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Is Education Level a Modulation Factor of Cognitive Abilities in Older Individuals?

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Purpose: Similar to bilingualism, musical abilities, socio-economic status, and physical activities; education level also plays a contributing factor to cognitive reserve in an individual. Literature suggests that educational level and years of schooling enhance cognitive development and also show a correlation with better Intelligence Quotient. It is important to consider the level of education and its relationship with cognitive abilities particularly assessed on standardized cognitive tests which were not considered in earlier research.

Methods: The present study recruited 25 native Kannada speakers aged 50 to 70 years and divided them into two groups based on level of education (lower education and higher education group). All the participants were assessed on Cognitive Linguistic Assessment Protocol (CLAP)-Kannada (Kamath & Prema, 2001). The performance scores were tabulated and analyzed across all the domains of the test.

Results: Descriptive statistics highlighted that the higher education group had greater overall scores and also across the domains compared to their counterparts. Inferential statistics utilizing the Mann-Whitney U test found a significant difference between the two groups on overall performance and also across the domains with high effect size. Both groups performed poorly in the organization domain, attributed to task demands that need a greater level of processing skills.

Conclusions: The current study highlights that higher education levels influence better cognitive function and that this effect persists with age as compared to the lower education levels group indicating higher educational levels can help an individual to resist the effects of the aging process on cognitive function decline.

Keywords: Literacy, Cognitive functioning, Intelligence quotient, Aging

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INTRODUCTION

Across many nations, a very scarce proportion of individuals complete their higher education, particularly graduation. A few factors contributing to failure to complete graduation or higher educational degrees are due to lack of family support, financial affordability, and other individual factors like age, gender, socio-economic status, person's interest and so on. Owing to the cost of higher education, the majority of them ponder is it a worthwhile investment. On the brighter side, education may assist a person in engaging in tasks that allow them to use their conceptual knowledge to the greatest extent possible. It is implicitly assumed that education is not only important to enhance the range of achievements of their respective curriculum but also contributes to individuals' general and analytical skills holistically [1]. Consecutively, the level of education of an individual may invariably impact their cognitive abilities.

Higher education primarily offers the necessary qualifications for the job, but also strengthens individuals' critical thinking and preparation for life-long learning [2]. Certainly, Universities may provide enriched experiences that improve domain-general thinking and learning abilities such as thinking rapidly (processing speed), storing information (working memory), reacting flexibly to task goals (cognitive regulation), and handling novel issues (reasoning). These experiences may boost the individual's cognitive skills via learning, having a social life, being exposed to various environments, and a few other factors. In addition, the strength of education is also influenced by socio-contextual factors, individual's own actions and scholastic performance [3-5].

Education has a positive implication on measures of intelligence [6]. To understand the influence of education on cognitive abilities, it is essential to assess the cognitive skills concerning the extent of education level and not to focus on the tests mirroring their educational curriculum. Cognition and intelligence are two different entities, wherein cognition involves acquiring knowledge and it's an ongoing process through thoughts, experience, and the senses. Intelligence is known to be a quality of cognition, one of the measures of cognition reflecting the ability to learn, understand new things, and deal with new situations. Hence, there are many other aspects of cognition to be analyzed apart from mere intelligence quotient (IQ) assessment.

Education level also plays a contributing factor in cognitive reserve similar to bilingualism, musical abilities, socio-economic status, and physical activities [7,8]. Several aspects of cognitive performance deteriorate with age, and individuals with more cognitive reserve, regardless of its source, tend to show less age-related decline or protection from cognitive decline [9]. The education level may influence an individual's cognitive abilities. There is evidence that literate adults have enhanced cognitive skills such as immediate, concrete, and practical thinking, with limited reference to abstract and categorical relationships [10,11]. Also, there exists a positive correlation between education and measures of intelligence [6] and each year of schooling contributes to the increase of IQ [1]. Education, occupational intricacy, and cognitively stimulating leisure pursuits were shown to be favourably related to brain structure and improved cognitive performance, indicating that these may slow down the cognitive aging process and offset the negative impacts of neuro-degenerative processes.

Traditionally, cognitive abilities were assessed through various measures of IQ. Over the period, few longitudinal and quasi-experimental studies imbibed more abstract evaluations apart from comprehensive measures of IQ among the school-going population. Longitudinal studies conducted in Scandinavian nations, utilized the available data from obligatory military service and were analyzed. It was found that each completed year of secondary education translates into a gain of almost two to four IQ points in adolescence and early adulthood; and similarly, analyzed the available data from database and observed an average increase of four IQ score points for each year of schooling [12].

Another study [13] that looked at cognitive sub-domains by comparing individuals aged 70 years who had schooling up to 14 years and 15 years of their chronological age (data retrieved from the repository). It was found that individuals who had education till the age of 15 years performed better than their counterparts in executive and memory components of the task. The authors reported that the additional year of schooling enhanced specific cognitive abilities by almost 50% of the standard deviation. Ritchie, Bates, and Deary [14] in their study noted that the length or period of education significantly predicts the performance of cognitive control on tasks of reasoning and working memory in older adults but not the processing speed. Thus, these research studies' outcomes highlight that the magnitude of exposure to education tends to reflect differential regulated effects on various aspects of cognition. In the Indian context, a study [15] reported that levels of education affect the type of task and performance, where individuals performed significantly better in phonemic fluency task followed by category naming task across no education, five and ten years of education.

Overall, the aforementioned studies opine that education has a positive impact on reasoning and verbal skills, both being termed as sub-components of cognition [16,17]. Thus, the majority of the prior research works are based on the notion that improvements in cognitive skills are resultant of education and its length, as they involve repeated cognitive taxing and engaging coursework [18].

Cognitive abilities are essential in an individual to do an activity that may range from simple to complex. An individual's cognitive abilities are influenced by a variety of elements, including literacy, educational level, cultural background, environmental exposure, and the type of work they are involved in daily day-to-day basis. All of these factors may have a direct effect on an individual's use of cognitive abilities. In addition, education level may produce changes not only in a conversational style, but also in analytical thinking, reasoning, logical reasoning, predicting outcomes, and so on, resulting in changes in cognitive capacities.

There is a paucity of literature on the relationship between education level and cognition in the Indian context considering that it varies significantly. Given the wide range of educational attainment among different population segments, this is of utmost relevance. Consequently, a comprehensive investigation into the nature of cognitive capacities within distinct groups, characterized by varying levels of education, becomes imperative. This can be accomplished through the utilization of a standardized cognitive assessment test that effectively evaluates diverse components of cognition, including but not limited to attention and memory abilities. Furthermore, there is a need to assess in homogenous group based on factors such as the number of languages spoken (monolingual and multilingual) and the type of language exposure (e.g., Kannada (monolingual) versus Kannada/English/Hindi (bilingual/multilingual), Additionally, it is important to control for participants who have undergone training with a similar academic curriculum during their education in Indian context.

By delving into this area, the current study aims to illuminate and contrast the cognitive abilities of individuals belonging to two distinct strata: those with lower education levels and those with higher education levels. Furthermore, the findings from this study hold substantial promise for enriching the practice of speech-language pathologists (SLPs). By gaining insights into the intricate relationship between cognitive abilities and education levels across different dimensions, SLPs will be equipped with a range of strategies tailored to each specific group. This means that SLPs will possess distinct sets of reference values to identify and diagnose cognitive impairments within their respective groups.

A deeper comprehension of the intricate interplay between cognition and education also carries implications for the concept of cognitive reserve, particularly in the context of aging individuals. Unraveling the nuances of how education levels influence cognitive capacities can shed light on the concept of cognitive reserve, the brain's resilience built over years of cognitive challenges posed by higher education. This understanding becomes especially pertinent for the older population, emphasizing the potential benefits of lifelong learning and education in bolstering cognitive functions during the aging process.

METHODS

Participants

A total of 25 Kannada native speakers (Kannada is a Dravidian language that is primarily spoken in Karnataka state, South India) were recruited, ranging in age from 50 to 70 years ($M=56.8$, $SD=3.97$). Furthermore, these 25 individuals were divided into two groups: the lower education group (with minimum secondary education or less) comprising of 15 participants, and the higher education group (higher educational level, with gradation and/or above) comprising of 10 participants. All the participants were recruited for the study after the detailed evaluation concerning schooling, education, and lingualism. Further participant's socio-economic status scale [19] was computed.

The participants' nature of work was also categorized using Dictionary of Occupational Titles (DOT) revised–4th edition [20] by the US department of labour. DOT classifies occupation based on complexity with data, people and things in 9-digit code., wherein lowest score '0' or '1' reflects more complex jobs and highest score '9' reflects simple job. Thus, according to this classification by labour, the higher education group in the study were entitled to 'professional technical and managerial occupations,' which represented Doctors, Lawyers, professors, teachers, and sport trainers (with '0' or '1' complexity score). The participants of lower education group were entitled as 'structural and bench work occupations' representing security guard, factory workers, and farmers (with '8' as the complexity score.)

The participants recruited for lower education group met the following inclusion criteria; all were from government school; studied state syllabus in their formal schooling; all were from lower socio-economic status; all were low or below average achievers in their academic performance; showing lack of interest in reading; all individuals' family with poor education background; all individuals' peers with low education background; all were monolinguals; and belonged to 'structural and bench work occupations' group.

The participants enrolled in the higher education group met the following inclusion criteria: All underwent CBSE/ICSE syllabus in their formal schooling; all were from mid to higher socio-economic status; all were average or above average achievers in their schooling; all showed interest in reading; all their respective family members were educated through formal schooling; all their peers had good education background; all were bilinguals or multilinguals; and represented 'professional technical and managerial occupations' class of occupation.

Study design and subject sampling

In the present study, a standard group comparison research design was employed and participants were selected using a convenience sampling method.

Procedure

Participants were comfortably seated in the room with minimal or no background noise and with fewer visual distractions. As part of the exclusionary protocol, participants were subjected to MMSE [21] and WHO [22] screening checklist to rule out cognitive-linguistic deficits and to screen visual, hearing deficits respectively, and signs or history of neurological illness were also screened.

Further, both the lower education group and higher education group were assessed for detailed cognitive abilities through Cognitive Linguistic Assessment Protocol (CLAP)-Kannada [23]. All the sections of CLAP-K were administered, namely; attention, memory, problem solving, and organization. In addition, instructions for carrying out activity across the domains was followed as prescribed in the manual.

Scoring

Every task in all the sections (attention, memory, problem-solving, and organization) received a score of '0' and '1' for correct and incorrect response, respectively. The subtotals of each section were computed, along with a grand total for every participant. The scores of each participant from both the lower and higher education groups were averaged and appropriate statistical measures were applied to compare between-group performance differences.

RESULTS

The performance scores of participants were tabulated and subjected to statistical analysis using descriptive and inferential statistics. The statistical analysis was carried out in SPSS version 20. Initially, the data were subjected to a normality check using the Shapiro Wilk normality test. It was found data were non-normally distributed ($p<0.05$). Further, based on a visual inspection of a box plot and descriptive data, one participant's performance data was found to be an outlier from the lower education group. Hence, the detected outlier was removed and further analysis was performed.

The descriptive statistics are provided in Table 1. It was observed that the higher education group ($M=180.60$, $SD=8.04$) had a higher total score on the CLAP test than the lower education group ($M=153.85$, $SD=14.02$). The maximum scores documented by the higher education group versus the lower education group was 193 and 177, respectively. The minimum overall scores of higher education group versus the lower education group was 167 and 126, respectively.

With regard to domains of the CLAP test, the higher education group had greater mean scores across all domains compared to the lower education group. The performance across each domains of CLAP-K between groups is as illustrated in Figure 1.

As the data were non-normally distributed, non-parametric tests were used to compare the performance between the groups across domains of the test. The Mann-Whitney U test was utilized, and a significant difference was found between the two groups at p (alpha) value less than 0.05 level across all domains, attention (/Z/=2.85, $r=0.58$), memory (/Z/=3.15, $r=0.64$),

Table 1. Descriptive statistics of CLAP-K scores across groups

Domains	Group	Descriptive statistics			
		Mean	S.D	Minimum	Maximum
Attention	Lower education	52.85	4.16	47.00	60.00
	Higher education	57.80	1.98	55.00	60.00
Memory	Lower education	47.50	3.95	40.00	56.00
	Higher education	52.40	2.11	50.00	57.00
Problem solving	Lower education	40.71	8.74	25.00	56.00
	Higher education	52.30	5.03	45.00	60.00
Organization	Lower education	12.78	3.55	4.00	17.00
	Higher education	18.00	4.61	11.00	27.00
Total score	Lower education	153.85	14.02	126.00	177.00
	Higher education	180.60	8.04	167.00	193.00

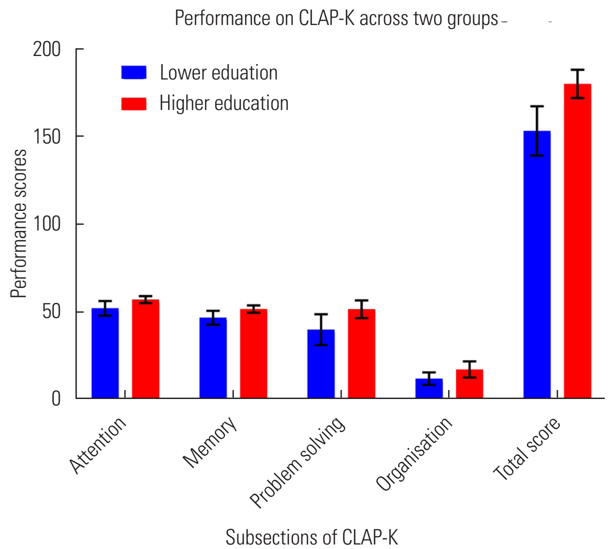

Figure 1. Performance scores of participants in CLAP-K across the groups.

problem-solving (/Z/=3.08, r=0.62), organization (/Z/=2.71, r=0.55), and overall performance scores (/Z/=3.86, r=0.78) on CLAP-K with high effect size (Field, 2005). Further, no significant (p>0.05) correlation was noted across domains of CLAP-K in both groups based on the Spearman correlation coefficient analysis.

DISCUSSION

The current research work investigated the cognitive abilities between lower education level group and the higher education level group using CLAP-K. The performance data were subjected to descriptive and inferential statistics. The findings of the present study noted the better performance in higher education group than in the lower educational group; this finding is in par with the study by G [18], who posited that higher education levels predicted better performance throughout that age range and moderate performance in some cognitive sections more than others (e.g., reasoning task vs processing speed). The present study results also align with the findings of [13], indicating years of education contribute to better cognitive abilities such as memory and executive domains. Further, both the groups had significantly poorer performance i n the subsection of the organization, which can be attributed to the task demands that involve a higher level of processing skills. In addition, both group of participants performed relatively better in attention, perception, and discrimination domain as the older age individuals can devote their exclusive attentional ability to a particular stimulus while ignoring the other when compared to younger individuals [24]. The current study findings are also in concur with [25] which observed education positively affect both crystallized and fluid abilities. Crystallized abilities refers to the skill the individual learned bearing to schooling. Fluid abilities refers to skill such as reasoning, problem solving, and conveying message appropriately to the context.

Furthermore, the higher education level group fared substantially better than their counterparts in the current study, who performed closer to ceiling level scores, when they are conventionally expected to perform poorer than younger counter parts. Despite this, the higher education level group outperformed the lower education level group due to the cognitive reserve associated with their education level. The current study observed that higher education levels have a greater influence on cognitive function and that this impact remains with age when compared to the lower education level group. The present study indicates that education level is imperative when assessing cognitive-linguistic aspects in neuro-typical individuals and those with communication disorders. Attaining high education level contributes to better general and some specific cognitive skills compared to a lower education level, as well as maintaining cognitive capacities in older age, that are prone to deterioration owing to the aging process. As a result, a higher education level can resist the influence of the aging process on the loss of cognitive function in an individual.

The study's limitations are a smaller sample size, which limits the generalizability of the results to the population; and the study did not control the factors like individuals who take medication for blood pressure, diabetes, etc.

Future research should look at the impact of education level on mild cognitive impairment, dementia, and so on. A combined strategy of behavioural and neuro-objective testing on this line would also offer a deeper insight on cognitive reserve, assessment, and management based on these characteristics. In addition, the relationship between parameters such as education level, socio-economic position, number of languages known, site of living (rural versus urban), and employment type should be investigated further in the Indian context.

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AUTHOR CONTRIBUTIONS

Dr. Darshan HS was responsible for designing, drafting and editing of the manuscript. Dr. Deepak P and Ms. Akshaya was responsible for editing and proof reading of the manuscript. Mr. Madhusudhan involved in data collection process.

CONFLICTI OF INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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