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Research Paper

Neuropsychological Dysfunction As Associated With Cognitive Factors among Clinical Population of Older Adults

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ABSTRACT

The study was initiated to understand the nature of cognitive impairment among Indian older adults. Given that research on Indian population has been carried out on patient groups (seizures, dementia etc.) more often, this study was looked at as a timely contribution being conducted on individuals who did not receive any diagnosis. The clinical sample was drawn from the division of Neurology clinic of Bangalore Neuro Centre, Bangalore India. Mental status and cognitive functions were assessed by MMSE (30-score) and standardized 10 Neuropsychological tests (Attention, Fluency, motor speed, mental speed, logical memory, auditory verbal learning & memory, visuo-spatial ability and visual long term memory). The tools used in this study are the MMSE and the NIMHANS Neuropsychological Battery for adults. Sample was obtained through referrals from other professionals and informed consent was obtained for participating in the study. The study explores the inter-relationship of the Neuropsychological test variables, (Pearson's) correlation analysis and fact-finding factor analyses were performed. Further, we analyzed a principal component and a varimax rotation method to extract number of cognitive factors. Results indicated the high sensitivity of few tests in understanding neuropsychological functioning. This lead us to conclude that the tests, Auditory Verbal Learning Test, Logical Memory test, Complex Figure Test, Controlled Oral Word Association Test, Colour Trails Test and Digit Symbol Substitution Test, are sufficient to understanding the impairment of cognition in the given sample.

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The present study aims to understand the clustering of cognitive functions among a population of Indian older adults. Considerable research on Indian population has focused on the epidemiology of cognitive impairment and nature of cognitive impairment among different patient groups. In India there have been few studies in the area of cognitive changes and profile of cognitive function, particularly, in relation with older adults. So, as far as cognitive functions are concerned perhaps not even a single study has carried out research on cognitive factors into justification.

This study is one of the few, which aims to understand the interrelationship of cognitive functions among individuals who do not meet criteria for diagnosis but suffer significant impairment. Understanding the relationship among different cognitive functions will provide information to develop time and cost effective tools of assessment and interventions for individuals with cognitive impairment.

Cognitive impairment is a broad term that is used to describe difficulty in cognitive functions such as remembering, decision making, focusing and learning new things which is not caused by any other illness (U.S. Department of Health, 2011). Neuropsychological assessment is used to examine cognitive functioning and to detect the deficits if any. It comprises of a battery of performance- based tests, each measuring different cognitive functions (Harvey, 2012).

One of the recurrent interests of study in the field of cognition is mild cognitive impairment (MCI). Mild cognitive impairment is the difficulty in exercising cognitive functions which is higher compared to that faced by a normal average individual in a given age group. A study carried out in Kolkata, India, reported a prevalence rate of 14.89% for MCI (Das, Bose, Biswas, Dutt, Banerjee, Hazra, Raut, Chaudhuri & Roy, 2007). The prevalence of MCI was 4.3% among individuals aged above 65 years as reported in an international study (Sosa et al, 2012).

MCI has been regarded a predictive factor for dementia. In some population samples, MCI has been regarded a crucial risk factor for dementia, making it extremely important for providing timely screening and intervention (Sosa et al, 2012). Dementia of Alzheimer's type causes a handicapping impact on the individual and it is predicted that the number of individuals with dementia will double in every two decades (Ferry et al, 2005). Conversion rates of MCI to dementia was reported to be 10% and researchers have stressed on the implication that MCI is not to be considered a component of normal ageing (Bruscoli & Lovestone, 2004). Implications for this study can be understood in the light of these findings which suggest the importance of understanding of MCI.

Nature of cognitive deficits across different groups and conditions is understood through neuropsychological testing. As previously mentioned, studies have found that deficits in individuals with MCI are beyond the normative standard of cognitive decline. Similar findings have been reported for Alzheimer's disease compared to age-related cognitive decline. Most significantly affected cognitions in Alzheimer's disease are those of episodic memory, semantic knowledge and memory and executive functions (Salmon & Bondi, 2009). Studies on individuals with seizures have reported no significant difference between the cognitive functioning of individuals diagnosed with seizures and those not diagnosed (Mazzini, Cossa, Angelino, Campini, Pastore & Monaco, 2003). The findings from previous research lend valuable material for comparison of the current sample with different populations studied across different periods of time. The study is understood to be valuable for diagnostic purposes and intervention planning.

In the present study, we aimed to identify the early risk factors associated with older adults' cognitive impairments and its progressive dysfunctional patterns.

MATERIALS AND METHODS

Participants:

The study was conducted on a sample of 127 subjects. A final sample of 90 older adults was set at or above the cut-off of MMSE i.e., <24. The total sample was classified according to their MMSE <24) score. A total of 90 older adults (58 males and 32 females, mean (standard deviation) age 68.19 (8.19 years) who had complete MMSE screening and 10 Neuropsychological tests, were eligible for the study. The participants attending out patients' clinic of Neurology, psychiatry and neuropsychology, Bangalore Neuro center, Bangalore, India were selected from the community. All participants attended at least 8th grade. Their education ranged from 8th grade to Ph.D. and the majority of them (N=88) are right-handed. All participants gave their informed consent to participate.

Materials:

We administered the MMSE and NIMHANS Neuropsychological Battery for adults (Rao et.al, 2004).

Neuropsychological Tests.

The NIMHANS battery measures motor speed, processing speed, attention, concentration, executive functions, visuoconstructive ability, learning, and memory. The battery facilitates analysis using Indian standard norms.

Mini-Mental Status Examination (MMSE).

We assessed MMSE (Rovner & Folstein, 1987) with the English version. This instrument consists of 30 items, which assess the aspects of orientation, registration, attention, and calculation, recall, language and praxis.

Procedure:

All tests were administered individually. The above-mentioned tests take approximately 2 hours depending on the subject's performance. Informed consent was obtained post which the MMSE was administered followed by the NIMHANS Neuropsychological Battery (Rao et.2004).

1. ***Finger tapping test:***
   Measures the motor speed of each index finger. Motor speed allows understanding the efficiency with which the brain is able to integrate various functions which contribute to the movement. (Rao, Pillai, 2004).
2. ***Digit symbol substitution test:***
   Measures mental speed. The test measures different functions such as visuomotor coordination, motor persistence, sustained attention and response speed (Rao, Pillai, 2004).
3. ***Color trails test:***
   The test was developed by the WHO. The test measures focussed attention. It is administered in two parts. Part one measures the ability to sustain attention, engage in perceptual tracking and carry out sequencing activities. Part two requires the individual to engage in mental flexibility in addition to using the above-mentioned cognitions (Rao, Pillai, 2004).
4. ***Digit Vigilance test:***
   The test measures the cognition of sustained attention. The subject is required to focus attention on the set target and complete the task with sustained mental effort (Rao, Pillai, 2004).
5. ***Controlled oral word association (COWA):*** The test measures phonemic fluency which is the ability to generate words which are phonetically similar (Rao, Pillai, 2004).
6. ***Rey's auditory verbal learning test:*** The test is a measure of both learning and memory. The Indian adaptation of the test has been used for this study. Verbal learning and memory are assessed based on the individual's ability to learn presented material over trials and recall the same on instruction (Rao, Pillai, 2004).
7. ***Logical memory:***
   The test measures an individual's capacity to retain logically connected information and reproduce it at different intervals; an immediate recall and a delayed recall. The Indian adaptation of the test passage was used for the study (Rao, Pillai, 2004).
8. ***Rey's Complex figure test:***
   The test measures visuoconstructive ability (coping skills) and visuospatial short-term and long-term memory. Visuoconstructive ability includes attention, visuospatial perception, visuomotor coordination, planning and error correction abilities. Visuospatial memory is measured using an immediate and delayed recall (Rao, Pillai, 2004).

Statistical analyses

To examine the inter-relationship of the Neuropsychological test variables, (Pearson's) correlation analysis and fact-finding factor analyses were performed.

Pearson's product moment correlation technique was used to find out the relationship between neuropsychological variables.

Fact-finding factor analysis was performed. Further, we analysed a principal component and a varimax rotation method to extract a number of cognitive factors. This analysis determines the minimum number of independent dimensions needed to account for most of the variance in the original set of variables. The varimax rotation is, therefore, used to simplify the columns (factors) rather than rows (variables). All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS version 20).

RESULTS

After testing the demographic variables and related neuropsychological variables, the most high-ranking cognitive factors were identified through factor analysis by using SPSS 20 version software. Factor analysis is a data reduction method used to give a clear picture of changeability among observed, correlated variables in terms of a possibly lower number of unobserved variables labeled factors. In addition, it helps in structure detection among the variables and further helps in studying the essentially decisive factors that bring about the variation. The present researcher carried out the factor analysis test to find the most powerful factors.

Table -1: Means and Standard Deviations of the scores obtained by the older adult group on neuropsychological performances (N=90)

Neuropsychological Variables	Mean	Standard Deviation
Finger Tapping- Right-Hand Tapping	31.07	5.96
Finger Tapping – Left Hand Tapping	29.14	4.45
Logical Memory – Immediate Recall	5.16	2.89
Logical (Passage) Memory – Delayed Recall	3.63	2.56
AVKT – Total Responses	28.25	10.74
AVLT - Immediate Recall	4.46	2.64
AVLT - Delayed Recall	3.77	2.87
Complex Figure Test – Copy	26.43	8.84
Complex Figure Test - Immediate Recall	7.99	4.98
Complex Figure Test - Delayed Recall	7.47	5.41
Coding – DSST (Time)	421.46	144.38
Digit Vigilance (Time)	724.63	234.84
Color Trails – 1 (Time)	148.11	73.21
Color Trains – 2 (Time)	258.12	95.23
Verbal Fluency – COWA (Average)	6.22	4.85

KMO and Bartlett's Test

Prior to scheduling for factor analysis, the eligibility of the data has to be tested by conducting KMO-Bartlett‟s test. This KMO and Bartlett‟s test is a measure of sampling adequacy and multivariate normality among variables. The KMO value in this study is 0.77 > 0.5 which says that the sample taken is adequate. Bartlett's Test of Sphericity value is 0.000<0.005, indicating multi normality among variables. Further the KMO and Bartlett‟s test significance values are, KMO>0.5 and Bartlett‟s value <0.01. This significance paves the way for factor analysis.

Correlation Analysis

The inter-correlations involving all the fourteen neuropsychological variables are shown in Table 3 and the following tables represent original and rotated factor matrix of neuropsychological contributors. On the basis of the findings obtained in these tables, factors along with factors loadings on each factor from the given set of variables were identified as per the criterion laid down for the same. These factors, both original and Varimax, are described hereunder.

Table -3: Correlation Matrix: Inter Correlations among Neuropsychological variables

NP Tests	FT-R	FT-L	AK-IR	AK-DR	AVLT-TOT	AVLT-IR	AVLT-DR	CFT-COPY	CFT- IR	CFT-DR	DSST	DV	CT-1	CT-2
FT-R	1.00													
FT-L	0.64**	1.00												
AK-IR	0.12	-0.14	1.00											
AK-DR	-0.01	-0.23**	0.77	1.00										
AVLT-TOTAL	-0.05	-0.21*	0.64**	0.63**	1.00									
AVKT IR	0.07	-0.17	0.65**	0.58**	0.81**	1.00								
AVLT - DR	0.08	-0.17	0.64**	0.62**	0.73**	0.77**	1.00							
CFT-Copy	-0.01	-0.04	0.16	0.28**	0.33**	0.25**	0.18	1.00						
CFT-IR	-0.12	-0.22*	0.26**	0.41**	0.41**	0.34**	0.31**	0.49**	1.00					
CFT-DR	-0.08	-0.21*	0.22*	0.31**	0.36**	0.30**	0.31**	0.39**	0.75**	1.00				
DSST	-0.14	-0.17	-0.23*	0.26**	-0.13	-0.13	-0.16	-0.15	-0.01	0.13	1.00			
DV	-0.08	-0.06	-0.05	-0.10	-0.10	-0.11	-0.03	-0.24**	-0.05	-0.11	0.28**	1.00		
CT-1	-0.08	0.02	-0.07	-0.22*	-0.22*	-0.23*	-0.19*	-0.53**	-0.26**	-0.15	0.39**	0.39**	1.00	
CT-2	0.05	-0.05	-0.10	-0.17*	-0.24**	-0.17	-0.07	-0.50**	-0.30**	-0.08	0.43**	0.31**	0.66**	1.00
COWA	0.14	0.03	**0.30****	**0.35****	**0.27****	**0.18***	0.14	**0.26****	**0.23****	**0.21***	-0.16	**-0.30****	**-0.30****	**-0.30****
NP Tests	**FT-R**	**FT-L**	**AK-IR**	**AK-DR**	**AVLT-TOT**	**AVLT-IR**	**AVLT-DR**	**CFT-COPY**	**CFT-IR**	**CFT-DR**	**DSST**	**DV**	**CT-1**	**CT-2**

* Significant at 0.05 level; **Significant at 0.01 level.

Table 3 presents the correlation matrices for neuropsychological variables of older adults and their performance relationship between cognitive domains, namely, (1) Motor speed, (2) Processing Speed (3) Attention, (4) Visuoconstructive ability (5) Verbal Learning and Memory (6) Visual learning and Memory.

Table 3 shows that verbal learning & memory and logical memory performances are negatively and significantly related with other cognitive contributors, such as visuoconstructive ability, visual short-term memory, visual long-term memory, processing speed, focused attention, divided attention and verbal fluency scores. Processing speed function is positively correlated with sustained attention, focused attention and divided attention for older adults whereas visuoconstructive ability, visual short-term memory, and visual long-term memory functions have shown a significant positive relationship only with verbal fluency score. Therefore, the significant and positive relation between memory variables, processing speed, and the visuoconstructive ability measures, might be interpreted as older adults having positive and inter-related cognitive functions concerning attention and fluency.

It can be noted from table-3 that motor speed function is negatively and significantly related to some of the neuropsychological functions namely, verbal learning, verbal short-term and verbal long-term memory. Processing speed focused attention and divided attention scores were negatively correlated with the verbal fluency score. The relationship between visuoconstructive ability and visual memory scores is negatively correlated with other cognitive variables namely, sustained attention, focused attention and divided attention. In addition, verbal learning and memory variables are significantly and negatively correlated with focused attention and divided attention.

Hence low scores on motor speed mean, higher verbal learning and memory functioning. Older adults were found to have the least score in verbal and visual memory functioning.

Most of the other neuropsychological variables are negatively but not significantly related with finger tapping speed – right and left hand.

To sum up, it may be inferred that some of the verbal learning and memory variables are positively related with visual learning and memory and some of the attention variables are negatively related with verbal fluency and it is highly significant. In other words, learning and memory domain variables are related differentially with attention and executive functions variables.

Total Variance:

Table-4: The factors with Eigenvalues greater than 1 are considered as most influencing factors. This is arrived by using Extraction method and the analysis is principal component analysis.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings	
	Total	% of Variance	Cumulative %	Total	% of Variance
1	4.90	32.70	32.70	4.90	32.70
2	2.34	15.61	48.31	2.34	15.61
3	1.86	12.38	60.69	1.86	12.38
4	1.29	8.63	69.32	1.29	8.63
5	0.92	6.11	75.43	0.92	6.11
6	0.76	5.05	80.47		
7	0.66	4.38	84.85		
8	0.47	3.15	88.00		
9	0.45	2.98	90.98		
10	0.35	2.33	93.31		
11	0.26	1.76	95.07		
12	0.22	1.49	96.56		
13	0.20	1.31	97.87		
14	0.18	1.18	99.05		
15	0.14	0.95	100.00		

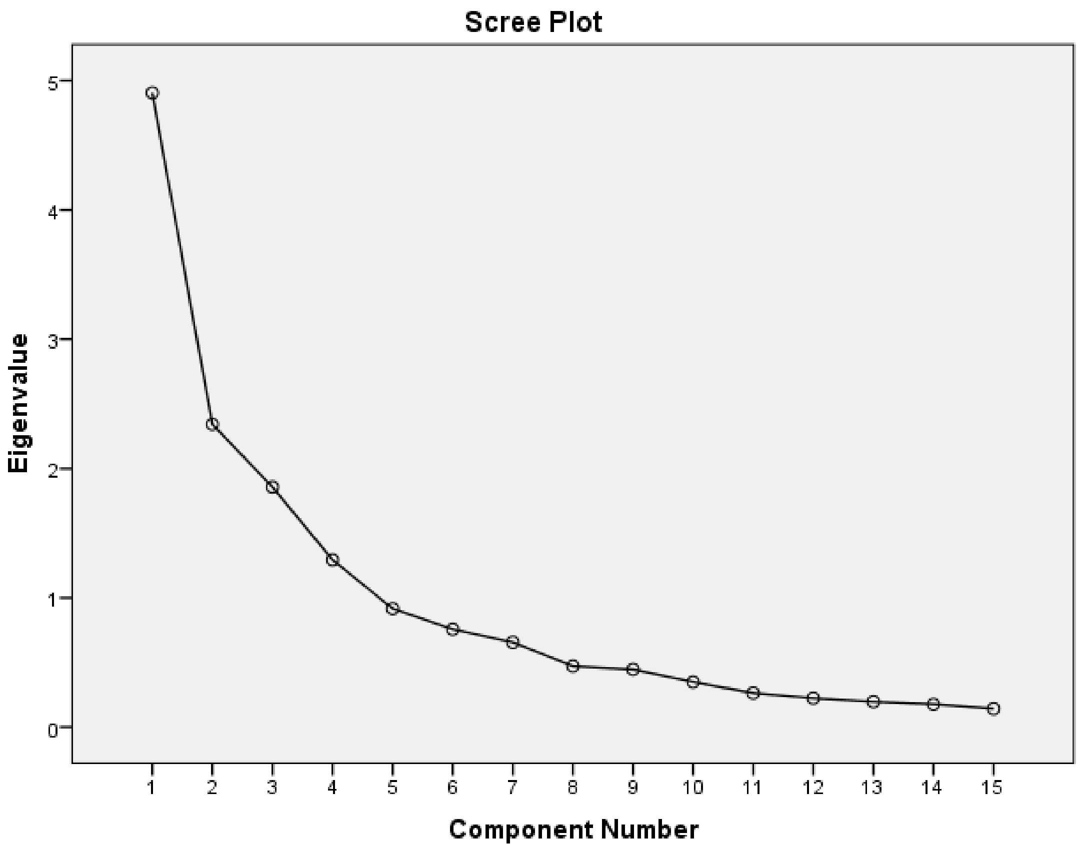
Factor:
The initial number of factors used is the same as the total number of variables used in the factor analysis. However, all the 15 factors (variables) will not be retained. In this study, only 5 factors will be retained since their Eigenvalue is greater than 1 and the cumulative percentage is 75.43%.

Initial Eigenvalues:
Eigenvalues represent the variance of the factors.

Total:
This column contains the Eigenvalues. The first factor will always account for the maximum variance and the next factor will account for lesser variance compared to the first factor as observed and so on. Hence each successive factor will account for lesser and lesser variance.

Rotated component matrix:
The principal component matrix gives the component matrix, which is rotated using the varimax with Kaiser Normalization rotation technique. Rotation of factors helps in the better interpretation of factors.

Figure-1 Scree plot



The number of factors extracted should be about one third the number of variables (Nunnally, 1967). In this case five factors were extracted for 15 variables. An added evidence in support of the totality of factor extraction is the quantity of variance, in the numbers matrix, describe put-together explained up to 75.43 per cent of variance. The fifth factor describes 8.75 per cent of variance in the different data matrices. The extraction of factors was stopped here, as further factorization did not appear important.

Since the original factors are as good in a statistical sense as any rotation of them (Nunnally, 1967), the discussion has been centred around both the original and rotated sets of loadings, more specifically to those which are represented by the collection of significant factor loadings on neuropsychological contributors. On the other hand, factors not found significant for the rationale of discussion have been described in brief along with the tabular presentation of significant loadings. In respect of the values of significant factor loadings, too, there is no commonly established measure. As recommended by Guilford (1954) the value of + 0.300 has been considered applicable for the purpose of interpreting outcomes of the factor analysis in the present research.

The description of figure-1 is given above the scree plot helps to plot the Eigen values against the corresponding factor/variable. These values are seen in the plotted graph. The first three columns of the variables account for the maximum variance and from the fourth factor on wards it is observed that the curve is almost flat, which means that each successive factor is accounting for smaller and smaller variation in the data.

Table-5: The Significant Factor Loading on Un-rotated Factor-1 Along with its Varimax Rotated Factor Loadings, given in Descending Order

S.No.	Original Factor - 1 Neuropsychological Variables	Loading	Varimax Factor -1 Neuropsychological Variables	Loading
1	AVLT – Total	0.83	AVLT –DR	0.87
2	Logical Memory - DR	0.79	AVLT - IR	0.86
3	AVLT- IR	0.79	Logical Memory -IR	0.86
4	AVLT – DR	0.75	AVLT-TOTAL	0.83
5	Logical Memory -IR	0.73	Logical Memory -DR	0.79
6	CFT –IR	0.63		
7	CFT-COPY	0.56		
8	CFT – DR	0.54		
9	COWA	0.46		
10	CT-2	-0.45		
11	CT-1	-0.50		
12	DSST	-0.31		
	Sum Square	3.84		
	Variance	32.70		

Factor – 1

The factor loadings on factor-I as extracted from the factor analysis of data are given in table 5. The table 5 shows that the original factor-1 is illustrated by significant loading shared by verbal learning, visual learning, long-term retrieval, attention tasks, mental speed and verbal fluency variables.

Auditory verbal learning and memory variables with significant factor loadings include Auditory Learning, (AVLT –Total = 0.83), logical memory delayed recall (LM-DR = 0.79), Auditory Verbal immediate recall (AVLT -IR = 0.79), Auditory Verbal delayed recall (AVLT -DR = 0.75), logical memory immediate recall (LM-IR = 0.73), complex figure – immediate recall (CFT –IR = 0.63), visuo-constructive ability (CFT –copy = 0.56), complex figure – delayed recall (CFT –DR = 0.54), and verbal fluency (COWA = 0.46). Significant negative factor loading on attention and psychomotor speed variables include Divided attention (CT-2 = -0.45), focused attention (CT-1 = -0.50) and processing speed (DSST = -0.31). Eight out of eight learning & memory variables (range of loadings = 0.54 to 0.83) shared positive loadings on the first factor. Therefore two out of three psychomotor speed variables (range of loadings = 0.45 to 0.50) shared negative loadings on the first factor.

Varimax factor-1 accounts for 3.84 of the common factor variance, which is 32.70% of variance accounted for by all the five factors.

The results of the original factor-1 having predominance in all the measures of learning and memory, one measure of verbal fluency contributors and three measures of attention and psychomotor speed, which to bring about the element of early predictors, leading us to identify with a specific impairment of temporal lobe functions of older adult patients.

Factor -2

The Significant Factor Loading on Un-rotated Factor-2 Along with its Varimax Rotated Factor Loadings, Arranged in Descending Order

S.No.	Original Factor – 2 Neuropsychological Variables	Loading	Varimax Factor -2 Neuropsychological Variables	Loading
1	CT2	0.65	CT2	0.85
2	CT1	0.64	CT1	0.83
3	DVT	0.53	DSST	0.64
4	DSST	0.51	CFT - COPY	-0.59
5	AVLT – DR	0.34		
6	FINGERTAPPING - Left	-0.46		
7	CFT-COPY	-0.39		
8	FINGERTAPPING - Right	-0.32		
9	COWA	-0.31		
Sum Square		2.40		
Variance		15.61		

The factor loadings on factor 2 as extracted from the factor analysis of data are given in table 6.

Table 6 shows that original factor 2 is illustrated by significant factor loading shared by auditory-verbal memory, visuoconstructive abilities, attention tasks, mental speed, motor speed and verbal fluency variables. Variables of attention with significant factor loadings include divided attention (CT-2= 0.65), focused attention (CT-1=0.64) and sustained attention (DVT= 0.53). Variables of attention are followed by mental speed (DSST= 0.51) and auditory verbal delayed recall (AVLT-DR= 0.34).

Significant negative factor loadings were found on motor speed (FT-L= -0.46, FT-R= -0.32), visuo-constructive ability (CFT-copy= -0.39) and verbal fluency (COWA= -0.31). Factor 2 is characterized by positive loadings from one variable of learning and memory and four variables of attention and mental speed (range of loadings= 0.34 to 0.65). Psychomotor variables, visuo-constructive ability and verbal fluency had negative factor loadings on factor 2 (range of loadings= -0.31 to -0.46).

Varimax factor-2 accounts for 2.40 of the common factor variance which is 15.61% of variance accounted for by all the five factors.

Factor- 3

The Significant Factor Loading on Un-rotated Factor-3 Along with its Varimax Rotated Factor Loadings, Arranged in Descending Order

S.No.	Original Factor – 3 Neuropsychological Variables	Loading	Varimax Factor -3 Neuropsychological Variables	Loading
1	FINGERTAPPING - Right	0.67	CFT –DR	0.86
2	FINGERTAPPINGL - Left	0.56	CFT –IR	0.83
3	LOGICALMEMORY-IR	0.39	CFT-COPY	0.55
4	CFT -IR_A	-0.49	DSST	0.35
5	CFT – DR	-0.46		
6	CFTCOPY	-0.36		
7	DSST	-0.31		
Sum Square		2.08		
Variance		12.38		

The factor loadings on factor 3 as extracted from the factor analysis of data are given in table 7.

Table 7 shows the original factor 3 is illustrated by significant factor loading shared by logical memory, visuospatial memory and visuoconstructive ability, mental speed and motor speed. Significant positive factor loadings were found for motor speed (FT-R= 0.67 and FT-

R= 0.56) and logical memory (IR= 0.39). Significant negative factor loadings were found for visuo spatial immediate recall (CFT-IR= -0.49), visuospatial delayed recall (CFT-DR= -0.46), visuo-constructive ability (CFT copy= -0.36) along with mental speed (DSST= -0.31).

Varimax factor-3 accounts for 2.08 of the common factor variance which is 12.38% of variance accounted for by all the five factors.

Factor 4

The Significant Factor Loading on Un-rotated Factor-4 Along with its Varimax Rotated Factor Loadings, Arranged in Descending Order

S.No.	Original Factor - 4 Neuropsychological Variables	Loading	Varimax Factor - 4 Neuropsychological Variables	Loading
1	FINGERTAPPING - Right	0.55	FINGERTAPPING-Right	0.91
2	CFT – DR	0.53	FINGERTAPPING-Left	0.88
3	FINGERTAPPING - Left	0.48		
4	CFT-IR	0.41		
5	DSST	0.39		
Sum Square		1.68		
Variance		8.63		

The factor loadings on factor 4 as extracted from the factor analysis of data are given in table 8.

Table 8 shows the original factor 4 is illustrated by significant factor loading shared by visuospatial memory, mental speed and motor speed. Significant positive factor loadings were found for motor speed (FT-R= 0.55 and FT-L= 0.48), visuospatial delayed recall (CFT-DR= 0.53), visuospatial immediate recall (CFT-IR= 0.41) and mental speed (DSST=0.39).

Varimax factor-4 accounts for 1.68 of the common factor variance which is 8.63% of variance accounted for by all the five factors.

Factor 5

The Significant Factor Loading on Un-rotated Factor-5 Along with its Varimax Rotated Factor Loadings, Arranged in Descending Order

S.No.	Original Factor - 5 Neuropsychological Variables	Loading	Varimax Factor - 5 Neuropsychological Variables	Loading
1	COWA	0.67	COWA	0.83
2	DV-Total Time	-0.43	DV-Total time	-0.64
Sum Square		1.31		
Variance		6.11		

The factor loadings on factor 5 as extracted from the factor analysis of data are given in table 9.

Table 9 shows the original factor 5 is illustrated by significant factor loadings shared by verbal fluency and sustained attention. Significant positive factor loading was found for verbal fluency (COWA= 0.67) and significant negative factor loading was found for sustained attention (DVT= -0.43).

Varimax factor-5 accounts for 1.31 of the common factor variance which is 6.11% of variance accounted for by all the five factors.

DISCUSSION

The task of naming the factors has been essentially an arbitrary one. For this purpose, the researcher has attempted to give names to the factors by looking at the description of variables in a particular factor. The variable having highest loading was given the maximum consideration in naming the factor. However, the researcher tried to encompass most of the description into the process of naming. While analysing the factor structure the variables are discussed in the descending order of the magnitude of factor loadings. The intercorrelations involving all the fifteen variables are shown in Table 5 represents the original factor as well as Varimax rotation factor.

The study summarizes the results of data obtained from South Indian population. Performance is indicated by scores on the NIMHANS Neuropsychological Battery and the same is not bifurcated on the basis of gender.

Based on factor analysis, five factors were extracted with significant Eigenvalues.
Factor-1: Learning & Memory and attention functions emerge as a significant predictor of patients with cognitive problems, explaining 32.70 percent of the variation in the dimension. Interpreting verbal (learning & memory), visual (learning & memory) and attention modes involve part of design called “Memory awareness”. The trend of the relationship suggests that memory is contributing to cognitive dysfunction. Due to cognitive impairment, auditory verbal learning, immediate and delayed recall, passage memory – immediate and delayed recall, complex figure test – immediate and delayed recall, visuospatial ability, focused attention, divided attention and processing speed, patients may have cognitive impairment. As a result, their neurobehavioral problems may increase which suggests their way of thinking will be affected, which further leads to the severe cognitive impairment or dementia.

Factor-2:“Interlinked cognitive abilities” emerge as the second predictor variable, explaining 15.61 percent of the variance. Interlinked cognitive factors namely are focused attention, divided attention, sustained attention, mental speed, auditory long-term retrieval skills, motor speed, visuoconstructive ability and executive functions. They appeared as strongest predictors of cognitive impairment. These variables are significantly contributing to cognitive impairment related to older adults as reflected in Varimax rotation factors and also have common interlinked cognitive factors with age-related cognitive impairment. The result supports similar conclusions in the research on MCI. A study published in 2007, concluded that MCI includes damage to executive functioning rather than just memory as previously assumed and the same should be kept in mind during assessment and diagnosis (Traykov et.al. 2007).

Factor-3: Analysis of the neuropsychological variables resulted in four major age-related cognitive impairment-generating areas as experienced by the neuropsychologists, namely motor speed, short-term logical memory, visuospatial learning and memory, visuoconstructive ability and mental speed. Both the original and Varimax rotation factor loadings bring about a pattern of cognitive associations contributed to the third prominent factor termed as "movement performance and visual sequential memory”.

Factor 4: It was found that motor speed, visual scanning, and visual memory go together and have a common structure called “Speed of mental processing and storage”

Factor 5: “Mindful intelligibility” has also come out as another main factor under one roof. It includes existing information linking to older adults’ cognitive problems. The factor of phonemic fluency and sustained attention require the involvement of the frontal lobe. A study conducted on understanding the neuropsychological factors contributing to phonemic fluency stated that it is a combination of functions namely, “clustering” and “switching”. For phonemic fluency to occur, these variables perform together and switching is a function of the frontal lobe (, et al., 1997).

The importance of “Visual-scanning awareness” is established by the finding of a significant negatively loaded factor. These variables contributed specific variance as revealed in factor-1 and 2 with visuoconstructive ability, visual memory, verbal fluency, motor and processing speed.

It was noted that the most affected cognitive functions in this population were those of learning and memory. These variables contribute significantly to factor loadings in three among the five factors extracted. Variables of attention follow variables of learning and memory. Sustained attention, divided attention and focused attention; mental speed and visuoconstructive ability. The functions next affected were found to be visuoconstructive ability and visuospatial memory; and mental speed. It was found that motor speed formed an independent factor contributing to the decline in cognitive functioning in the particular sample which was followed by the functions of verbal fluency and sustained attention.

The above-mentioned factors indicate that the decline in cognitive functioning is most significantly reflected in the frontal lobe.

In this study, older adults presented with deficits in almost all the cognitive functions. Highest cognitive impairment was seen in verbal memory, visual memory, attention, motor functions, processing speed, visuoconstructive ability and executive functions.

A remarkable outcome of this study is that even among patients with no diagnosable clinical brain problems, cognitive impairment was relatively common and performance across tests was poor. It may be concluded that cognitive problems inter-related with the aging process or with other medical conditions related to aging, to increase in the chance of cognitive impairment. On the other hand, to our understanding, this is the first kind of study to establish a progressive factor involvement of “memory cognitive abilities’ to neuropsychological performance in older adults. In addition, it will be essential for upcoming studies to investigate the probable neuropsychological re-training techniques to treat cognitive impairment.

From original and varimax rotation factors extracted, the neuropsychological variables affected were highly interrelated and repetitive. The average age of the population is 68.19 years. Hence we have concluded the five independent factors to be, "Memory awareness”, “Interlinked cognitive abilities”, "Movement performance and visual sequential memory”, “Speed of mental processing and storage”, “Mindful intelligibility”.

After studying the factor loadings, we propose that the screening of Indian older adults with cognitive impairment can be carried out using the Auditory Verbal Learning Test, Logical memory test, Complex Figure Test, Controlled Oral Word Association Test, Colour Trails-1, Colour Trails-2 and Digit Symbol Substitution Test along with the Mini-Mental Status Examination. We conclude that these tests will suffice to understand their cognitive functioning, owing to the sensitivity of the tests as understood by factor analysis.

Implication: the future implications of this study as we suggest, would be to explore the role of gender and address the effect of educational qualification on cognitive impairment.

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Conflict of Interest

The authors colorfully declare this paper to bear not a conflict of interests

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