dependency and mood modification due to the cognitive preoccupation with the Internet causing more destructive effects from repeatedly disturbed using patterns (Caplan & High, 2006). Studies have also found dependents usually feel "longing" and "sense of missing" when internet activities are absent, resembling drug craving in SUD. A higher frequency of experiencing depression and anxiety is also reported from Internet addicts regarding the relative normal emotional responses from regular users, especially in certain categories of IA such as video gaming dependency (Padilla-Walker, Nelson, Carroll, & Jensen, 2010).

On a neurochemical basis, involvement in active Internet activities shows a significant correlation with activation of the brain reward pathway. Video gaming is considered a typical subtype of IA and studies found responding brain activation in the left occipital lobe cuneus, left dorsolateral prefrontal cortex, and left parahippocampal gyrus not only during playing StarCraft but also in response to game cues (Han, Hwang, & Renshaw, 2011). Similar to substance addicts, fMRI studies also found a continual effect of decreased dopaminergic activity and gradual structural change to brain regions including the cerebellum and right frontal lobe in long term pathological internet users (Lee, Han, Kim, & Renshaw, 2013).

SHARED ETIOLOGY BETWEEN IA AND SUD

Operant Conditioning

Internet provides pleasurable experiences easily and has the same addictive potential compared to traditional drugs due to its higher intensity, accessibility, and availability to the general population. Excessive internet users tend to actively search for stimulation through interactive services, resemble the chemicals which act as stimulants in substance abuse. In both IA and SUD, specific stimulants activate the reward system, and this process is associated with the basic mechanism of operant conditioning. When a certain behavior provides positive feedback, dopamine neurotransmitter is released, causing

mood alternation (sense of pleasure) and there is an increased likelihood for repetition in the future to obtain the same pleasurable effects (D. Greenfield, 2011). This pleasurable effect generated from engaging in Internet activities closely resembles substance intoxication and the positive reinforcement structure enables Internet users to establish the addictive behavioral cycle, which is also a classic behavioral pattern for SUD. Internet users experience dopamine elevation following the pleasurable online actions, leading to negative life consequences and causing negative emotional feedback such as feeling guilty and shame for abuse. This leads to increased desire and more engagement for online activities to avoid or alter the negative mood. Following this negative cycle, Internet dependents gradually increased Internet use just like how substance addicts increasing the use of drugs, eventually causing abuse.

Neuroimaging Evidence

According to fMRI studies, the brain regions corresponding to Internet and substance stimulation are highly overlapped. Lee (2013) found that during Internet gaming and presentation of game cues, there is increased neural activity in brain regions associated with reward, addiction, craving, and emotions, resemble the increased brain activity patterns observed in substance addicts when substances are taken (Lee et al., 2013). Neuroimaging studies have also found brain activities corresponding to Internet video game cues resemble that observed in SUD patients corresponding to substance-related cues. Pathological video game users exhibit more activity in dorsolateral prefrontal cortex (DLPFC), orbitofrontal cortex, anterior cingulate, nucleus accumbens and caudate nucleus compared to the healthy control when game stimuli are presented. Plus, activation in left inferior frontal gyrus, left parahippocampal gyrus, and right thalamus towards game cue presentations suggests a craving effect for Internet video gaming. Thus, the significant correlation and similar neurochemical characteristics may indicate a shared pre-existing mechanism between IA and SUD.

Tolerance and Withdrawal

Besides, the presence of tolerance and some withdrawal symptoms suggested IA may have the common etiology of addictive behavior and general impulse-control disorders. Similarly, cognitive preoccupation in IA and SUD results in typical tolerance features. From numerous studies, internet addicts engage more time online and searching for greater degrees of stimulating content or more frequent use just like substance addicts increasing dose and time for using chemicals. Due to this excessive use, negative impacts are both observed and self-reported from substance addicts during withdrawal and similar discomfort is found on behavioral and physical aspects from Internet dependents, including heightened state of psychological and physiological arousal, higher level of irritation and anxiety-related symptoms when excessive users are separated from Internet, change or eliminate their using habits. Evidence was found for the presence of tolerance and withdrawal symptoms from both subjective self-reports

and objective observations. The study from Greenfield (1999) also found significant tolerance and withdrawal effects in Internet dependents, including preoccupation with going online (58%), multiple unsuccessful attempts to cut back (68%), and feeling agitated when attempting to cut back (79%)(D. N. Greenfield, 1999). However, this result needs further testing due to the preliminary analysis carried out despite using a relatively large sample size.

Some other studies which examine the relationship between Internet use and potential for substance abuse also show consistency with Greenfield. Correlational studies have proved the amount of time spent online is highly associated with increased potential for alcoholism and substance abuse(Armstrong, Phillips, & Saling, 2000). Similar results were also found by Padilla-Walker (2010) among USA college students, reporting significant correlations between video gaming and substance abuse (i.e. alcohol and drug use), self-perception (i.e. self-worth and social acceptance), and relationship quality based on the type of internet use. The findings indicate pathological gaming is also linked to detrimental outcomes on both psychological and physiological aspects for users despite different patterns are found for males and females. (Padilla-Walker et al., 2010). To further explore the potential correlation between SUD and IA, a much larger sample group was used by Young (2013) involving 73238 teenagers (aged 13-18) in Korea. Consistent findings are reported of which smoking and drug use may predict a high risk for internet addiction among users and students with a high risk for internet addiction tend to be more vulnerable for SUD(Lee et al., 2013). Therefore, the above findings provide strong evidence for interconnection between IA and SUD, suggesting IA may have the same potential shared etiology with SUD.

Indirect Associations between IA and SUD

Apart from direct overlapping addictive core features on behavioral, emotional, and neurochemical aspects, there is other indirect evidence supporting the hypothesis of IA is highly related to SUD. It was suggested that IA and SUD have the same psychological drive and are used as escaping-coping strategies from real-life difficulties for dependents. Substance including classic psychedelic intake often results in a significant reduction of psychological distress and alleviate negative emotions, even preventing suicides(Hendricks, Thorne, Clark, Coombs, & Johnson, 2015). A recent study also shows that 8.2% of Internet dependents use Internet as a way to escape problems and alleviate negative emotions are significantly reduced after online activities. During Internet engagement, individuals experience severe time distortion and dissociation caused by loss of sense of self. Studies also found 80% of Internet users lose track of time and space and reported feeling less inhibited during online activities(Toronto, 2009). However, these results are collected mainly via subjective self-report methods and the reliability is questioned.

Overlapping Treatments: Bupropion Treatment

Some chemicals applied for SUD treatment are also significantly effective for IA. According to studies, after two months of bupropion treatment, addicts shows a reduction in depressed mood and drug craving (e.g. tobacco, cocaine) and there are reduced brain metabolic activities in dorsolateral prefrontal cortex (DLPFC), orbitofrontal cortex, anterior cingulate cortex, striatum, etc, during the presentation of smoking-related cues, resulting from the potential modulating effect of bupropion on norepinephrine or dopamine.(Rush, Stoops, & Hays, 2009). Surprisingly, after 6 weeks of bupropion SR treatment, excessive Internet users also show significant improvement on maladaptive behaviors caused by excessive online gaming, and reduction in Internet game craving, total playing game time and total Internet use time. There is also a significant reduction for brain activation in DLPFC in responding to online gamine cues, perhaps due to the modulating mechanism of bupropion on norepinephrine or dopamine release(Han, Yoo, Renshaw, & Petry, 2018). However, due to the limited number of subjects and duration for treatment, this positive effect of bupropion on IA may not be fully confirmed and there are relatively weak behavioral improvements on excessive Internet users compares to the effects on substance addicts because only six patients show improvement on their daily routines and four patients were no longer absent from school during the treatment and longer treatment time and larger patient group is still required.

Self-Esteem Predicts IA and SUD

Some factors that explain SUD are also correlated with IA, such as lower level of self-esteem. It was found that self-esteem level predicts the amount of time spent online per week therefore indicates IA severity(Armstrong et al., 2000). However, whether the presence of low self-esteem causes IA or IA causes users to slowly develop low self-esteem is questioned. This unsolved causal correlation in IA differs from the impact of SUD, of which self-esteem is often considered as a negative consequence due to IA and resulted in the change in social conditions.

POTENTIAL EXISTENCE OF A DIFFERENT MECHANISM FOR IA

Though numerous evidence was found for shared features between IA and SUD, the lack of some core components of substance addiction and the presence of unique addictive features may suggest a different underlying mechanism for IA.

Absence of Core SUD Features

Sensation seeking is the core motive and common feature for all forms of SUD(Robinson & Berridge, 1993). However, no empirical evidence shows direct

associations between sensation seeking and IA, only correlation between craving and some subcategories of IA were found. Though self-esteem is a strong predictor for both SUD and IA, it is questionable whether self-esteem is caused by IA, similar to the negative impact generated from SUD. Furthermore, another factor impulsivity, which is closely associated with sensation-seeking and often present in other addictions, shows no relationship with IA (Han et al., 2011).

Both DLPFC regions are activated when substance-related and Internet-related cues are presented to substance and Internet dependents, however, additional structural change and some differentiations are present in IA patients. Due to the intense and prolonged exposure to interactive activities such as online gaming, frequent Internet users show increased activity in DLPFC and additional areas including parahippocampal and occipital lobe during game cue presentation. The additional regions are associated with visuospatial working memories in IA patients and there is stronger connectivity for better integration of sensorimotor and perceptual information(Ko et al., 2006). In contrast, impairments on visuospatial working memory are reported in SUD patients such as cocaine addicts(Hester & Garavan, 2009).

Besides, not all forms of IA correlate with SUD, and there is a limited degree of coexistence, e.g. video game addiction correlates with drug and alcohol. Alcohol and drug use were positively correlated to internet use specifically for chat rooms and shopping but negatively correlated to Internet use for academic purposes such as e-mail and school internet use(Padilla-Walker et al., 2010). The lack of significant association between some forms of IA such as cell-phone abuse and SUD suggests there might be alternative explanations for IA mechanism.

Presence of Unique IA Characteristics

IA is not directly a tissue-damaging addiction and most of the destructive effects are caused by imbalances created by excessive time spent with the technology. Apart from the actual dopamine elevation after Internet-related cue presentation, IA is also induced based on the intoxication in the imbalance or avoidance in one's life for an unlimited time. Unlike SUD, when social dysfunction is usually considered a secondary negative consequence, the detrimental impact generated on major living aspects is the major concern for IA.

Instead of being categorized as an interchangeable form of SUD, IA may constitute a separate diagnosis label because Internet is used as a platform for perusing other stimulating and enjoyable content. Many of the identified excessive users are not Internet addicts but using internet excessively as a medium to fuel other forms of addictions and there are other elements users can be addicted to including the act of typing, communication medium, absence of face-to-face interaction, obtainable information and available activities.(Griffiths, 1998). Pathological users used the Internet for meeting and interacting with new people, gaining emotional support. Moreover, most IA cases that require treatments are addictions involving sexual content and interactive gaming. Excessive Internet users often show preference for particularly enjoyable or stimulating online activities such as porn and video gaming (Aboujaoude, Koran, Gamel, Large, &

Serpe, 2006), but neither area is new or limited to Internet. Therefore, Internet act as a platform that allows users to electronically access the addicted content.

However, Internet itself may contain addictive properties since when individuals access the desiring content via internet, the addictive potential of the content is significantly amplified(D. Greenfield, 2011). Internet offers users high efficiency and direct accessibility for the desiring content, leading to addiction-enhancing properties. One example is multiuser games which utilize the Internet platform. Despite the content for gaming alone is stimulating and addictive, additional attractive components are included such as virtual social interaction, real-time competition, challenge and accomplishment, social hierarchy, and complex reward schedule(Padilla-Walker et al., 2010). This combination of both factors becomes a new psychoactive raw material that acts as a unique form of addictive stimulants of Internet, plus the high degree of unpredictability and novelty of the Internet may also add flavor to this content. Compared to regular games, multiuser games seem to be much more addictive because of the high interactivity from the Internet platform, provides evidence for Internet alone may also act as a potential addictive subject.

Though the Internet may contain addictive properties and share addictive features with SUD, one core element presents in IA is not observed in SUD: the unique intoxication caused by extended personal power experience. Internet enables users powerful experiences of fantasy (e.g. sexual fantasy) with relative ease, disinhibition, and anonymity (Pawlikowski, Nader, Burger, Stieger, & Brand, 2014). These enhance information availability and provides satisfaction and sense of extended personal power since instantaneous answers can be obtained for previously inaccessible, illegal, or hard-to-find content, with a simple mouse clicking or screen touching, leading to highly intoxicating experiences of Internet.

FUTURE RESEARCH AND TREATMENT

Unlike the desired goal in SUD treatment, of which the addictive chemicals are completely removed; the difficulty with treating IA is the impossibility of achieving complete elimination of this technology because modern living style prohibits the complete avoidance of Internet and other digital medias. Studies revealed a 63.1% completion and 42% recovery rate among patients within an 8-week behavioral treatment session with sufficient family support(Han et al., 2018). Thus, the alternative goal is to create a moderated pattern of use with self-control through psychoeducation and behavioral intervention with more than 8 weeks of treatment course, and additional care would be provided for patients who had not fully recovered. Chemical treatment such as bupropion treatment can also be added to this long-term therapy for reducing craving and corresponding brain activities, based on well-studied SUD research. From the investigation above, similar criteria with SUD are developed including IAT and YIAS for both early detection of at-risk Internet use, especially in vulnerable groups, and monitoring for symptom severity during treatment.

CONCLUSION

Throughout this review, it can be primarily concluded that Internet addiction (IA) is an interchangeable form of substance use disorders but the factor which acts as the stimulants for IA remains unclear. Though there is no current research to prove the direct association between Internet abuse and sensation seeking, the shared behavioral, psychological, and neurochemical features between IA and SUD remained unrefuted while the shared addictive mechanism is proved to be partially incorrect since SUD only explains the negative cycle generated from activation of reward circuit but not the enhancing effect of sensorimotor integration and visuospatial working memory. Many of the overlapping addictive properties of IA can be reduced by SUD treatments (e.g. bupropion treatment) but some are not explained by SUD diagnosis. IA includes the addiction-enhancing characteristics, but the specific stimulant is difficult to identify due to the complexity of Internet properties, thus resulting in the challenge of IA treatments. Therefore, the goal of treatment is to develop reasonable patterns of Internet use via self-control and external intervention.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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COMPETING INTERESTS

The authors declare no conflict of interest.

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