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Examining the Importance of Literacy in Neuropsychological Research: Insights from Indian Adults Living in the Community

Ajay Datt[1], Ruhi Panandiker[2], Keshav Kumar[3], P. Marimuthu[4], RavikeshTripathi[5]

ABSTRACT

Literacy is widely explored topic in cross cultural neuropsychology research. Indian culture is unique in terms of literacy and related cultural belief systems. There is paucity of research on Illiterate participants as majority of the Indian studies focus on educated participants including low and high educated participants with inadequate representation of illiterate participants. **Aim/ Objective:** The main purpose of this study was to investigate the impact of literacy on neuropsychological test performance in an educationally diverse population. **Method:** Total sample consisted of 140 healthy participants with heterogeneous educational backgrounds. Illiterate and literate participants between the age range from 18 to 50 years were selected in this study. They were screened using the Modified MINI Screen, HMSE and Edinburgh Handedness Inventory, and followed by detailed neuropsychological assessment. **Results:** The results of this study revealed that the participants not having formal education or having less years of education performed poorly on tests of attention, construction ability, memory, phonemic fluency, naming and global cognitive screening (HMSE). On the other hand, participants having higher or more years of education performed better than them on similar tests. Literacy has a significant impact on neurocognitive functions and ability to read and write few words can enhance cognitive functioning. Further, results revealed that the impact of education on neuropsychological test performance is nonlinear. **Conclusion:** The findings clearly demonstrates the role of literacy on Neurocognitive functions. Further considering education as proxy measure for level of literacy in Indian context might not be appropriate method especially in low educated participants. Therefore, there is urgent need to examine literacy related influence on cognition using contextualized approach and we recommend developing sensitive and culturally valid tools to assess neurocognitive functions for Indian participants.

Keywords: *Literacy, Neuropsychological test, cognitive impairment, indigenous test*

INTRODUCTION

Literacy is regarded as an important skill for effective functioning in the community. Literacy includes reading, writing and numeracy skills that can be acquired through intensive tuition and practice (Carreiras, 2009). When a person can read, write, and comprehend a brief statement about his or her daily life, it is frequently deemed that individual to be literate(UNESCO, 2008). Years of education is often used as a proxy for level of literacy in neuroscientific research (Noroozian et al., 2014).

Literacy has a beneficial role in our mundane life and known to enhance our cognitive well-being. Learning to read or literacy reinforces and facilitates better phonological awareness, visuospatial awareness, visuomotor skills, remembering strategies and working memory(Ardila et al., 2010) provides protection against dementia and is associated with ontogenic structural brain changes (Carreiras, 2009). There is mounting evidence suggesting that literacy could strongly influence neuro-cognitive performance. Participants with higher education perform significantly better on several neurocognitive tests including working memory, executive functioning, learning and memory, fluency and construction (Tripathi et al., 2014; Ardila et al.,2010; Rao et al., 2004; Mathuranath et al., 2007; Ganguli et al., 1996;Ostrosky-Solis et al., 1998). Lower literacy is considered to be a significant risk factor for dementia and other associated disorders. (Brucki, 2010). However, the impact of literacy on neurocognitive tests is not systematically explored in Indian context.

Higher illiteracy rates have been recorded in developing nations, particularly among women and in rural areas (UNESCO, 2008) and 35% of the world's illiterate population resides in India. Assessment of cognitive functions among illiterates and low educated is a major concern due to poor adaptation of neuropsychological tests (Brucki, 2010), culture specific belief system and lack of indigenous tests (Tripathi et al., 2014). Most of the neurocognitive tests being used in India are developed in the West and attempt has been made to adopt these tests in Indian context (Tripathi et al., 2014; Rao et al., 2004; Mathuranath et al., 2007; Ganguli et

1 Clinical Psychologist, Pandit Deendayal Energy University, Gandhinagar, Gujarat
2 Clinical Psychologist, Head of special needs department, Manthan International School, Hyderabad
3 Professor of Clinical Psychology, NIMHANS, Bangalore
4 Professor of Biostatistics, NIMHANS, Bangalore
5 Assistant Professor of Clinical Psychology, NIMHANS, Bangalore

al., 1996) and this is consistently observed that educated participant scored higher on Trail Making Test (Rao et al., 2004; Ganguli et al., 1996; Bhatia et al., 2007), Category Fluency (Tripathi et al., 2014; Rao et al., 2004; Mathuranath et al., 2007; Ganguli et al., 1996), Episodic Memory Test (Tripathi et al., 2014; Rao et al., 2004; Ganguli et al., 1996), Complex Figure Test (Rao et al., 2004), and Picture Naming Test (Tripathi et al., 2014; Ganguli et al., 1996). Surprisingly, Low educated participants' score remains at base level and they often refuse to participate. Lower scores on neuropsychological test may be caused by a variety of things, such as different learning opportunities, exposure to psychological testing scenarios, and the suitability and utility of the items in the particular cultural environment. It is argued that several measures of cognitive functions are biased by our current schooling systems.

It has been observed that the majority of the neuropsychological studies conducted in India are on educated participants including low and high educated participants with inadequate representation of illiterate participants. Indian socio-political culture has a unique influence on the literacy levels of its citizens. Moreover, several attempts have been made since independence to eradicate illiteracy including social education, Gram Shikshan Mohim, formers functional literacy project and national literacy mission etc. Such efforts have significantly changed the rate of literacy in India. Those who benefited may read and write in the local language. This could have been rewarding experience and might facilitates better adjustment in the society. However, there is limited data to suggest its impact on functional outcome and cognition. Neuropsychological assessment with a low educated group is quite challenging and yields confusing results (Tripathi et al., 2014; Ganguli et al., 1996). Therefore, there is an urgent need to understand neuropsychology of low educated participants using culturally appropriate tools.

METHOD

The total sample consisted of 140 healthy participants with heterogeneous educational backgrounds. Illiterate and literate participants, aged from 18 to 50 years were included in this study. The participants were healthy adults from Ahmedabad, Gandhinagar and other nearby rural areas. Each participant received information about the study and gave their consent to take part. Participants in this study were excluded if they had a known history of a serious psychiatric or neurological condition, had visual or auditory impairment, or had an HMSE score below 24.

Sample was distributed in a total five groups on the basis of their years of education. Participants who had not attended school or had not formal education (Illiterate) been included in Group 1 (N=27), participants with 1 to 5 years of education were included in Group 2 (N=13), participants with 6 to 8 years of education were included in Group 3 (N=25), participants with 9 to 12 years of education were included in Group 4 (N=36) and participants with 13 and above years of education were included in the Group 5 (N=39).

Screening tools

Socio-demographic data sheet: It comprised of name, age, date of birth, gender, education, address, socio-economic status, mother tongue, languages known, occupation, family type, religion, domicile, handedness, with history of physical illness and any form of medication taken, head injury or accident in past, known history of mental disorder and neurological disorders.

Edinburgh Handedness Questionnaire (old field, 1971): This test was used to determine handedness. It has 10 items and often used in neuropsychiatric research.

Hindi Mental Status Examination: HMSE was used to screen cognitive impairment in participants. It consists of 23 items which screens cognitive functions like orientation, registration and recall, attention, naming, repetition, three step task, sentence writing and copying a figure. The possible scores can ranged between 0 to 31.

Modified MINI (Mini International Neuropsychiatric Interview) Screen: This test was used to screen psychiatric symptoms or illness. MMS is a screening measure for major psychiatric disorders.

Neuropsychological tests

Several tests were included to assess attention, working memory, learning and memory, language functions and constructional abilities.

Word List: This test was used to assess episodic memory, developed specially for the elderly persons to assess verbal learning, delayed recall and recognition.

Paired Association Test: This test was used to assess verbal learning memory. This test is an episodic memory paradigm in which pairs of words (e.g. lotus - silver) are presented during four learning trials. The maximum score of all trials with delayed recall is 50 and minimum score is 0.

Stick Construction Test: This test was used to assess construction ability, visual learning and memory. The participants have to make presented designs using sticks. The maximum score is 24 and minimum score is 0 for construction and recall.

Digit Span: This test was used to assess attention and verbal working memory or short-term verbal memory (Richardson, 2007). The maximum score 8, and minimum score is 3 for forward sequence. The maximum score is 7, and minimum score is 2 for backward sequence.

Corsi Block Tapping Test: This test is majorly used to assess visuospatial working memory and attention. The maximum score is 8, and minimum score is 3 for forward sequence. The maximum score is 7, and minimum score is 2 for backward sequence.

Category Fluency: In categorical fluency participants were presented with a category and had to generate as many names in one minute per category that he/she knew belong to the category. In this study three widely used categories "Fruit", "Animal" and "Vegetables" were used. The total number of accurate names produced in each category consideredas a score.

Phonemic Fluency: This test was used to assess phonemic fluency. Participants have to generate words starting with Ka, Ma, Pa in one minute per category.

Picture Memory Test: Visual-spatial memory test examines spatial memory for visually presented, meaning material while allowing verbal responding. In the present test, individuals were shown a scene of a park. The picture is exposed for 10 seconds. After which the client is asked to describe what is happening in the picture. Later the picture is taken away and the participant is to recall it again. The task consists of delayed recall phase taken after 20 minutes. The maximum score of the entire test is 15 and minimum score is 0.

Picture Naming: This test was used to assess semantic memory and language abilities (Tripathi et al., 2014). Picture naming test includes 24 pictures belonging to different semantic categories that is relevant to daily life. The total number of correctly reported answers is considered as a total score. The maximum score is 24 and minimum score is 0.

Administration of all the neuropsychological tests takes around 45 minutes to administer. All the screened participants were tested individually. The data were examined using the Statistical Package for Social Sciences (SPSS 16.0). The effect of literacy on particular neuropsychological test were examined by using one-way analysis of variance.

RESULTS

A total of 140 participants were assessed with screening and neuropsychological tests. Mean age of the participants was 34 years (SD=11) and mean education was 9 years (SD=6.00). Each group was categorized on the basis of different levels of education. To examine the impact of education on neuropsychological test performance one way analysis of variance was used.

Figure 1: Mean values on Word List Test by education

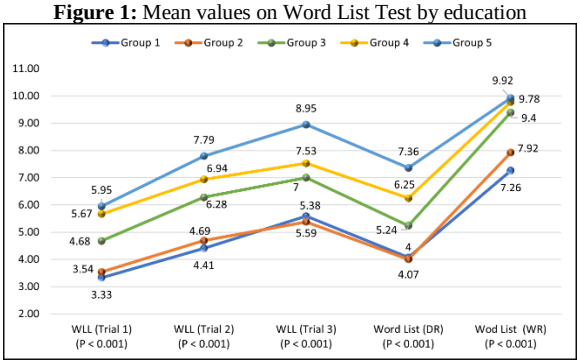

Figure 2: Mean values on Stick Construction Test by education

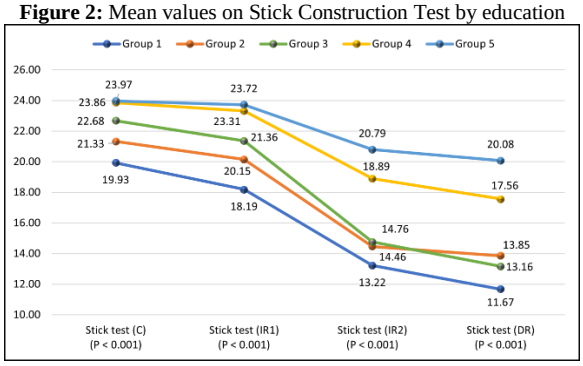

Figure 3: Mean values on Digit Span and Corsi Span by education

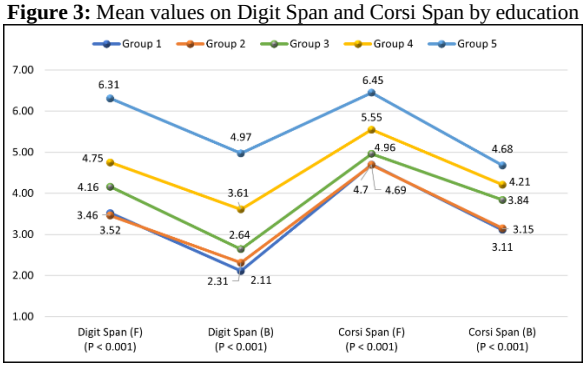

Figure 4: Mean values on Paired Association Test by education

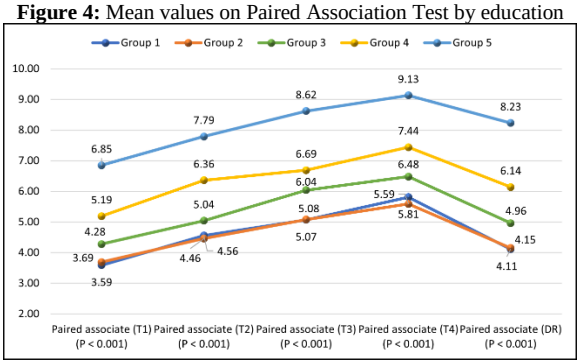

Figure 5: Mean values on Category Fluency by education

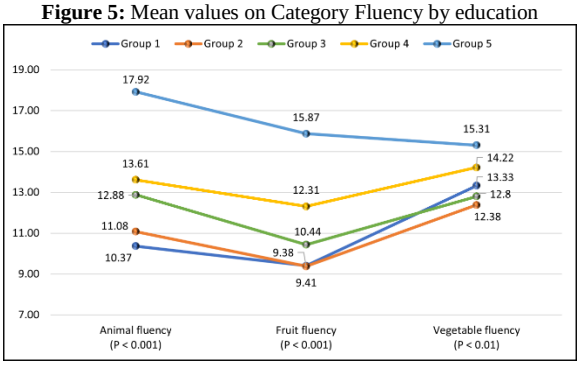

Figure 6: Mean values on Phonemic Fluency by education

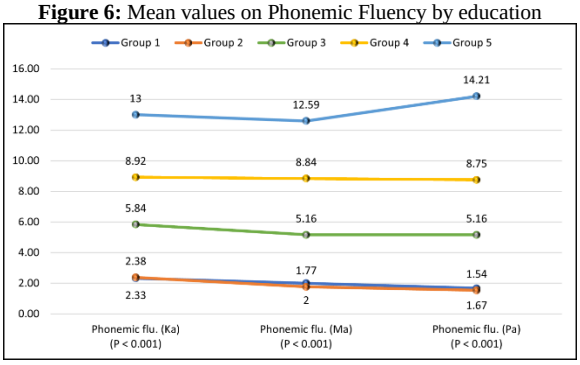

Figure 7: Mean values on Picture Memory Test by education

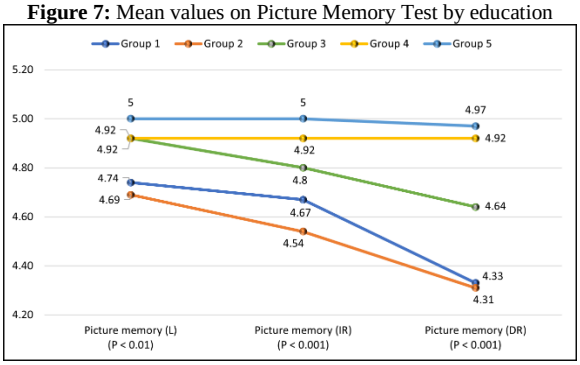

Figure 8: Mean values on Picture Naming and HMSE by education

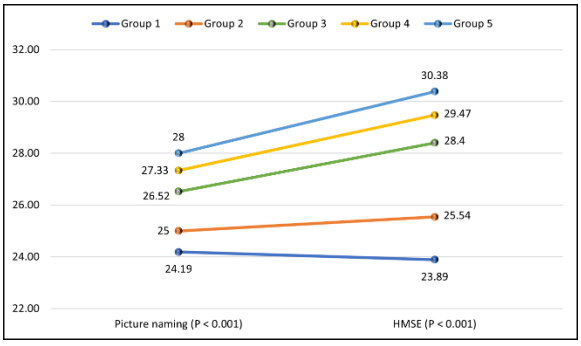

Figure 1 to 8 depicts mean, and significance level of participants with different educational experiences on different neuropsychological tests. As depicted in the figures, participants with higher education performed better on all the neuropsychological tests than their low educated counterparts i.e., Group 1 and group 2.

Findings of post-hoc analysis revealed that Group 5 performed significantly better on each neuropsychological measure than Group 4 and Group 3, Group 2 and Group 1. In Word list recognition and HMSE statistically significant difference between illiterate and low educated group (G2) were noted. Otherwise, G1 and G2 performed similarly on all the neuropsychological tests except word list recognition and HMSE total score, G1 & G3 on stick construction delayed recall, digit span test forward and backward, corsi block tapping test forward, paired association test trial 1, trial 2, trial 4, delayed recall, animal naming, fruit naming, vegetable naming, picture memory learning, G1 & G4 on vegetable naming, picture memory learning and immediate recall, G2 & G3 on stick construction learning, SC immediate recall 1, SC immediate recall 2, digit span forward & backward, corsi block forward & backward, paired association test trial1, trial2, trial3, trial4, delayed recall, animal naming, fruit naming, vegetable naming, picture memory test learning and delayed recall, G2 & G4 on animal naming, vegetable naming and picture memory test learning and immediate recall, G2 & G5 on picture memory test immediate recall, G3 & G4 on word list trial 2, trial 3, word recognition, stick construction learning, corsi block backward, paired association test trial 3, animal naming, fruit naming, picture memory learning, delayed recall and HMSE score, G3 & G5 on picture memory test learning, and G4 & G5 on word list test trial 1, word recognition, stick construction learning, SC immediate recall 1, SC immediate recall 2, corsi block backward, picture memory learning, delayed recall, picture naming and HMSE score.

DISCUSSION

Results of our study clearly showed that education plays an important role in determining neuropsychological test performance. Participants with higher education perform significantly better on selected tasks including attention and working memory (span tasks), learning and recall (Word list, Stick construction test, Picture memory test, Paired association test), fluency (Phonemic and semantic), naming (Picture naming) and construction (stick construction). Educated participants perform better than their low educated counterparts (Ardila et al.,2010; Tripathi et al., 2014; Rao et al., 2004; Mathuranath et al., 2003; Ganguli et al., 1996; Ostrosky-Solis et al., 1998) is well established finding. The organization and functioning of the brain are altered by reading and writing. (Stern, 2009) that might result in better performance on neuropsychological tests.

Our finding further supports the previous observation that the association between the education and neuropsychological test performance is nonlinear with

diminishing returns as education increases (Ostrosky-Solis et al., 1998). Said differently, the impact of education is seen significantly higher when comparison is made between high and low educated participants. However, a similar effect of education could not be observed while comparing educated participants (middle educated and higher educated). This could be due to the ceiling effect (Ostrosky-Solis et al., 1998), opportunity and stimulation related to test, test taking attitude and item validity in cultural context.

Interestingly, our study revealed that illiterate and low educated participants (educated up to 5 years) perform similar on several tests including attention and working memory (span tasks), learning and recall (Word list, Stick construction test, Picture memory test, Paired association test), fluency (Phonemic and semantic), naming (Picture naming) and construction (Stick construction). There are several reasons that could explain such findings. In this study, most of the illiterate and low educated participants are engaged in either the agricultural or informal sector that could provide similar cognitive stimulation. Several efforts have been initiated since independence to eradicate illiteracy among adults in India including social education and national literacy mission. Such efforts from the government are known to be proven beneficial as most of the uneducated participants could read and write their names in local language. In this study too, it was noted that several uneducated participants could read and write their name. Owing to the fact that illiterate and low educated participants have similar occupational and work environments and therefore perform similarly on cognitive tests. However, future studies are required to explore neurocognitive function in low educated participants. Our study clearly demonstrates that considering education as a proxy measure for level of literacy in our culture might be misleading especially in low educated participants.

Participants with low education (Group 2) and illiterate participants (Group 1) performed equally poor on most of the tests, especially on digit span, corsi block tapping test and phonemic fluency. We would like to recommend to avoid using span tasks and phonemic fluency with low educated participants. There is an urgent need to develop robust normative data on these tasks in future. Kosmidis et al. (2011) found that illiterate and functionally illiterate participants performed equally worse and similarly on digit span, spatial span, and sentence span. These findings support the findings of the present study. Tripathi et al. (2015) found that healthy older adults with lower education level performed poorly on corsi block tapping test, digit span and other neuropsychological tests. This is in line with the findings of the present study. It is interesting to note that our illiterate participants performed better on spatial span task than on digit span. It needs to be further examined in future studies. Those having attained some level of education may have been accustomed to recognizing stimulus on paper, whereas not having attained any education may mean that the person may heavily rely on environmental exposure in making calculations. Providing physical stimulus may improve the performance of the illiterate group due to familiarity. In our study, illiterate and low educated participants performed poorly on all neuropsychological tests. The possible reason behind poor performance could be lack of stimulating opportunities, tasks exposure and context inappropriate items.

Our study has certain constraints that should be considered. The sample size is very small and future study is required to examine impact of literacy on neurocognitive functions using larger populations. We have used years of education as a proxy to determine literacy levels. However standardized measures of literacy was not used in this study. In this study we have used HMSE and self-report to rule out presence of neurologic deficits that could not be sensitive enough to identify psychopathology, especially in low educated participants.

In conclusion, our findings extend the investigation of neurocognition and literacy in Indian participants. This study confirmed previous results indicating education can affect neuropsychological test performance. Our study clearly showed low education could adversely affect performance on several neuropsychological tests that may not necessarily imply neurocognitive impairment. There is urgent need to develop indigenous tools to assess neurocognitive functions for Indian population.

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