

**Study of Cognitive Functioning among Smart Phone users and it's  
Correlation with Loneliness**

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**Abstract**

**Background:** The recent development of the multifunctional smartphone and its subsequent global popularity has changed the communication and information landscape; remolded the interests, values, and desires of many users; and triggered concerns around the world about overuse and addiction.

**Methods:** Recent study conducted on 100 subjects and categorized as per the duration of smart phone use with all participants' written informed consent. Present study evaluated cognitive levels among smartphone and their correlation with loneliness through different scales.

**Results:** Problem caused by excessive smartphone use was significantly related to the severity of loneliness and levels cognitive domains.

**Conclusion:** This study reports there is decline in cognitive levels with smartphone use and it is correlated with the loneliness too.

**Keywords:** Smartphone use severity, cognitive domains, loneliness, depression, anxiety, and learning.

**Introduction**

The use of smartphones is a necessity now instead of a choice. The innovation of phones and various software has made our lives more convenient. However, the negative effects of our excessive dependence on them cannot be ignored<sup>1-2</sup>. Around the world, smartphones were used by 1.85 billion people in 2014 which was expected to be 2.32 billion in 2017 and 2.87 billion in 2022. Mobile phones make our lives easier, but on the other hand, it ties us. Mobile addiction has physical effects and psychological and academic effects at the same time. Sleep deficit, anxiety, stress, and depression associated with internet abuse have also been related to mobile phone

usage too<sup>3</sup>.

Many recent studies have explained the relationship between smartphones and cognitive functions and have argued that dependence on smartphones may increase anxiety and negatively affect cognitive functions<sup>4-6</sup>.

Another observational study reports that insomnia may lead to depression. Li et al. (2016) did a prospective cohort and proposed that insomnia and risk of depression are associated. DeSola Gutiérrez et al. (2016) revealed that problematic cell phone usage had been associated with sleep deficit, depression, anxiety, and stress. Cha and Seo (2018) aimed to examine the predictive factors of smartphone addiction in middle school students in South Korea. Two groups were chosen, one risk group and another normal group. The two groups expressed significantly different results. The predictive factors for smart phone addiction were social networking and awareness of game overuse. A researcher revealed that teenagers who spend more hours on their gadgets are highly likely more at risk of suicide. Another study by Augner and Hacker (2012) examined an association between over-usage or dysfunctional usage of cell phones and psychological health. They indicated low emotional stability, chronic stress, and depression correlate with phone usage. According to latest studies, it is come to know that there are two schools of thoughts. Some researchers believe that there is a positive association between cell phone addiction and the mental health of adolescents, and some believe there is a negative or indirect relation in them.<sup>5-7</sup>

Several previous studies observed that mobile phone use has potential to affect cognition. Thornton et al reported that the mere presence of a cell phone results in diminished attention and worsen task performance<sup>7</sup>. Poorer working memory was exhibited in studies by Cain et al and Uncapher et al in case of frequent media multitaskers<sup>8, 9</sup>. Lepp et al demonstrated negative correlation between smartphone usage and academic performance<sup>10</sup>. Furthermore, even brain imaging studies reported that associated cognitive deficit may be directly manifest in the functioning of the brain's corresponding control circuitry. Loh and Kanai found reduced grey matter in the anterior cingulate cortex of frequent media multitaskers, indicating that this habit may directly impact the structural properties of an important locus of attentional control in the brain. Based on previously available literature, it can be surmised that smartphone usage could also negatively affect various other domains of cognition. However, limited literature is available to show definite cognitive decline concerning different domains of cognition and a global

cognitive decline associated with smartphone usage. Therefore, this study looks forward to study levels of cognitive decline with smartphone usage.<sup>10, 11</sup>.

**An overview of correlation between smartphone uses and cognitive levels.**

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Cognitive abilities can be assessed under 5 domains as follows: -

1. Attention
2. Memory
3. Verbal fluency
4. Language
5. Visuospatial abilities

To assess cognitive function of any individual, cognitions tests are designed specifically. These tests involve the systematic administration of clearly defined procedures. They are also used for clinical and neurological research. This study aims to use Addenbrooke's Cognition Examination (ACE-III) to assess cognitive levels.<sup>12-15</sup>

## **Tests for evaluation of Cognitive function**

The tests that can be used for cognitive function evaluation are either Neurophysiological or Neuropsychological. Neurophysiological tests include Evoked Potentials, EEG, and Sensory Evoked Potentials. Neuropsychological tests include an array of tests, which can be either general screening tests for cognition or in-depth testing for a particular domain.

### **General Screening Tests**

These include mainly MMSE (Mini-Mental State Examination), the 3MS (Modified Mini-Mental State), CCSE (the Cognitive Capacity Screening Examination), and The Montreal Cognitive Assessment (MoCA).

### **Specific tests**

Comprehensive testing specifically targets different domains of cognition such as intelligence, memory, orientation, mental status, attention and vigilance, verbal skills, visuospatial abilities, and many others. The degree of impairment of such cognitive domains could be estimated by administering these tests. These include Reaction Time (RTI) for attention; Trail-Making tests (Trail A and Trail B) for Executive function; Delayed Matching to Sample (DMS) for Memory; Emotional Recognition Test (ERT) for Social and emotional cognition, among many others.<sup>16-20</sup>

### **Loneliness**

Loneliness can be defined as a state or a situation in which someone experiences a feeling of deficiency in social or close relationships quantitatively or qualitatively. Weiss proposed two categories of loneliness. These are emotional loneliness and social loneliness. When someone experiences a deficiency in networks of social relationships, such as not being socially integrated into a group of friends and acquaintances with common interests, social loneliness arises. Emotional loneliness occurs when a lack of close and intimate relationships, such as losing a partner or following a divorce. Generally, loneliness has been found to affect psychological health<sup>21, 22</sup>.

## **Materials and Methods**

### **Study setting**

The present study was conducted in the Department of Physiology, Pacific Medical College & Hospital, Udaipur, after taking approval from Institutional Ethics Committee. Written informed

consent was obtained from all participants. One hundred subjects were recruited and categorized as per the duration of smartphone use.

The Smartphone usage was determined by self-reporting or scales PRIUSS. Addenbrooke's Cognition Examination (ACE-III) was administered to assess each participant's cognition functioning.

**Inclusion Criteria:**

1. Age between 18-50 years
2. Both male and female
3. Minimum SSC pass
4. Smart phone users

**Exclusion Criteria:**

1. Diagnosed cases of neurological or psychiatric disorders.
2. Patients taking medications, which are known to affect cognition.
3. Presence of any medical psychiatric disorder.
4. History of severe head injury.

**Neurocognitive test:**

The cognitive assessment tools.

**Addenbrooke's Cognitive Examination - III (ACE-III)**

ACE-III is a cognitive test that assesses five domains: Attention, memory, verbal fluency, language and visuospatial abilities. The total score is 100, with higher score indicating a better cognitive function. The test is available in both English and Hindi.

Total Score	/100
Attention	/18
Memory	/26
Verbal Fluency	/14
Language	/26
Visuospatial	/14

**Smart phone use severity scale using PRIUSS scale**

Please answer the questions below based on how you have felt and conducted yourself regarding your Internet use over the past 6 months. Please do your best to interpret these questions as they apply to your experiences and feelings.

When considering your Internet use time, consider any time you spend online, whether you are using a computer or a mobile device. Do not include time you spend texting unless you use text messages to interact with an online application such as Facebook or Twitter.

**DASS scale for loneliness**

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

- 0 Did not apply to me at all.
- 1 Applied to me to some degree, or some of the time.
- 2 Applied to me to a considerable degree or a good part of the time.
- 3 Applied to me very much or most of the time.

- 1(s) I found it hard to wind down 0 1 2 3
- 2 (a) I was aware of dryness of my mouth 0 1 2 3
- 3 (d) I couldn't seem to experience any positive feeling at all 0 1 2 3
- 4 (a) I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion) 0 1 2 3
- 5 (d) I found it difficult to work up the initiative to do things 0 1 2 3

6 (s) I tended to over-react to situations	0	1	2	3
7 (a) I experienced trembling (e.g. in the hands)	0	1	2	3
8 (s) I felt that I was using a lot of nervous energy	0	1	2	3
9 (a) I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10 (d) I felt that I had nothing to look forward to	0	1	2	3
11 (s) I found myself getting agitated	0	1	2	3
12 (s) I found it difficult to relax	0	1	2	3
13 (d) I felt down-hearted and blue	0	1	2	3
14 (s) I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
15 (a) I felt I was close to panic	0	1	2	3
16 (d) I was unable to become Enthusiastic about anything	0	1	2	3
17 (d) I felt I wasn't worth much as a Person	0	1	2	3
18 (s) I felt that I was rather touchy	0	1	2	3
19 (a) I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat)	0	1	2	3
20 (a) I felt scared without any good Reason	0	1	2	3
21 (d) I felt that life was meaningless	0	1	2	3

**DASS-21 Scoring Instructions**

The DASS-21 should not be used to replace a face-to-face clinical interview. If you are experiencing significant emotional difficulties, you should contact your GP for a referral to a qualified professional.

**Depression, Anxiety and Stress Scale - 21 Items (DASS-21)**

The Depression, Anxiety and Stress Scale - 21 Items (DASS-21) is a set of three self-report scales designed to measure the emotional states of depression, anxiety and stress. The three DASS-21 scales contain 7 items, divided into subscales with similar content. The depression scale assesses dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest/involvement, anhedonia and inertia. The anxiety scale assesses autonomic arousal, skeletal muscle effects, situational anxiety, and subjective experience of anxious affect. The stress scale is sensitive to levels of chronic non-specific arousal. It assesses difficulty relaxing, nervous arousal, and being easily upset/agitated, irritable /over-reactive and impatient. Scores for depression, anxiety and stress are calculated by summing the scores for the relevant items.

The DASS-21 is based on a dimensional rather than a definite conception of psychological disorder. The assumption on which the DASS-21 development was based (and confirmed by the research data) is that the differences between the depression, anxiety and stress experienced by normal subjects and clinical populations are essentially differences of degree. The DASS-21 therefore has no direct implications for the allocation of patients to discrete diagnostic categories postulated in classificatory systems such as the DSM and ICD.

Recommended cut-off scores for conventional severity labels (normal, moderate, severe) are as follows. NB Scores on the DASS-21 must be multiplied by 2 to calculate the final score.

**Table 1:** Mean characteristics of smartphone users (n = 100)

	<b>Depression</b>	<b>Anxiety</b>	<b>Stress</b>
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-25
Severe	21-27	15-19	26-33
Extremely Severe	28+	20+	34+



**Result:**

- PRIUSS scale and Attention, Memory, Fluency, Language and Visuospatial have a statistically significant linear relationship ( $p=0.001$ ).
- The direction of the relationship is negative (i.e., PRIUSS scale and Attention, Memory, Fluency, Language and Visuospatial are negatively correlated), meaning that if PRIUSS scale increases and Attention, Memory, Fluency, Language and Visuospatial decreases.

**Discussion:**

The present study evaluated cognitive domain levels across 100 smartphone users and observed changes in cognitive domain levels with smartphone use. This study also assessed severity of loneliness perceived in each subject and then correlated with the use of smartphone use and levels of cognitive domains. The PRIUSS scale determined Smartphone usage, whereas DASS scale was used for the perceived loneliness in the subjects. Addenbrooke's Cognitive Examination (ACE-III) was administered to assess each subject's cognitive domain levels.

The results revealed that the subjects with more smartphone use experienced greater decline in all the cognitive domain levels and the overall cognitive decline was reported as total ACE-III score. Our finding aligns with the study by Tze Pin Ng et al.<sup>15</sup>, who found a decline in global cognitive, attention and working memory, memory functioning with more frequent use of mobile phones.<sup>16, 17,18,19</sup> The study specifically evaluated cognitive function in attention and memory domains and found a decline in both with smartphone use. This finding follows studies by researchers 18-30 who examined cognitive decline with greater smartphone use and found a significant association between them.

Most previous researchers used one or two domains of cognition, whereas our study assessed the major 5 domains with an overall global cognitive level. The present study is unique in that the decline in cognitive decline has been well assessed with smartphone use with the major cognitive domains, which could be helpful in the prompt diagnosis of smartphone-related cognitive problems encountered by its users.<sup>31-41</sup>

Caplan et al.<sup>41-51</sup> observed that lonely and socially isolated people feel relieved when participating in the virtual reality world. Loneliness in individuals makes them prone to using

mobile phones and other media. The DASS scale study evaluated the level of loneliness in the subjects and found that smartphone use and higher DASS score have a significantly linear relationship ( $r=0.753$ ,  $p = 0.001$ ). We also observed the direction of the relationship is positive, which implies that these tend to increase together. One study<sup>58</sup> by Morikawa et al. investigated the influence of social isolation and smartphone use on cognitive functions in adults and found that smartphone use was associated with cognitive functions (memory, attention, executive function, and processing speed). The current study also found a decline in cognitive functions declines with the severity of loneliness in the subjects. Furthermore, we also assessed individual levels and reported a decline in all the domains of cognition.<sup>52-59</sup>

## Summary and Conclusion:

The use of smartphones in our daily life is crucial but brings with it a variety of adverse effects too. One major adverse effect among them is a decline in our cognitive abilities. The use of smartphones has been increasing daily to help us in our work and family life, but with the increasing stress and loneliness, people are inclined more towards its use. This study aimed to evaluate changes in cognitive decline with smartphone use and find the correlation between loneliness and smartphone use. This study reports a decline in cognitive levels with smartphone use, which also correlates with loneliness.

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