Original Article

Association between multilingualism and cognitive performance among older adults in rural southern India

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ABSTRACT

Objectives: Recent studies have shown that multilingualism may play an important role in enhancing cognitive health. The process of language acquisition constitutes a form of natural brain training, which in turn is hypothesized to increase neuroplasticity and hence, maintains the cognitive reserve. The study aimed to analyze the relationship between the number of languages known to an individual and its effect on cognitive functioning in both healthy and cognitively impaired study participants.

Materials and Methods: This study utilized cross-sectional (baseline) data from Srinivasapura Aging, Neuro Senescence and COGnition study, which is an ongoing community-based, longitudinal aging cohort study conducted in a rural setting in southern India. A total of 3725 participants were considered for the study. The participants were separated into two groups, namely, monolinguals (participants knowing one language) and multilingual (participants knowing more than one language). The cognitive performance of the participants was assessed using the Clinical Dementia Rating (CDR) Scale. In addition, bivariate analyses and binary logistic regression analyses were carried out.

Results: The result of CDR scores with respect to language category shows that, among the monolingual participants, 86.5% were healthy individuals and 13.5% were with mild cognitive impairment (MCI). Similarly, among the multilingual, 94.3% were healthy and 5.7% were with MCI. The odds ratio value derived from logistic regression (0.69 95% CI (0.5-0.9)) that an individual has a higher chance of developing cognitive impairment if he/she is a monolingual.

Conclusion: This study highlights that knowing more than one language might have a profound positive impact on cognitive health, thereby reducing the likelihood of developing cognitive decline.

Keywords: Cognition, Language, Multilingualism, Mild cognitive impairment

INTRODUCTION

Language, thoughts, and social interaction can be considered the key aspects of the development of cognition in humans.[1] Language acquisition has been studied extensively using techniques such as magnetic resonance imaging,[2] diffusion tensor imaging,[3] functional near-infrared spectroscopy[4], and magnetoencephalography,[5] which helps in studying the structural and functional changes in the brain associated with language acquisition. However, the direct association between language and cognition is still not established.

The cerebral hemisphere works in complement to each other. Two such areas that are responsible for language are "Broca's and Wernicke's areas." It is known that Broca's and Wernicke's areas are the language centers of the brain and are located on the language-dominant hemisphere, which is the left hemisphere in the majority of people. Broca's area is responsible for speech articulation and Wernicke's area is primarily involved in language comprehension.[6,7] When a word is heard or read, the information goes to the cortex, and from there the information goes to Wernicke's area. Wernicke's area is important with respect to language comprehension. The information from Wernicke's area is then passed onto Broca's area through white matter tracts called the arcuate fasciculus. The damage to any of these specific brain regions or all can result in speech impairment which leads to a condition called aphasia.

Many theories attempt to understand the origin of language development. According to Chomsky (1981), one of the pioneers in the field of linguistics, a child has an innate biological basis for learning a language – language association device. He also described the critical period of time at which language is acquired effortlessly and this critical period is generally before the child attains puberty.[8,9] However,

there will always be a considerable variation in the onset of language acquisition among different people. Despite this, subsequent languages learned after the native language cannot be learned in a way as to achieve native language-like proficiency. The frequency of usage of the language also has an important role with respect to the proficiency with which an individual is able to speak or understand the language.

Multilingualism can be defined as the ability of a person to read, write, or understand an additional language other than their mother tongue.[10] Multilingualism can strengthen executive functions as it plays a relevant role in inhibiting one language while focusing on the more relevant language. As a result, in a multilingual individual, the language systems tend to be active and competitive.[11]

Learning a new language affects the neuroplasticity that helps the brain in dealing with the increasing pathological changes before the onset of developing symptoms.[12] Knowing more than one language have protective effects on dementia and it helps in withstanding the onset symptoms of dementia like mild cognitive impairment (MCI).[13]

Although there is no clear definition of multilingualism, it is considered an ability of a person to manage more than one language regularly.[10] Therefore, in this study, a person who can speak, read, or understand more than one language is considered multilingual. The primary objective of this study was to analyze the impact of multilingualism as a protective factor in MCI, which is the prodrome of dementia.

MATERIALS AND METHODS

Study design

The study was cross-sectional, conducted in a cohort from Srinivaspura village called Srinivaspura Aging, Neuro Senescence and COGnition study (SANSCOG), which is an ongoing community-based, longitudinal aging study conducted in a rural setting in southern India.[14] The study site falls under the administrative area of Srinivaspura taluk which is located in the Kolar district, Karnataka, close to the border of an adjoining state, Andhra Pradesh.

Selection criteria

Participants aged 45 years and above, residing in Srinivasapura and enrolled in the SANSCOG cohort, whose baseline clinical and cognitive assessments were completed, were included in the study. Individuals diagnosed with psychiatric illness, substance dependence (except nicotine), or any serious medical condition were excluded from the study as it might interfere with their participation in this study. In addition, participants who have the inability to communicate due to significant hearing loss or visual impairment and participants consuming medications

that can have remarkable effects on cognitive functions (anticholinergic drugs, anti-Parkinsonian drugs, etc.) were also excluded from this study.[15,16]

Assessment tools

This study utilized two reliable measures of cognition. The first measure used was clinical dementia rating (CDR),[17] which is a validated global rating scale which is based on six different cognitive and behavioral domains such as orientation, memory, judgment and problem-solving, homes and hobbies, community affairs, and personal care.[18] Any participant with a CDR score of 0.5 is considered to have MCI. Self-reported information was considered for categorizing people between monolingual and multilingual.

Statistical analysis

The Chi-square test was used to check the association of CDR (CDR = 0 and CDR = 0.5) with respect to the language category (monolingual and multilingual).

In addition, a logistic regression analysis was performed wherein the CDR score was treated as a dependent variable with respect to the language category and age, gender, literacy, years of education, occupation, and socioeconomic status as independent variables. All analyses were done using the SPSS Software Version 28 (Armonk, NY: IBM Corp. Released 2021).

RESULTS

A total of 3725 participants from the rural cohort were considered for the study. Sociodemographic characteristic profile of monolinguals and multilinguals are provided in Table 1. The cognitive impairment was measured using CDR scores.

The CDR scores of 918 monolinguals and 2807 multilingual were compared with reference to the language category as shown in the Table 2. Out of 918 monolinguals, 794 (86.5%) were healthy and 124 (13.5%) were with MCI. Similarly, among 2807 multilingual participants, 2648 (94.3%) were healthy and 159 (5.7) were with MCI [Figure 1].

The logistic regression model of CDR scores with reference to the language category was calculated after adjusting for age, gender, occupation, years of education, literacy, and socioeconomic status. The odds ratio is 0.69* 95% CI (0.5-0.9), which implies that monolinguals are more likely to develop MCI, when compared to multilinguals as given in Table 3.

DISCUSSION

This study aimed to analyze the influence of knowing more than one language on the cognitive performance of individuals

from rural cohorts. In this study cohort, multilingual performed better in cognitive tasks when compared to monolinguals. The majority of the participants who developed MCI were monolinguals. Therefore, the present study suggests that multilingualism has an advantage over monolingualism.

An individual is considered to be multilingual when he/she can communicate in more than one language which is speaking, reading, writing, or simply understanding the language. Cognitive reserve is maintained in multilingual by the active use of different languages known to the individual.[19] Since multilingualism has a relevant role in neuroplasticity, it helps in delaying the onset of MCI by coping with changes in the brain. The poor performance of monolinguals in cognitive tasks could be due to the correlation with non-linguistic task-switching ability which might be improved in multilingual allowing for greater cognitive reserve.

A similar study on the influence of bilingualism on the prevalence of dementia and MCI by Papilikar *et al.*[20] suggests that bilingualism can act as a potential protective factor in delaying the onset of dementia and MCI. The result of the present study is in contrast with a previous meta-analysis which identified a small advantage in global cognitive performance in bilinguals compared to monolinguals, especially in older adults with MCI.[21] However, there have also been studies that reported otherwise. One study on the Australian Longitudinal Study of Ageing cohort found that bilinguals had poorer MMSE scores at baseline than monolinguals but the difference was not significant on subsequent follow-ups. However, this study was done on monolingual societies, which might as well imply that they were not active users of their alternative languages.[22]

The capacity to perceive and comprehend a second language is associated with the subcortical regions (like the basal ganglia) of the brain, which is thought to be activated during verbal fluency tasks.[23] This might enhance the cognition and sensory processing in multilingual individual, which, in turn, helps them in processing the information better than monolinguals. Therefore, the positive influence on attention and problem-solving tasks due to multilingualism can act as a protective factor in cognitive impairment, thus delaying the onset of disease progression.

India is facing challenges with an increasingly older population in the country. The prevalence of dementia in India is predicted to increase by 20% in 2050.[24] India has an exceptional language diversity with inhabitants speaking hundreds of different indigenous languages. Therefore, India being a country rich in linguistic diversity, there is always a scope for exploring the associated protective effect of multilingualism as a determinant in cognitive performance. In light of this future, it is very important to study the role of such a relevant potential confounder with the risk of developing dementia.
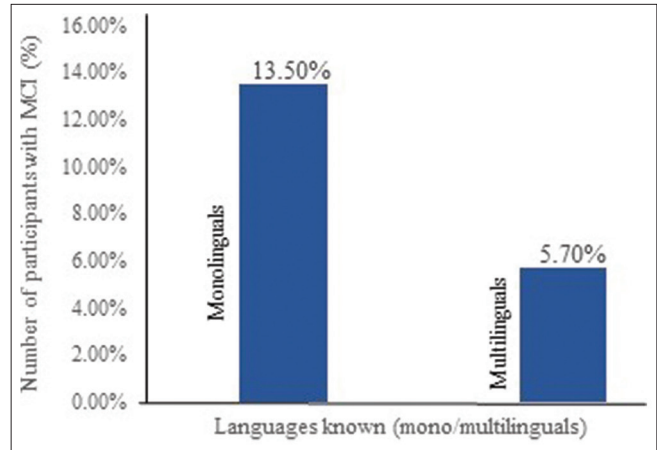
Figure 1: Distribution of MCI for monolinguals and multilinguals. MCI: Mild cognitive impairment.

Table 1: Sociodemographic characteristics for monolinguals and multilinguals

Monolinguals		Multilinguals
Age	61.34 ± 9.30	57.58 ± 9.69
Years of Education	1.05 ± 2.41	5.81 ± 4.76
Gender Distribution		
Female	68.30%	46.80%
Male	31.70%	53.20%

Table 2: CDR scores with respect to language category

Monolinguals		Multilinguals
Healthy (CDR = 0)	794 (86.5%)	2648 (94.3%)
MCI (CDR= 0.5)	124 (13.5%)	159 (5.7%)
Total	918	2807

*Chi-square test, MCI: Mild cognitive impairment, CDR: Clinical dementia rating

Table 3: Logistic regression for CDR scores with reference to the language category

Language Category	Unadjusted OR	Adjusted OR
Monolinguals	1	1
Multilinguals	0.39	0.69*
	95% CI (0.3-0.5)	95% CI (0.5-0.9)

*Adjusted OR derived from the logistic regression predicting CDR category adjusted for age, gender, years of education, literacy, occupation and socioeconomic status, OR: Orientation, CDR: Clinical dementia rating, CI: Cognitive impairment

This is a cross-sectional study involving a large sample size. The cognitive performance was assessed using CDR, which is a widely used tool to assess the severity of dementia. This study has its own limitations with respect to not having adequate information about the proficiency with which the participants understand

the language. Although the study shows multilingual advantage, there is an absence of strong evidence to support the same.

Based on our study, some future directions can be offered. First, more cognitive tests can be considered that specifically scores the different language domains like pragmatics, phonology, syntax, morphology and semantics. Second, the role of different basic components of language on cognitive performance can be particularly considered. Furthermore, the age of acquisition, what are the different languages known to the participants and the similarities and differences between the different languages known to them can be important aspects to be looked into.

Although multilingualism alone is not an indicator of cognitive advantage, it can be considered as one of the protective factors against cognitive decline. Further studies have to be conducted to provide firm evidence for the same.

CONCLUSION

The effect of multilingualism on cognition is still an area under research. Previous studies on multilingualism and cognition indicated that knowing more than one language can have an influence on executive functioning. The evidence from our study suggests that multilinguals performed better in cognitive tasks when compared to monolinguals. This indicates that multilingualism essentially strengthens the cognitive reserve. Understanding the neural basis of language processing and acquisition can provide strong evidence for the same.

Ethics clearance and informed consent

The SANSCOG study has the approval from the Institutional Ethics Committee, Centre for Brain Research, Indian Institute of Science. A written informed consent was obtained from the participants before recruiting in the study. The ethics approval date is 30 June 2017.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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