**Research Paper**

# Implications of Neuropsychological Deficits and Intervention in Gaming Addiction: A Case Series

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**ABSTRACT**

The effects of playing online games on brain functions and cognitive processes are not yet clear. Neuropsychological profiling of online gamers in many studies has focused on deficits in working memory and response inhibition. *Objective:* The main aim of this paper was to propose a neuropsychological model based on a case series. *Method:* Assessment was conducted with interview and screening tools. Clients were playing multiplayer online games. The average use was of 10 hours a day. It also leads to disturbance in biological function, academic as well as in their lifestyle. None of the clients had significant psychiatric morbidity. The clients above the cut off were administered Wechsler's memory scale and NIMHANS neuropsychological battery. The assessment revealed deficits in frontal, temporal and right parietal cognitive functions. Deficits were found in sustained attention, working memory, immediate recall and response inhibition, and other executive functions. The clients were given cognitive retraining strategies on the basis of deficits found on the assessments. The post-intervention assessment revealed a significant decrease in neuropsychological deficits and excessive gaming. Based on the results of a theoretical neuropsychological model for gaming was formulated integrating the assessment and intervention data. The theoretical model explained the relationship between cognitive domains and gaming. Excessive gaming could lead to the presentation of neuropsychological deficits. *Conclusion:* This paper provides a stepwise understanding of the development of gaming disorder. There is scope for getting more empirical data with a larger sample. It has implications for the promotion of changes in lifestyle interventions.

*Keywords:* *Neuropsychological Assessment, Gaming Addiction, Neuro-Rehabilitation, Case Series, Neuropsychological Model*

**I**nternet gaming disorder (IGD) has been defined as , persistent and recurrent use of the Internet in engaging in online or offline games, leading to significant impairment or distress in day to day functioning like sleep, appetite, self care and academics in a period of 12 months (Pontes, Király, Demetrovics, & Griffiths, 2014). The Diagnostic and Statistical Manual for Mental Disorders 5th edition (DSM) has included IGD in Section III, a concept

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warranting further research to be called as a disorder (A. Weinstein, Livny, & Weizman, 2017). Currently there is immense research for the prevalence, conceptualization and psychopathology formulation of the disorder (Byun et al., 2009; Zhang & Brand, 2018). There are many models proposed on different domains of the psychopathology of the disorder like cognitive behavioural models, (Davis, 2001; D. Lee, Namkoong, Lee, & Jung, 2017) neuropsychological models (Wei, Zhang, Turel, Bechara, & He, 2017), and social emotional models (Savci & Aysan, 2017). The focus of this paper is on neuropsychological deficits found in internet gaming disorder and proposing a model based on case series. Neuropsychological studies on IGD have mainly focussed on front limbic and fronto stritial pathways especially the reward circuit pathways (Palaus, Marron, Viejo-Sobera, & Redolar-Ripoll, 2017; A. M. Weinstein, 2017). In the fronto limbic system, which focus on prefrontal cortex, deficits have been found in executive functions like decision making, attentional bias, information processing, delay discounting and impulse control (Buono et al., 2017; Choi et al., 2017; Kim & Kang, 2018; Ko et al., 2017). Orbitio frontal deficits are found to be in terms of response inhibition, poor self regulation mechanisms (D. Lee, Lee, Namkoong, & Jung, 2018). Deficits are also found in the fronto statial pathways especially in the domains of psychomotor control (S. B. Hong et al., 2015). Studies have been conducted using neuropsychological assessments like Stroop test for response inhibition, go no go task for cognitive control, tower of London test for decision making and problem solving abilities. These studies show deficits in executive functions and impulse control. (Chen et al., 2015; J. Lee et al., 2015; Wang et al., 2017; Y. W. Yao et al., 2015). Dopamine-caudte- putamen pathway in the basal ganglia has been well researched in addictions and has shown to have implications in IGD (G. Dong, Li, Wang, & Potenza, 2017; Meng et al., 2015; Palaus et al., 2017). The purpose of the study is to assess neuropsychological deficits and affective deficits and integrating both aspects into a comprehensive model through a case series.

## MATERIALS AND METHODS

### *Participants*

Survey methodology was used to collect the sample for the study. The subjects were taken from SHUT (Services for Healthy Use of Technology) clinic NIMHANS. Total of 6 individuals between the age group of 16 to 30 years who were using internet for one year and had the ability to read and write English were included in the study. Participants who scored above the cut off were selected and categorized into 3 groups based mild, moderate and severe usage based scores. Subjects with neurological disorders, psychiatric disorders and other medical problems which interfere in taking assessment were excluded.

### *Tools*

1. **Background data sheet**
   A background data sheet was developed by the investigator to record socio demographic details which cover age, sex, socio economic status etc and details about internet usage.
2. **Internet Addiction Test(IAT)**
   The Self-report internet addiction scale consists of 20 items with 5 point Likert scale. Total scores that range from 0 to 30 points are considered a normal; scores of 31 to 49 indicated mild; 50 to 79 moderate level; and 800 to 100 indicate a severe (Young, 1996).
3. **Internet Gaming disorder test (IGDT):**
   The self-administer questionnaire designed to measure the gaming activity, IGDT consists of 20 items and the respondent indicates on a 5 point Likert scale and above 50 cut off is considered to be excesssive user (Pontes et al., 2014).

**4. Depression Anxiety Stress Scale (DASS):**
The self-administer questionnaire measure the negative emotional state of depression, anxiety and stress consists of 21 items, with 7 items in each category. (Lovibond & Lovibond, 1995).

**5. Barratt Impulsivity Scale (BIS-11):**
The self-report questionnaire developed by Ernest Barratt in 1995 designed to assess impulsivity (Patton, Stanford, & Barratt, 1995).

*Cognitive tests:*
Tests of executive functions:

6. *NIMHANS Neuropsychological Battery:* developed by Shobini Rao, Subbakrishna, Gopukumar in 2002 (Rao, 2004).

- Mental Speed: Digit symbol substitution test developed by Wechsler in 1981. The test consist of sheet in which the numbers 1-9 are placed randomly in 4 rows in which the subject has to copy symbols corresponding to the digits as quickly as possible.
- Response inhibition: Stroop colour and word test developed by Golden 1978.The subject has to look at each sheet and move down the columns reading words or naming the ink colour as quickly as possible.
- Cognitive flexibility: Colour trails test 1 and 2 developed by D'Eliz, Satz, Uchiyama and White in 1996. The part 1 consists of numbers written in colour and Part 2 numbers and colours written alternatively, subject will point in serial order.
- Planning: Tower of London test developed by Shallice in 1982. The test consists of two identical boards with 3 poles of variable lengths and three balls each.
  Tests of memory

7. *Wechsler Memory Scale III (MS III, 1997):* Indian Adaptation (Pushpalatha, Rao, & Indira, 2004)

- Working Memory: Digit span test consists of numbers which is presented in both forward and Backward of progressively increasing digit sequence with two trials per item.

*Procedure*
Subjects approaching SHUT clinic were approached for the study. Consent form was taken. According to the test cut off out of the 6 participants, 2 participants each were categorized into mild, moderate and severe category of internet use. Socio demographic details and psychology questionnaires were given. NIMHANS Neuropsychological battery was administered. Intervention sessions were undertaken. Post intervention assessments including internet addiction test and internet gaming disorder test were given. The complete flow of the process is diagrammatically represented in **Error! Reference source not found.**.
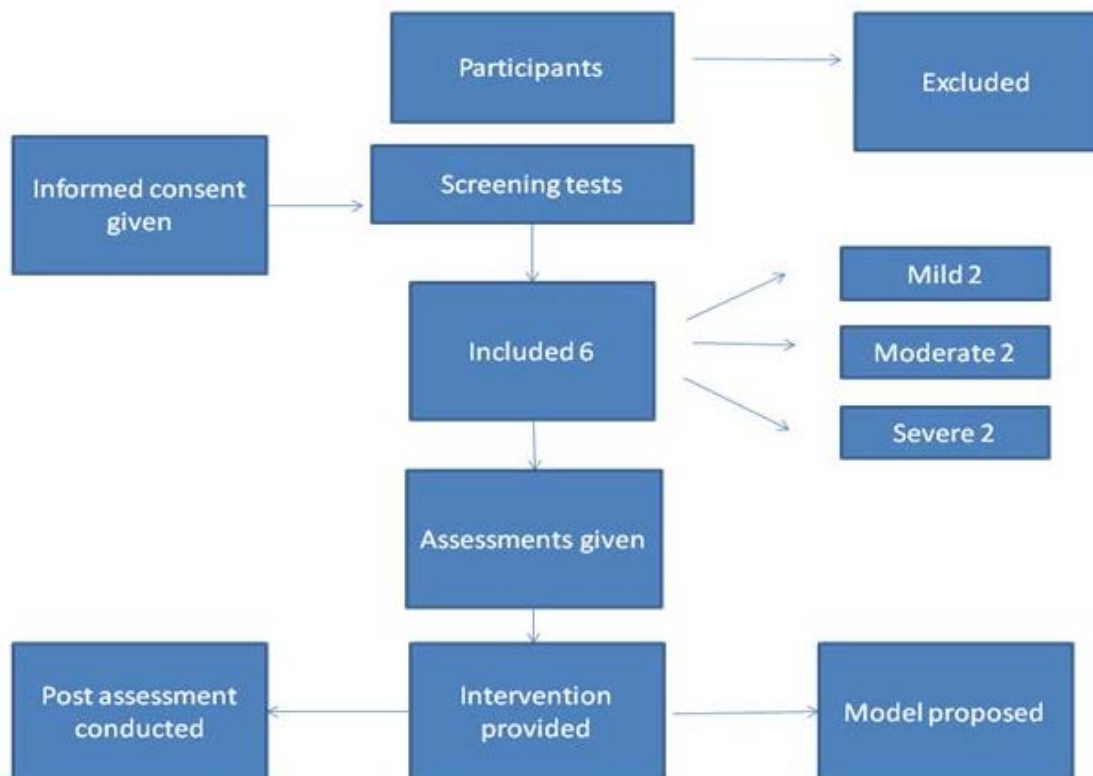
*Figure 1 Flow chart for data collection and model development*

## RESULTS

The socio demographic details (**Error! Reference source not found.**) of the 6 participants indicated that 5 out of 6 participants were males. The participants belonged to the age range from 18-25, educated up to graduation and all of them were single. They belonged to nuclear families and middle socio economic status. The co-morbid diagnosis was found to be OCD, ADHD and Depression. The internet and mobile phone usage indicated (**Error! Reference source not found.**) that all participants had 4G data and mostly more than 5 years of use. The number of hours varied from 2-3 to 7-8 according to the severity. Mild users played offline games and moderate users played online multiplayer interactive games. (**Error! Reference source not found.**) shows the scores on screening tests, psychological tests and neuropsychological tests. Total scores on each test and their percentiles are written in brackets. Table shows scores on assessments and highlighted numbers show above cut off indicating dysfunction on various assessments.

*Table 1 Socio demographic details of each participant*

| Sr No | Initials | Age | Gender | Education | Occupation | Languages | Rural/Urban | Type of Family | Marital Status | Handedness | Co-morbidities |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | SN | 18 | Male | B.Tech | Student | English, Hindi | Urban | Nuclear | Single | Right | ADHD |
| 2. | AG | 21 | Female | B.Sc | Student | English | Urban | Nuclear | Single | Right | Depression |
| 3. | RS | 25 | Male | B.Tech | Unemployed | English | Urban | Extended | Single | Right | NA |
| 4. | GS | 20 | Male | B.A | Student | English, Hindi | Rural | Joint | Single | Right | OCD |
| 5. | AM | 18 | Male | LLB | Student | English | Urban | Nuclear | Single | Right | NA |
| 6. | SR | 19 | Male | B.Tech | Student | English | Urban | Nuclear | Single | Right | Depression |

*Table 2 Nature of internet use and games played by the participants*

| Sr.No | Initials | Information on technology use | Years of Use | Hours of Use | Monthly Charges | Games | Social Media |
|---|---|---|---|---|---|---|---|
| 1 | SN | Mobile, Laptop | 5 | 2-3 | 500 | Spiderman | Instagram, Facebook |
| 2 | AG | Mobile Laptop | 4 | 2-3 | 500 | Candy Crush | Instagram,Facebook |
| 3 | RS | Mobile, Laptop, Xbox | 6 | 4-5 | 1000 | Counter strike | Instagram, Facebook |
| 4 | GS | Mobile, Laptop | 2 | 3-4 | 1000 | Forthnight | Instagram |
| 5 | AM | Mobile , Laptop | 3 | 7-8 | 2500 | PUBG | Instagram |
| 6 | SR | Mobile, Laptop, Xbox | 4 | 7-8 | 2500 | PUBG | Instagram |

*Table 3 Scores on assessments and highlighted numbers indicating dysfunction*

| Sr No | Initials | IAT | IGD | Groups | DASS | BIS | DSS | SCWT | CT 1 | CT2 | TOL | DF | DB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SN | 36 (Mild) | 51 | G1 | 28 | 26 | 201 (36) | 161 (32) | 36 (84) | 67 (90) | 11 | 6 | 5 |
| 2 | AG | 41 (Mild) | 55 | G1 | 29 | 25 | 244 (53) | 167 (36) | 34 (89) | 66 (89) | 12 | 7 | 5 |
| 3 | RS | 55 (Moderate) | 63 | G2 | **34** | **29** | 207 (24) | 176 (29) | 61 (38) | 122 (32) | 9 (70) | 5 | **4** |
| 4 | GS | 61 (Moderate) | 62 | G2 | **36** | 27 | 215 (21) | 181 (23) | 62 (35) | 126 (30) | 8 (60) | 5 | **4** |
| 5 | AM | 82 (severe) | 70 | G3 | **45** | 31 | **232 (20)** | **210 (16)** | **73 (24)** | **135 (22)** | **6 (25)** | 4 | 3 |
| 6 | SR | 85 (Severe) | 76 | G3 | **56** | 32 | **232 (20)** | **200 (19)** | **74 (22)** | **134 (24)** | **7 (27)** | 4 | 3 |

*Intervention Phase*

Intervention phase involved 6-8 sessions with cognitive retraining and cognitive behaviour therapy. The sessions were focussed on executive functions like sustained attention and concentration, cancellation tasks, sorting tasks and tasks to enhance planning and organization CBT sessions skills. Post assessment revealed significant reduction in the scores of IAT and IGDT and overall improvement in the well being reported post intervention assessment.

*Table 4 Post intervention assessment*

| | | IAT | IGDT |
|---|---|---|---|
| 1 | **SN** | 30 | 39 |
| 2 | **AG** | 32 | 38 |
| 3 | **RS** | 36 | 41 |
| 4 | **GS** | 38 | 45 |
| 5 | **AM** | 41 | 50 |
| 6 | **SR** | 44 | 55 |

# DISCUSSION

Current case series focuses on neuropsychological functions, including attention, memory and executive functions of behavioural addictions. A tentative theoretical model is proposed based on the findings.

The socio-demographic assessment of the participants revealed 5 out of 6 participants were males, considering worldwide prevalence rates shows more use of games in men (Cheng & Li, 2014). The sample mostly belonged to urban population with nuclear families and mainly co-morbid psychiatric diagnosis like OCD, ADHD and depression (Goel, Subramanyam, & Kamath, 2013). The number of hours varied from 2-3 to 7-8 according to the severity, studies have suggested 2-3 hours average per day with more than 5 to be considered excessive use (A. Weinstein & Lejoyeux, 2010). Mild users played offline games and moderate users played online multiplayer interactive games and all of them used Instagram and 3 of them used Facebook. Assessment revealed deficits in frontal, temporal and right parietal cognitive functions and above average score on impulsivity and affective components.



*Figure 2 Framework for the model*

**Error! Reference source not found.** illustrates the basic framework and development of the model. The model is divided in 3 ways (i) benefits of gaming with mild use (ii) The shift from mild use to moderate use with cognitive deficits especially executive functions, planning problem solving (iii) severe use mainly showing cognitive deficits in executive functioning and response inhibition eventually addiction, leading to a vicious cycle.
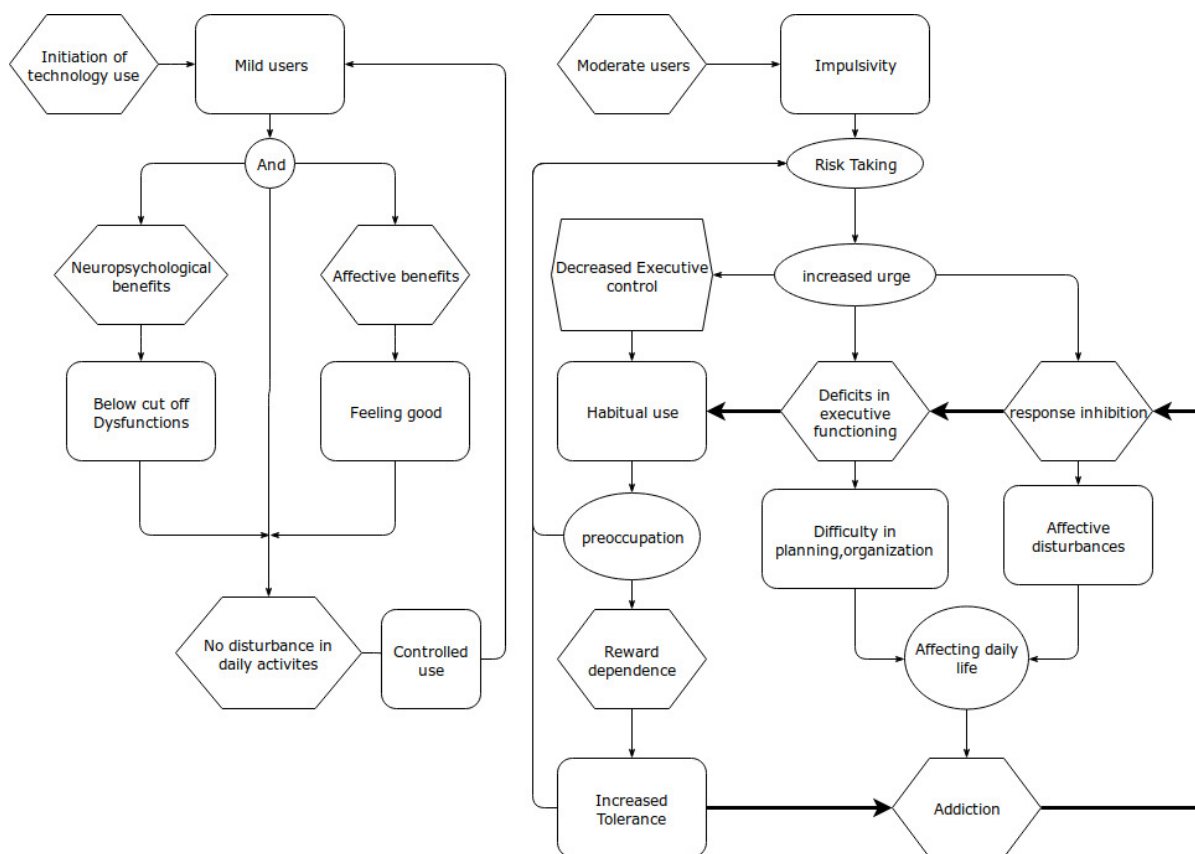
*Figure 3 Diagrammatic representation of the model*

**Error! Reference source not found.** illustrates the pictorial representation of the developed model which is separated on the left and right for mild and moderate use respectively.

On the left side there is representation of development of use for mild users. Post the initiation period, initially the gamers experience neuropsychological benefits like increase in attention and concentration or visuo spatial benefits. The benefits of gaming have been identified in many studies mainly to improve visuo motor functions and sustained attention and concentration (Li, Chen, & Chen, 2016). In the case series, mild users reported benefits and their assessments revealed below cut-off percentiles in executive functions and affective tests. The overall 'feel good factor' might lead to increase in productivity and sense of well-being resulting in no disturbance in daily activities and controlled use which continues and maintains itself to only mild use and balancing between technology use and non technology use.

On the right side, there is representation of development of use for moderate users. Moderate use is combined with psychological and personality factors like impulsivity and more increased risk taking behaviour which was found to be high in moderate users. This leads to increased urge, difficulty in exercising executive control leading to habitual use, preoccupation and reward dependence. This might result in difficulty in carrying out daily activities and increased tolerance leading to addiction and increased impulsivity and decreased control. During the same time there are increased neuropsychological deficits, where the moderate users scored high on dysfunctions in executive functions and memory deficits along with psychological distress. Some studies have also showed negative effects of gaming especially in executive functioning (Guangheng Dong & Potenza, 2016).The

addiction mechanism highlights on spectrum of use, controlled use then excessive use and addiction (Griffiths, 2015). Earlier studies have shown high impulsivity in severe gamers as a precursor for addiction (Nuyens et al., 2016; Sariyska, Lachmann, Markett, Reuter, & Montag, 2017). Combined with risk taking, impulsivity, executive dysfunctions and affective disturbances the reward dependence mechanism in addiction gets triggered and which leads to excessive use of gaming, daily life disturbances and difficulty in response inhibition again, hence continuing the cycle (Griffiths, 2015). Intervention should be focused on cognitive retraining and dealing with affective components which according to this model seem to go hand in hand and shows more improvement using an eclectic approach.

## STRENGTHS

A Profile and pattern of three groups (healthy to addictive internet user) was able to get in the study, assessment of internet gaming use, impulsivity, DASS.

## LIMITATIONS AND SUGGESTIONS

Age group for the sample is between 16 to 30 years, wider age group can be taken
Case series lacks generalization; same tests should be conducted on the sample to check the validity of the model with statistics with comparison of means.

## CONCLUSION

The study assessed the pattern and profile of addictive internet users; cognitive profile and psychosocial profile of addictive users in detail. However broader range of age group, gender difference among cognitive and psychosocial social variables can be considered. As there is a significant deficit in cognitive functions that need to be considered while screening the individual for internet use. Further is needed in India to develop more evidence on this area and to study the personality variables associated with internet addiction.

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*Conflict of Interest*

The authors carefully declare this paper to bear not conflict of interests