IJPSR (2021), Volume 12, Issue 1 **(Review Article)**

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 22 February 2020; received in revised form, 03 May 2020; accepted, 26 November 2020; published 01 January 2021

SMARTPHONE IS IT "BEHAVIOUR ADDICTION OR SUBSTANCE ABUSE DISORDER": A REVIEW TO FIND CHEMISTRY BEHIND

Bhumija Sharma, Pradeep Kumar and Preeti Sharma *

Department of Biochemistry, Santosh Medical College and Hospital, Ghaziabad - 201002, Uttar Pradesh, India.

Keywords:

Dopamine, Neurotransmitters, Behaviour addiction, Substance abuse

Correspondence to Author:
Dr. Preeti Sharma

Associate Professor,
Department of Biochemistry,
Santosh Medical College and Hospital, Ghaziabad - 201002,
Uttar Pradesh, India.

E-mail: prcdri2003@yahoo.co.in

ABSTRACT: Several behavioral addictions have been hypothesized as having similarities to substance abuse addictions. The DSM-4-TR has designated formal diagnostic criteria for several addictive disorders classifying them as impulse control disorders, a separate category from substance use disorder. There have been a lot of behavioral addiction studies like tanning, cosmetic surgery, sexual addiction, *etc*. Mobile phone addiction, which has more recently evolved into Smartphone addiction or nomophobia. The American Psychiatric Association first categorized a behavior: gambling as a no substance, related addictive disorder, and recommends further research on internet gaming disorder. The aim of this review is to find Smartphone addiction relations with neurotransmitters that could help us understand the possibly addictive effect similar to that produced by conventional drugs and also its potential to be diagnosed as an independent disorder. Multiple neurotransmitter systems are involved in the biochemistry of behavioral addictions; especially dopamine seems to be the most active. Brain activation in Internet gaming addicts occurs in the same brain regions as with drug-associated addiction. Brain imaging studies; suggest that the dopaminergic pathways may be involved in both substance use disorders and pathological gambling. Further, research in this area is obligatory, considering Smartphone addiction mechanisms similar to conventional drug addiction.

INTRODUCTION: The word addiction comes from the Latin word addicts, which means excessively devoted to something with loss of ability to choose freely or to be a slave. In recent years, the term addiction has been stretched beyond substance dependence to include non-substance-related behaviors that cause complications and impairment [1].

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.12(1).57-64

This article can be accessed online on www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.12(1).57-64

Also, 'substance dependency' is a group of behavioral, cognitive, and physiological phenol-menon that develop after the continuous use of a substance that typically includes: an intense craving to consume the drug, difficulties in controlling its consumption, persistence in this consumption in spite of the detrimental consequences, selecting consumption of the drug above other activities and obligations [2].

There are two groups of substance-related disorders: substance-use disorders (SUD) and substance-induced disorders (SID). SUD are patterns of symptoms resulting from the use of a substance that you continue to take, despite experiencing problems as a result.

SID (intoxication, withdrawal, and other substance/ medication-induced mental disorders), are included in SUD [3]. Several behavioral addictions have been hypothesized as having similarities to substance addictions. The Diagnostic and Statistical Manual of Mental Disorders (DSM)-4 has designated formal diagnostic criteria for several of these disorders (*e.g.,* pathological gambling, kleptomania), classifying them as impulse control disorders, a separate category from SUD. In the past few years, there has been a surge in the literature on behavioral addictions to studying [4], tanning [5], cosmetic surgery [6], Argentinean tango [7], Harry Potter [8] and various other potential topics like compulsive shopping, pathologic skin picking, sexual addiction, computer/video game playing, and internet addiction.

This increase in interest is particularly notable in the discussion on mobile phone addiction [9], which has more recently evolved into Smartphone addiction (SA), Or nomophobia (a portmanteau for "no mobile phone" and phobia). Nomophobia is considered a disorder of the modern digital and virtual society and refers to discomfort, anxiety, nervousness, or anguish caused by being out of contact with a mobile phone or computer [10].

Smartphones are mobile, a private device that provides numerous gratifications, such as sociability, entertainment, information, time management, coping policies and social identity maintenance etc but the most important feature is that a Smartphone has permanent access to the internet and consequently all of the Internet's appealing and problematic content. The Smartphone has become an essential part of daily life, and research has shown that certain people become so involved in their devices that they experience separation anxiety when it is not with them. The device can even be soothing at times of stress, offering a "security blanket" effect whereby the initial negative response to a stressor goes down. The Smartphone's fame and users' deep connection with it has, therefore, awoken apprehensions about its addiction potential. The American Psychiatric Association (APA), 2013, first categorized behavior: gambling as a non-substance, related addictive disorder, and recommends further research on internet gaming disorder [11]. The inclusion of Internet Gaming Disorder (IGD) in the appendix of the updated version of DSM-5 encourages further research [1]. However, until now, no mention has been made of SA in either the DSM-5 or in the International Classification of Diseases (ICD)-11's draft. Nevertheless, research on Smartphone and mobile phone addiction have remarkably increased in recent years [11].

Hence, we choose to continue our research in this direction considering Smartphone's internet source, and in reach of layman easily, it could be the most eligible candidate for becoming a member of the addiction family very soon. Again we will try to investigate SA on the opinion of top addiction expert Mandy Saligari" Giving your child a smartphone is like giving them a gram of cocaine," also its relation with neurotransmitters that could help us understand the possibly addictive effect similar to that produced by conventional drugs [12].

Behavioral Addictions & SUD Common Features: At first glance, it may seem complicated to speak of a cell phone addict as we speak of a drug addict, but if we stop to analyze this situation, it is not difficult to establish similarities between them. Comparing those that use the cell phone with self-control, the 'addicts' present a permanent state of vigilance or alert, focused on whatever signal that may come from the phone, which in turn provokes the almost compulsive and uncontrolled necessity of checking the cell phone persistently, independently of what they're doing. It almost seems as if they need to dedicate more and more time to it (tolerance perhaps), and this instrument begins to occupy a very special place in their lives. Recent studies have also shown that those 'addicts' that stop using their cell phones show a syndrome of withdrawal, both physical and psychological. This syndrome is characterized by visible symptoms of anguish, anxiety, nervousness, irritability, *etc*. These manifestations disappear once the 'addict' can use their phone again. The 'addict' also seems to have problems of insecurity, low self-esteem, difficulties in instituting inter-personal relationships, isolation, and other emotional factors. Actual cases of people are seen who centers 2 looks for therapy for SA in drug treatment. Before reviewing further, it is important to highlight the uniqueness of behavioral addiction in relation to drug or substance addiction. In substance addiction, with the exception of alcohol

there is a clear moment at which fluctuations in and interferences with daily life can be observed. It is difficult to determine whether problems result from awkward behavior, personality traits, or psychiatric comorbidities, in the case of behavior [13]. Some common features are depicted in **Table 1.** Nicola Luigi Bragazzi1 and Giovanni Del Puente strongly recommend the addition of nomophobia in the DSM-5 for providing clinicians with a useful tool, fostering advancements in the field. This topic is recent, but still, there are some validated psychometric scales, such as Questionnaire of Dependence of Mobile Phone / Test of Mobile Phone Dependence (QDMP/TMPD) Problematic Mobile Phone Use Questionnaire (PMPUQ), Perceived Dependence on the Mobile Phone (PDMP), Mobile Phone Problem Use Scale (MPPUS), Problematic Mobile Phone Use Scale (PMPUS), are available for diagnosing addiction [10] **Table 2** depicts some symptoms of nomophobia.

TABLE 1: [14] COMMON FEATURES

1	Common onset in adolescence and young adulthood and higher rates are among older adults
2	Both exhibit chronic, reverting patterns
3	Nature of these behavior addictions is experientially similar to the experience of substance use behaviors
4	Often preceded by feelings of "tension or arousal before committing the act" and "pleasure, enjoyment or relief at the time of committing the act
5	Reports of an urge or craving state prior to commencing the behavior, or substance use
6	Both behavior addiction and substance intoxication often decrease anxiety and result in a Positive mood state or "high
7	In both behavioral and substance use disorders, emotional dysregulation may contribute to cravings
8	Many people with pathological gambling, kleptomania, compulsive sexual behavior, and compulsive buying report a decrease in these positive mood effects with repeated behaviors or a need to increase the intensity of behavior to achieve the same mood effect, analogous to tolerance
9	People with the behavioral addictions also reported a dysphoric state while abstaining from the behaviors, same as found in withdrawal. However, unlike substance withdrawal, there are no reports of physiological prominent or medically serious withdrawal states from behavioral addictions

Ringxiety (ringing + anxiety) can sometimes assume intriguing and particular clinical forms of presentation, from the sensation of hearing "phantom ring tones" or "false mobile sounds" or confusing the sound of a cell phone ringing with a sound similar to it to the knee-jerk reaction to search for one's own mobile after hearing or presuming to have heard a ring tone [10].

TABLE 2: [10] SYMPTOMS OF SA / NOMOPHOBIA

1	To use regularly a smartphone and to spend considerable time on it, to have one or more devices, to always carry a charger with oneself
2	To feel anxious and nervous at the thought of losing one's own handset or because of lack of network coverage, flattened battery, and/or lack of credit, and try to avoid as much as possible the places and the situations in which the use of the device is banned (such as public transit, restaurants, theaters, and airports)
3	To look at the phone's screen to see whether messages or calls have been received (a habit referred to by David Laramie as "ringxiety" – a portmanteau for ringer and anxiety
4	To keep the mobile phone always switched on (24 hours a day), to sleep with the mobile device in bed
5	To have few social face-to-face interactions with humans which would lead to anxiety and stress; to prefer to communicate using the new technologies
6	To incur debts or great expense from using the mobile phone

Common Neurobiology of Addiction: A growing organization of literature implicates multiple neurotransmitter systems (*e.g*., serotonergic, dopaminergic, noradrenergic, opioidergic) in the biochemistry of behavioral addictions and SUD [14]. Dopamine seems to be the most dynamic, although it's not the only one. Although each drug possesses its own mechanism of action, all of them intervene to a greater or lesser measure on a neuronal reward circuit known as the mesolimbic dopaminergic system. We know that several natural substances and activities touch this system, and that shows properties of positive reward (food, drink, sexual behavior, *etc*.). The drugs that are abused have in common the ability to serve as positive reinforcement and of controlling behavior in a way that is similar to the positive natural fortification. The difference lies in that the natural reinforcement normally enters this system of reward through the senses, while drugs stimulate this circuit directly [2].

Cocaine factor the depiction of the neurobiology of cocaine addiction, focuses on two more discovered types of effects: alterations in genetic activity that last for weeks and alterations of nerve cell structure that last for months and possibly much longer. Snorted or injected, cocaine rapidly enters the bloodstream and penetrates the brain. The drug achieves its main immediate psychological effect

by causing a logjam of the neurochemical dopamine. Dopamine originates in a set of brain cells, called dopaminergic (dopamine-making) cells that manufacture dopamine molecules and launch them into their surroundings. Dopamine acts as a pacesetter for many nerve cells throughout the brain.

At every moment of our lives, dopamine is responsible for keeping those cells operating at suitable levels of activity to accomplish our needs and aims. Whenever we need to mobilize our muscles or mind to work harder or faster, dopamine drives some of the involved brain cells to step up to the challenge. The free-floating dopamine molecules connect to receiving cells. After attachment, the dopamine stimulates the receptors to alter electrical impulses in the receiving cells and thereby alter the cells' function. The more dopamine molecules come into contact with receptors, the more the electrical properties of the receiving cells is altered [1]. To keep the receiving cells in each brain region functioning at appropriate intensities for current demands, the dopaminergic cells continually increase and decrease the number of dopamine molecules they launch [2].

The amount of dopamine available is further regulated (to stimulate the receptors) by pulling some previously released dopamine molecules back into themselves. Cocaine interferes with the second control mechanism: It ties up the dopamine transporter, a protein that the dopaminergic cells use to retrieve dopamine molecules from their surroundings. Hence when, cocaine on board, dopamine molecules that otherwise would be picked up remain in action. Overactivation of the receiving cells is thereby dopamine build up action.

Cocaine's ability to produce pleasure and euphoria, loss of control, and compulsive responses to drug-related cues can all be traced to its impact on the set of interconnected regions in the front part of the brain that makes up the limbic system [15, 16, 17]. Dopamine-responsive cells are highly concentrated in this system, which controls emotional responses and links them with memories. In particular, the nucleus accumbens (NAc), seems to be the most important site of the cocaine high.

When stimulated by dopamine, cells in the NAc produce feelings of pleasure and satisfaction, flooded with dopamine molecules. By artificially causing a build-up of dopamine in the NAc, as described above, cocaine yields enormously powerful feelings of pleasure greater than that which follows thirst-quenching or sex. The limbic system also includes important memory centers, located in regions called the hippocampus and amygdala. These memory centers help us remember, when someone experiences cocaine high, these regions stamp memories of the strong pleasure as well as the people, places, and things associated with the drug. From then on, cocaine-related paraphernalia triggers emotionally laden memories and desire to repeat the experience [18].

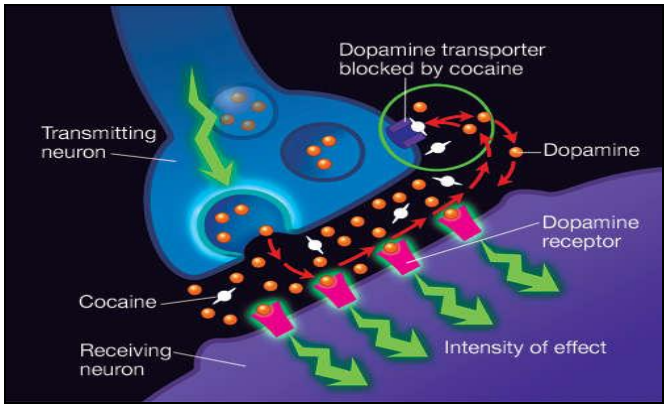

FIG. 1: COCAINE EFFECTS ON DOPAMINE IMAGE BY NATIONAL INSTITUTE OF DRUG ADDICTION [46]

Psychological addictions don't have chemical substances in them, but there is a degree of dependency and a certain amount of loss of control by the person having it. Also, cell phones emit microwaves, high electromagnetic modulated radiation also known as radio-frequencies, that interfere in important bodily systems (nervous, reproductive, endocrine, immunological) as well as in the processes and structures characteristic of living organisms, brain waves, the blood-brain barrier, the pineal gland and DNA [19]. Dependency or SA could have a base due to the interruptions that the microwaves provoke in the neuro-transmitters in the neural synapses of the reward system of the brain [2]. which is similar to cocaine. Studies suggest that an underlying biological mechanism for urge-driven disorders may involve the processing of incoming reward input by the ventral tegmental area/NA/orbital frontal cortex circuit.

The ventral tegmental area contains neurons that release dopamine to NA and the orbital frontal cortex. Evidence from neuroimaging studies

supports a shared neurocircuitry of behavioral addictions and SUD. Game associated brain stimulation in internet gaming addicts occurs in the same brain regions (orbitofrontal, dorsolateral prefrontal, anterior cingulate, nucleus accumbens) as with drug-associated brain stimulation in drug addicts.[14]Brain imaging research suggests that the dopaminergic mesolimbic pathway from the ventral tegmental area to the NA may be involved in both SUD and pathological gambling. Diminished ventral striatal activation has been implicated in the cravings associated with substance and behavioral addictions [14]. Henry Lai, the American scientist, discovered that microwaves increase the activity of brain endorphins or endogenous opioids (the biological basis of addiction to opium and it's derivate as well as alcohol) in analogous ways to morphine. There could also be a suggested existence of an opiate-like action, similar to actual opiates and alcohol, as being partly responsible for its pleasurable 'craving' and of the positive reinforcement observed in smartphone addicts. Dr. Lai states that in general, the effects of radio frequencies on addiction imply several biological processes that are similar to other agents, such as certain psychoactive drugs: alcohol, opiates, and benzodiazepines [2].

The latest reports on the mobile addiction-A study (2004) by the University of Navarro affirm that young people aged between [15-19] years admit being addicted to their cell phones [20]. Another study developed in South Korea demonstrates that the youth of that country suffer dependency on technology and that 30% suffer from confusion and transitory depression when they can't use their cell phone. A study by Sanjeev Davey and Anuradha Davey (2014) predicted that the SA magnitude in India ranged from 39% to 44% as per ($P < 0.0001$).

SA among Indian teens can not only damage interpersonal skills, but also it can lead to significant negative health risks and harmful psychological effects on Indian adolescents [21]. A study by Dong gioseo (2016) results showed that mobile phone dependency negatively predicted attention and positively predicted depression, which in turn affect social relationships with friends and both Korean language arts and mathematics achievement [22]. According to a survey performed by Stewart Fox-Mills, more than 13 million Britishers suffer from nomophobia, about 53% of mobile users (48% women, 58% men) [23]. A study (2017) showed that the proportion of highly dependent mobile phone users was more raised in Belgium, UK, and France. Regression analysis identified several risk factors for increased scores on the PMPUQ dependence subscale, namely using mobile phones daily, being female, engaging in social networking, playing video games, shopping, and viewing TV shows through the Internet, chitchat and messaging, and using mobile phones for downloading-related activities [24].

In a study in South Korea (2018), according to the Smartphone Addiction Proneness Scale scores, 563 (30.9%) were classified as a risk group for SA, and 1261 (69.1%) were identified as a normal user group [25]. Jin-Liang Wang and associates in the USA (2019) found that mobile game addiction was positively associated with social anxiety, depression, and loneliness [26]. A study by L. K. Singh and others (2019), examined professionals from India and found that about 1.0% of the total sample population had severe internet addiction whereas 13% were in the range of moderate internet addiction; also total night time sleep (5.61 ± 1.17) is significantly lower in participants with moderate and severe internet addiction (6.98 ± 1.12) compared to those with no and mild internet addiction [27]. The results of one study of De Sola J (2017), showed that problematic use of cell phones shares features of recognized addictions, affecting large segments of the population and not only adolescents [28]. A study in Korea (2017) found high mobile phone addiction (mobile phone addiction score > 20) increased the risk of poor sleep quality [29].

A cross-sectional study (2018) on a general Swedish population aimed to translate and validate the Test of Mobile Dependence (TMD) and to investigate associations between mobile phone use and problem gambling. The TMD test score was significantly associated with problem gambling [30]. A study by Oviedo (2019) in Australia found meaningful differences between gender and age groups, with females and users in the 18-25-year-old age group showing a higher mean Mobile Phone Problem Use Scale (MPPUS) scores. Also, problematic mobile phone use was linked with mobile phone use while driving [31].

The results of a study by Alaavi SS (2018) indicated that cell phone overuse might be correlated with defects in some aspects of national and personal identity [32]. The research from a study (2017), showed that the problematic mobile phone use is mainly related to state anxiety and impulsivity, through the dimensions of Positive and Negative Urgency [33]. According to the Chiu SI (2013) result, (1) mobile phone addiction and Internet addiction are positively related; (2) female college students score higher than male ones in the aspect of mobile addiction [34]. In a case study by Kormendi A (2016), of Smartphone addiction depicted that case fulfills almost all the criteria of Griffiths, Goodman, and the DSM-5 and spends about 8 h in a day using Smartphone. Most of the subject activities with a mobile phone are connected to community sites, so the main problem may be a community site addiction [35]. A study by Jiang Z (2016) explored the association between self-control and mobile phone use patterns in which female students displayed significantly higher mobile phone dependence than males. Self-control was negatively correlated with interpersonal, transaction, and entertainment mobile phone use patterns, but positively correlated with information-seeking use pattern [36].

A study (2019) in a sample of college-aged young adults in the United Arab Emirates found that one-third of the sample evidenced scores indicated problematic mobile phone use ($M = 47.14$, $SD = 19.98$). Logistic regression identified female gender, increasing daily time using the mobile phone, and elevated depressive symptom logy predicted higher MPPUS-10 scores [37]. A study by Jafari H (2019) aimed to investigate the relationship between addiction to mobile phones and a sense of loneliness among medical sciences students and found significant and negative correlations between the same.[38]A cross-sectional study by Basu S (2018) in a medical college in New Delhi predicted Mobile phone use with increasing adoption of smartphones promotes an addiction-like behavior in a large proportion of Indian youth.[39]A study by Kuss DJ (2018) was done to predict the power of psychopathological symptoms (depression, anxiety, and stress), mobile phone use across Generations X and Y. Only for dependent mobile phone use, stress appeared as significant. Using social media and anxiety significantly predicted belonging to Generation Y, with calls per day predicted belonging to Generation X [40]. A cross-national study by Lopez Fernanadez (2018) suggested mobile gaming does not appear to be problematic in Belgium and Finland [41]. A study by Chen B *et al.* (2017) found that the prevalence of Smartphone addiction among participants was 29.8% Factors associated with Smartphone addiction in male students were the use of game apps, anxiety, and poor sleep quality. Significant factors for female undergraduates were the use of multimedia applications, the use of social networking services, depression, anxiety, and poor sleep quality [42].

A study (2018) in the Middle Eastern population found a significant positive linear relationship between smartphone addiction and depression and also significantly higher Smartphone addiction scores associated with younger age users [43]. A study by Z. Hussain and others (2017) demonstrated significant relationships between problematic smartphone use and anxiety, conscientiousness, openness, emotional stability, the amount of time spent on smartphones, and age [44]. A study by Daeyong Rohetal. (2018) modified the Implicit Association Test (IAT) for Smartphone and Internet addictions and investigated its validity in children and adolescents, and multiple regression analysis revealed that the IAT was independently and positively associated with Smartphone addiction ($p = .03$) after controlling for other clinical correlates [45].

Summary, Conclusions, and Recommendations: Based on studies, we conclude that smartphones could have a neurophysiological basis shared common mechanisms with some conventional drugs abuses through acting on neurotransmitters mechanisms (with roles for brain in opioidergic, serotonergic and mesolimbic dopamine systems). The response to electromagnetic exposure is having similar effects on the cerebral reward circuit. Now we have extensive data for pathological gambling, internet gaming, internet addiction/smartphone addiction. In the present state of knowledge, researches are still under investigation for smartphone addiction. But based on our knowledge and data collection, we can surely consider it as a full-fledged independent disorder; also, it could not really be considered that smartphone addiction

'without substance'. Also, we strongly recommend this idea for further longitudinal and cohort styles of research. Considering its own behavior and also its sharing mechanisms similar to conventional drug addiction, we are facing new phenomena in which there are hidden risks with negative consequences for health. While the scientific view progresses and becomes more flawless, it is our strong recommendation to add this Smart Phone Addiction /Nomophobia in Dsm-5.

ACKNOWLEDGEMENT: Santosh Medical College and Hospital FH Medical College and Hospital.

CONFLICTS OF INTEREST: None.

REFERENCES:

1. Poli R: Internet addiction update: diagnostic criteria, assessment and prevalence. Neuropsychiatry (London). 2017; 7(1): 04-08.
2. Puente MP and Balmori A: Addiction to cell phones: are there neurophysiologic mechanisms involved. Proyecto 2007; 61: 8-12.
3. Mclellan AT: Substance misuse and substance use disorders: why do they matter in healthcare. Trans Am Clin Climatol Assoc 2017; 128: 112-30.
4. Atroszko PA, Andreassen CS, Griffiths MD and Pallesen S: Study addiction a new area of psychological study: conceptualization, assessment and preliminary empirical findings. J of Behavioral Addictions 2015; 4(2): 75-84.
5. Nolan BV and Feldman SR: Ultraviolet tanning addiction. Dermatologic Clinics 2009; 27(2): 109-12.
6. Suissa AJ: Addiction to cosmetic surgery: representations and medicalization of the body. International Journal of Mental Health and Addiction 2008; 6(4): 619-30.
7. Targhetta R, Nalpas B and Perney P: Argentine tango: another behavioral addiction. Journal of Behavioral Addictions 2013; 2(3): 179-86.
8. Rudski JM, Segal C and Kallen E: Harry potter and the end of the road: parallels with addiction. Addiction Research & Theory 2009; 17(3): 260-77.
9. Bianchi A and Phillips JG: Psychological predictors of problem mobile phone use. Cyber Psychology & Behavior 2005; 8(1): 39-51.
10. Bragazzi NL and Puente DG: A proposal for including nomophobia in the new DSM-V. Psychol Res Behav Manag 2014; 7: 155-60.
11. Körmendi A, Czki ZB, Végh BP and Székely R: Smartphone use can be addictive. a case report. Journal of Behavioural Addictions 2016; 5(3): 548-52.
12. http://www.independent.co.uk/news/education/education-news/child-smart-phones-cocaine-addiction-expert-mandy-saligari-harley-street-charter-clinic-technology a7777941. html.
13. De-Sola Gutiérrez J, Rodríguez de Fonseca F and Rubio G: Cell-phone addiction: a review. Front Psychiatry 2016; 7: 175.
14. Grant JE, Potenza M N, Weinstein A and Gorelick DA: Introduction to Behavioral Addictions. Am J Drug Alcohol Abuse 2010; 36(5): 233-41.
15. Hyman SE and Malenka RC: Addiction and the brain the neurobiology of compulsion and its persistence. Nature Reviews Neuroscience 2001; 2(10): 695-03.
16. Kalivas PW and McFarland K: Brain circuitry and the reinstatement of cocaine seeking behavior. Psychopharmacology Berlin 2003; 168(1-2): 4-56.
17. Koob GF, Sanna PP and Bloom FE: Neuroscience of addiction. Neuron 1998; 21(3): 467-76.
18. Nestler EJ: The neurobiology of cocaine addiction. Sci Pract Perspect 2005; 3(1): 4-10.
19. Salford LG, Brun AE, Eberhardt JL, Malmgren L and Persson BR: 'Nerve cell damage in mammalian brain after exposure to microwaves from gsm mobile phones. Environmental Health Perspectives 2003; 111: 881-3.
20. Naval, Concepción; Sádaba, Charo; Bringué, Xavier. (2003). Impacto de lasTecnologías de la Información y de la Comunicación (TIC) en las Relaciones Sociales de los Jóvenes Navarros. Navarra: Gobierno de Navarra. Instituto Navarro de Deporte y Juventud.
21. Davey S and Davey A: Assessment of Smartphone addiction in indian adolescents: a mixed method study by systematic-review and meta-analysis approac. Int J Prev Med 2014; 5(12): 1500-11.
22. GiSeo D, Park Y, Kim MK and Park J: Mobile phone dependency and its impacts on adolescents' social and academic behaviors. Computers in Human Behavior 2016; 63: 282-92.
23. http://www.dailymail.co.uk/news/article550610/Nomophobia-fear-mobile-phone-contact--plague-24-7-age.html.
24. Lopez-Fernandez O, Kuss DJ and Romo L: Self-reported dependence on mobile phones in young adults: A European cross-cultural empirical survey. J Behav Addict 2017; 6(2): 168-77.
25. Cha SS and Seo BK: Smartphone use and Smartphone addiction in middle school students in Korea: Prevalence, social networking service, and game use. Health Psychol Open. 2018; 5(1): 2055102918755046.
26. Wang JL, Sheng JR and Wang HZ: The association between mobile game addiction and depression, social anxiety and loneliness. Front Public Health 2019; 7: 247.
27. Singh LK, Suchandra KHH, Pattajoshi A, Mamidipalli SS, Kamal H, Singh S and Sachacher B: Internet addiction and daytime sleepiness among professionals in India: a web-based survey 2019 Indian J Psychiatry 2019; 61(3): 265-69.
28. De-Sola J, Talledo H, Fonseca RF and Rubio G: Prevalence of problematic cell phone use in an adult population in Spain as assessed by the Mobile Phone Problem Use Scale (MPPUS). PLo SOne 2017; 12(8): 0181184.
29. Lee JE, Jang SI, Ju YJ, Kim W, Lee HJ and Park EC: Relationship between mobile phone addiction and the incidence of poor and short sleep among korean adolescents: a longitudinal study of the korean children & youth panel survey. J Kore Med Sci 2017; 32(7): 1166-72.
30. Fransson A, Chóliz M and Hakansson A: Addiction like mobile phone behavior - validation and association with problem gambling. Front Psychol 2018; 9: 655.
31. Oviedo-Trespalacios O, Nandavar S, Newton JDA, Demant D and Phillips JG: Problematic use of mobile phones in australi is it getting worse. Front Psychiatry 2019; 10: 105.
32. Alavi SS, Ghanizadeh M, Mohammadi MR, Mohammadi Kalhory S, Jannatifard F and Sepahbodi G: The survey of personal and national identity on cell phone addicts and non-addicts. Iran J Psychiatry 2018; 13(1): 15-21.

33. De-Sola J, Talledo H, Rubio G and de Fonseca FR: Psychological factors and alcohol use in problematic mobile phone use in the spanish population. Front Psychiatry 2017; 8: 11.
34. Chiu SI, Hong FY and Chiu SL: An analysis on the correlation and gender difference between college students' internet addiction and mobile phone addiction in taiwan. ISRN Addict 2013; 360607.
35. Körmendi A, Brutóczki Z, Végh BP and Székely R: Smartphone use can be addictive. a case report. J Behav Addict 2016; 5(3): 548-52.
36. Jiang Z and Zhao X: Self-control and problematic mobile phone use in Chinese college students: the mediating role of mobile phone use patterns. BMC Psychiatry 2016; 16(1): 416.
37. Vally Z and El Hichami F: An examination of problematic mobile phone use in the United Arab Emirates: Prevalence, correlates and predictors in a college-aged sample of young adults. Add Behav Rep 2019; 9: 100185.
38. Jafari H, Aghaei A and Khatony A: The relationship between addiction to mobile phone and sense of loneliness among students of medical sciences in Kermanshah, Iran. BMC Res Notes 2019; 12(1): 676.
39. Basu S, Garg S, Singh MM and Kohli C: Addiction-like Behavior Associated with Mobile Phone Usage among Medical Students in Delhi. Indian J Psychol Med 2018; 40(5): 446-51.
40. Kuss DJ, Kanjo E, Crook-Rumsey M, Kibowski F, Wang GY and Sumich A: Problematic mobile phone use and addiction across generations: the roles of psychopathological symptoms and smartphone use. J Technol Behav Sci 2018; 3(3): 141-49.
41. Lopez-Fernandez O, Männikkö N, Kääriäinen M, Griffiths MD and Kuss DJ: Mobile gaming and problematic smartphone use: A comparative study between Belgium and Finland. J Behav Addict 2018; 7(1): 88-99.
42. Chen B, Liu F, Ding S, Ying X, Wang L and Wen Y: Gender differences in factors associated with smartphone addiction: a cross-sectional study among medical college students. BMC Psychiatry 2017; 17(1): 341.
43. Alhassan AA, Alqadhib EM, Taha NW, Alahmari RA, Salam M and Almutairi AF: The relationship between addiction to smartphone usage and depression among adults: a cross sectional study. BMC Psychiatry 2018; 18(1): 148.
44. Hussain Z, Griffiths MD and Sheffield D: An investigation into problematic smartphone use: The role of narcissism, anxiety and personality factors. J Behav Addict 2017; 6(3): 378-86.
45. Roh D, Bhang SY, Choi JS, Kweon YS, Lee SK and Potenza MN: The validation of Implicit Association Test measures for smartphone and Internet addiction in at-risk children and adolescents. J Behav Addict 2018; 7(1): 79-87.
46. NIDA. Cocaine." National Institute on Drug Abuse, 6 May. 2016, https://www.drugabuse.gov/publications/research-reports/cocaine. Accessed 21 Nov. 2019.

How to cite this article:
Sharma B, Kumar P and Sharma P: Smartphone is it “behaviour addiction or substance abuse disorder”: a review to find chemistry behind. Int J Pharm Sci & Res 2021; 12(1): 57-64. doi: 10.13040/IJPSR.0975-8232.12(1).57-64.