

# Beyond Substance Addiction: Broadening the Concept of Addiction to Include Behavioral Addiction

Ji Hyun Kim and Jeong Seok Seo

Department of Psychiatry, School of Medicine, Konkuk University, Chungju, Korea

At the early 1950's, Olds and Milner's discovery of 'reinforcing structures in the midbrain' as a pleasure center spurred the rapid advancement of neuroscience research on addiction. The field will once again expand due to the recent redefinition of addiction. From the previous definition encompassing only substance addiction, such as addiction to alcohol and illegal or legal drugs, the concept of addiction has been broadened to include behavioral addiction including pathological gambling, shopping addiction, sex addictions, and the relatively new phenomenon of internet addiction. From the perspective of neuroscience, we briefly discuss similarities between substance addiction, on the one hand, and internet addiction as an example of behavioral addiction, on the other.

## DEFINITION AND CLINICAL FEATURES OF ALCOHOL AND BEHAVIORAL ADDICTION

According to the fourth edition of the Diagnostic and Statistical Manual (DSM-IV-TR), the definition of alcohol dependence is based on tolerance, craving, withdrawal symptoms, and social/occupational impairment due to alcohol use. Tolerance means that the subject is unable to feel the same effect from the alcohol that was felt previously with drinking, increasing intake to compensate. Withdrawal means that stopping intake suddenly can precipitate specific symptoms. Craving means that the desire for drinking is so strong that it makes a person act recklessly or obsessively to obtain liquor, challenging the limits of social acceptability. Acute or chronic excess ingestion of alcohol can cause problems in interpersonal relationships or at work, such as breaking important promises to family members or arriving at work late.

Similarly, excessive gambling, shopping, sex, or use of the internet causes tolerance and withdrawal and craving, dysfunction of interpersonal, social, and occupational relationships. Because this maladaptive obsessive behavior is related to specific actions rather than the just intake of drugs or alcohol, it is known as 'behavioral addiction.' Because there is no distinct category for these maladaptive behaviors, they have been diag-

nosed under various psychiatric classifications including obsessive-compulsive disorder, impulse control disorder, a portion of the sexual dysfunction or personality disorders, and so on.

New outcomes of clinical trials and considerable advances in addiction psychiatry have led to rapid changes in the concept of addiction, broadening its definition from substance use alone to pathologic behaviors.

In the 5th Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), which will be published in 2013, the title 'Substance Related Disorders' has been removed and the new title of 'Addiction Related Disorders' has been added based on the results of clinical studies in the effort to develop an integrative concept encompassing substance and behavioral addiction in one category. Also, in the DSM-5, pathological gambling, one of the behavioral addictions, was accepted as an official diagnosis title by the American Psychiatric Association.

## BRAIN STRUCTURE AND THE PATHWAY RELATED TO ALCOHOL AND INTERNET ADDICTION

The reward system, known as the "pleasure center", is located in the midbrain and primarily connected with the dopaminergic pathway from the midbrain to the forebrain. The reward system includes the ventral tegmental area (VTA), where the dopamine nucleus is located; the substantia nigra; the striatum, which consists of the nucleus accumbens anteriorly and caudate nucleus and putamen caudally; the prefrontal cortex; the hippocampus; and the amygdala.

When the VTA is activated by various stimulating agents (such as electrostimulation, stimulants, or sedative sleeping pills) via the dopaminergic pathway connecting the nucleus accumbens (NAC) of the VTA, pleasure (as a reward) is generated. Activation of the VTA causes the release of enkephalin, an end product of the pleasure center and an endogenous opioid, which acts as a positive re-enforcer. This process is a part of habit formation or obsessive behavior.

The brain structures related to alcohol craving are as follows: 1) the frontal lobe (the orbitofrontal and dorsolateral prefrontal

cortex), 2) nucleus accumbens, 3) amygdala, and 4) anterior cingulate cortex (ACC) (1, 2). However, in a functional magnetic resonance image (fMRI) study analyzing the brain responses of 10 internet gaming addicts to game-related cues (3) and another brain imaging study of the responses of 19 healthy young adult males to game stimuli following a 10-day period of internet video game play (4), the researchers found that the neural substrate of cue-induced craving in internet game addiction could be similar to that of cue-induced craving in substance addiction.

## CONSEQUENCES OF BEHAVIORAL ADDICTION

Functional and structural changes to brain can occur. The comprehensive abilities of an internet addict could be diminished (5). Furthermore, the volume of the dorsolateral prefrontal cortex, ACC, and parahippocampus could be decreased as a consequence of internet addiction (6).

The most serious complication induced by alcohol or sedatives is dementia due to severe cortical atrophy. In severe cases, it becomes alcoholic dementia, which is not distinguished from Alzheimer's dementia. Though the relationship between internet addiction and dementia remains unclear, cognitive impairment in particular, including decreased memory and judgment, is prominent similarly to that in patients with alcohol-induced cognitive impairment. Internet game addiction is also related to increased impulsivity (7).

Regardless of the scientific debate, if young adolescents who need to undergo balanced development of their body and mind are obsessed by internet usage or other maladaptive behaviors, it is worth considering the consequences to their well-being.

## CONCLUSION

Behavioral addiction is strongly related to brain dysfunction just as in substance addiction, and is a "brain disorder" caused by dysfunction in the connection between higher cortical brain

and limbic system including the VTA, striatum, and ACC. Clinical manifestations of behavioral addiction are just the same as those of substance addiction, including craving for pleasure, withdrawal, tolerance, and social/occupational impairment. Unless the brain is understood to be related to the pathogenesis, success of treatment for addiction will be frustrated. It is time to approach internet and other behavioral addictions with a holistic care perspective, including multidisciplinary psychosocial interventions and biological approaches as well.

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Address for Correspondence:

**Jeong Seok Seo, MD**

Department of Psychiatry, School of Medicine, Konkuk University,  
82 Gugwon-daero, Chungju 380-704, Korea  
Tel: +82.43-840-8470, Fax: +82.43-845-8470  
E-mail: sjs52632@daum.net