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Distinct educational level effect on general cognition between two geopolitical regions

Efeito do nível educacional distinto na cognição geral entre duas regiões geopolíticas

Efecto del nivel educativo distinto en la cognición general entre dos regiones geopolíticas

Laiss Bertola - ORCID - Lattes

Cândida Alves - ORCID - Lattes

Sandra Cristina Marques Santos - ORCID - Lattes

Rafaela Teixeira de Ávila - ORCID - Lattes

Maria Aparecida Camargos Bicallho - ORCID - Lattes

ABSTRACT:
Introduction: Low- and middle-income countries usually have larger heterogeneity in education quality, a reflection of complex socioeconomic and cultural diversity. Education is known to impact neuropsychological assessment, and tests norms usually are grouped by years of education. Disparities in education effect on cognition might result in diagnosis errors. **Objective:** We aimed to compare the effect of education on general cognition in older adults from two Brazilian geopolitical regions. **Method:** 125 northeast (NE) healthy older adults (mean age=70.08±7.76 years, 66% female) and 115 southeast (SE) (mean age=72.39±8.09 years, 76% female), with equal education range (1-19), mean and variance (p=0.52). All participants performed the Dementia Rating Scale (DRS-Mattis), and the residual variance (regressed on age) was used. We divided education into three achieved levels: primary (1-4 years), elementary-to-high school (5-11 years) and undergraduate (equal and higher than 12 years). **Result:** We found a distinct effect of education according to geopolitical region for episodic memory and visioconstruction ability. Comparing simple effect sizes for educational level by region, there is a medium effect (r=0.30) for

the primary level between regions, having the NE group a significantly lower performance. **Conclusion:** Education effect on general cognition is similar for both regions, but older adults with primary level have significant distinct performance depending on their region. Primary education inequality might be related to other socioeconomic factors presented across country regions. We highlight the necessity of representative samples in heterogeneous countries as Brazil, in order to avoid clinical assessment errors when using restrict national norms.

Keywords: education, disparity, cognition, old adults.

RESUMO:
Introdução: Países em desenvolvimento apresentam maior heterogeneidade na qualidade educacional, um reflexo da complexa diversidade socioeconômica e cultural. Sabe-se que a escolarização afeta o resultado em testes neuropsicológicos, e as normas desses instrumentos, geralmente, são divididas por anos educacionais. Diferenças no efeito da educação sobre cognição podem resultar em erros de diagnóstico. **Objetivo:** O presente trabalho objetivou comparar o efeito da escolarização sobre a cognição geral em idosos de duas regiões geopolíticas. **Método:** 125 idosos saudáveis provenientes do nordeste (NE) e 115 do sudeste (SE), com similar alcance, média e variância do nível educacional (p = 0,52) realizaram a Escala de Avaliação da Demência (DRS-Mattis). A variância residual desse instrumento, após regressão do efeito de idade, foi utilizada nas análises. A educação foi dividida em ensino primário (1-4 anos), ensino fundamental-médio (5-11 anos) e graduação (³12 anos). **Resultado:** Observou-se efeito distinto da educação, de acordo com a região, para a memória episódica e visioconstrução. Comparando os tamanhos de efeito simples para o nível educacional por região, há um efeito médio (r = 0,30) para o nível primário, tendo o grupo NE um desempenho significativamente menor. **Conclusão:** O efeito da educação na cognição geral é semelhante nas duas regiões, mas os idosos com nível primário têm desempenho significativamente diferente dependendo de sua região. Desigualdade na educação primária pode estar relacionada a outros fatores socioeconômicos apresentada por cada região. Destacamos a importância de se estudar amostras representativas em países heterogêneos como o Brasil, evitando erros de avaliação clínica ao usar normas restritas.

Palavras-chave: educação, disparidade, cognição, idosos.

RESUMEN:
Introducción: Los países de ingresos bajos y medianos suelen tener una mayor heterogeneidad en la calidad de la educación, un reflejo de la compleja diversidad socioeconómica y cultural. Se sabe que la educación influye en la evaluación neuropsicológica, y las normas de las pruebas generalmente se agrupan por años de educación. Las disparidades en el efecto de la educación sobre la cognición pueden dar lugar a errores de diagnóstico. **Objetivo:** Nuestro objetivo fue comparar el efecto de la educación sobre la cognición general en adultos mayores de dos regiones geopolíticas brasileñas. **Método:** 125 adultos mayores sanos del noreste (NE) (edad media=70,08±7,76 años, 66% mujeres) y 115 del sureste (SE) (edad media=72,39±8,09 años, 76% mujeres), con igual rango de escolaridad (1- 19), media y varianza (p=0,52). Todos los participantes realizaron la Dementia Rating Scale (DRS-Mattis), y se utilizó la varianza residual (regresión por edad). Dividimos la educación en tres niveles alcanzados: primaria (1-4 años), primaria a secundaria (5-11 años) y licenciatura (igual y superior a 12 años). **Resultado:** Encontramos un efecto distinto de la educación según la región geopolítica para la memoria episódica y la capacidad de visioconstrucción. Comparando tamaños del efecto simples para el nivel educativo por región, se encuentra un efecto medio (r=0.30) para el nivel primario entre regiones, teniendo el grupo NE un desempeño significativamente menor. **Conclusión:** El efecto de la educación sobre la cognición general es similar para ambas regiones, pero los adultos mayores con nivel primario tienen un desempeño significativo distinto según su región. La desigualdad en la educación primaria podría estar relacionada con otros factores socioeconómicos presentados en todas las regiones del país. Destacamos la necesidad de muestras representativas en países heterogéneos como Brasil, para evitar errores de evaluación clínica al utilizar normas nacionales restrictivas.

Palabras clave: educación, disparidade, cognición, ancianos.

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Introduction

Low-and middle-income countries (LMIC) host the majority of older adults with dementia or at higher risk for pathological aging [1, 2]. In 2018, 66% of all people with dementia live in those countries and is estimated that this proportion will increase to 71 or 72% by 2050 [3]. These countries face higher within socioeconomic heterogeneity that can directly affects the generalization of studies results that use only part of these populations.

Brazil is a wide LMIC with 26 states divided into five geopolitical regions with important socioeconomic inequity [4]. This inequity is expressed, for example, in average income, education level and quality, and health access disparities. Lower education level is broadly associate with worse baseline cognitive status [5-8], and increased dementia incidence and prevalence [9-12].

Within Brazil, the northeast region experience lower socioeconomic status and education level (with 35% of adults with less than 4 years of schooling) [13] On the other side, the southeast region is the one with higher socioeconomic status and education level (with 15% of adults with less than 4 years of schooling) [13].

The southeast region produces the majority of national studies about aging and standardization for countrywide used neuropsychological tests. This pattern results in studies that does not consider the profile of the entire nation, increasing the risk of older adults from disadvantage regions being misdiagnosed based on norms from the southeast region, as already shown in other countries.

Despite the financial challenge to recruit a national representative sample, some studies have shown that this issue is essential, once subjects from distinct regions might have significant difference in test performance [14].

A common solution is to combine some subjects from distinct geopolitical regions under the same group based on age and educational level. The puzzling with this solution is that the quality of education might not be the same when dealing with a country with sociocultural disparities, resulting in subjects with the same number of years of education, but with inequal return on cognition [6, 15, 16, 17].

Educational condition and quality are known to be discrepant across Brazil's regions [18, 19], and this should promote awareness in cognitive assessment. However, it is not broadly common to evaluate the effect of this difference across these geopolitical regions prior to using completed years of schooling as parameter for homogenous cognitive achievement.

To verify possible disparities in education effect on cognition that might lead to incorrect cognitive impairment diagnosis, we aimed to compare the effect of education on older adults´cognition from two Brazilian geopolitical regions (northeast and southeast).

Methods

Participants

The present study has a cross-sectional design. Two hundred and forty healthy Portuguese-speaking Brazilian older adults were recruited on the basis of preserved general cognition, absence of current psychiatric symptoms, and absence of self-reported neurological disease history. Active recruitment took place in two urban cities from two geopolitical regions (Belo Horizonte, state of Minas Gerais at the Southeast region and São Luis, state of Maranhão at the Northeast region).

Participants were recruited between 2014 to 2018, from public Health System as outpatients, from the general community, from groups of government programs (i.e., public activity groups for older adults), and retirees' groups (i.e., groups of retired workers from a public institution). All participants underwent a clinical interview and neuropsychological assessment conducted by a neuropsychologist.

The assessment comprised three stages: 1) a clinical interview designed to exclude subjects with neuropsychiatric disorders, or other self-reported diseases with impact on cognition; 2) a cognitive screening to exclude those subjects with possible pathological cognitive decline; and 3) a specific cognitive assessment to compose a normative sample for a instrument under standardization [20, 21].

Participants were assigned to two region groups based on their local of recruitment and residence address (Southeast–SE and Northeast–NE), and assign to three educational levels based on years of formal education.

For this study illiterates were excluded. The three educational levels were determined based on the national legislation of schooling for these cohort of older adults. Those who studies 1 to 4 years were assign to the primary educational level, those who studies 5 to 11 years were assign to the elementary educational level, and those who complete high school and/or experienced undergraduate degree (12 or more years) were assign to the high educational level. The absence of cognitive scores discrepancies between possible subgroups of elementary education (5-8 years and 9-11 years) subsidized the decision to keep those participants at the same educational level group.

The Universidade Federal de Minas Gerais (UFMG) ethics committee approved this study (CAAE-26795714.4.0000.5149), which was conducted in accordance with the ethical rules for human experimentation stated in the Declaration of Helsinki. All participants gave written consent.

Assessment

All the participants performed the Dementia Rating Scale (DRS) as a screening cognitive assessment. This instrument was design to assess briefly the domains of episodic and semantic memory, attention, executive function and constructional praxis and has been adapted and psychometrically studied to the Brazilian population [22, 23].

For this study we used all five partial scores of Attention (DRS-AT), Initiation/Perseveration (DRS-IP), Construction (DRS-CT), Conceptualization (DRS-CC) and Memory (DRS-MM), and also the total score (DRS-TT). The socioeconomic status (SES) information was acquired using a standardized national survey [24].

Statistical Analysis

Groups were compared according to sociodemographic characteristics and cognitive performance. Even though the region x education groups did not differ on mean age, we regressed the cognitive scores form DRS on age in order to reduce its effects upon the results. The age standardized residual from all DRS measures were used for path analysis.

We performed a basic multiple group moderation path analysis in order to assess the interaction effect between region and education upon cognition. This model was designed to verify the difference between the effects for the two regions. We used a maximum likelihood estimator with bootstrapping. Bootstrapping offers non-symmetric confidence intervals, an important specification for possible non-normal distributions parameter estimates and, particularly, for small samples.

We also performed a simple effects ANOVA analysis to break down interaction effects for each educational level and analyze the effects sizes for each educational level across region. The analysis were performed using the SPSS [25] and Mplus software's [26].

Results

Table 1 summarizes groups descriptive data. Group comparison between educational group by region revealed that SE and NE subjects did not differ in mean age and sex distribution. Socioeconomic status (SES) differ only between the low educated group (1-4 years between the SE and the NE).

DRS performance was different, except for Conceptualization partial score, across regions for the low (1-4 years) and medium (5-11) educated groups, having the SE older adults higher scores than the NE counterparts. Between the high education groups there was a difference only for the Initiative/Perseveration partial score having the SE older adults a higher score than the NE counterparts.

Basic multiple group moderation path analysis revealed that the interaction effect between region and education is significant for Construction and Memory (Table 2).

Simple effects analysis to the interaction effects for each educational level revealed moderated effects for low (1-4 years) education across regions for the total DRS score (Table 3 and Figure 1). Also, for most single effects the low education group showed higher effect sizes when compared to the medium and high education groups.

Considering that the low education groups had a discrepant SES level, we performed a basic moderation analysis using this variable as a moderator between the effect of region on cognition only for the low education group. This analysis showed that there was no simple or interaction effect between SES and region upon cognition (data not shown).

Discussion

Our study aimed to verify if education level would distinctly impact cognition based on the participants geopolitical region. The main result highlights that education does have distinct impact on visuoconstruction ability and episodic memory depending from which Brazilian region the participants is originated. Also, our results indicated that these effects are higher for the low educated subjects (1-4 years of schooling).

Primary school is known to cause the highest impact on cognitive abilities changing the brain connectivity [27, 28, 29] and how to solve problems and process information [30, 31].

National education quality data reveal disparity on learning and proficiency across the country, in which the north and northeast regions still present lower achievement than the south and southeast regions [32].

Disparities on education quality during the first years of schooling might be related to the higher geopolitical region effect on cognitive performance in our scenario. Also, the socioeconomic disparity might contribute to distinct early life condition that are known to impact late life cognition, as maternal education, access to books, and nutrition to list some examples [33, 34, 35, 36, 37, 38, 39, 40].

The effect reduction after more years of schooling might indicate that more years homogenizes the impact of education quality, but also, it can be a consequence of selection bias. The Northeast and North geopolitical regions still suffer from higher early school dropping (comparing to the Southeast) before the elementary full cycle is completed (8 years of schooling) [13].

If we assume the same cultural situation (or even more expressive) probably happened for this cohort of older adults, the students that persisted on higher levels of schooling might have higher intellectual interests or better early life socioeconomic conditions. This reality would open to them a potential cognitive improvement during the following years of education. Unfortunately, the absence of these information is a limitation for our study.

Only episodic memory and visuoconstruction abilities were distinctly impacted by educational level based on geopolitical region. The DRS Construction subscale is a black-and-white pencil and paper copying task. It is known education level does affect process of white background and

black lines interaction [15, 30, 31]. Education quality is also known to impact episodic memory achievement in tasks [6, 16, 40], but not necessary in daily life.

Our study did not included measures of education quality once this was not the first aim of the research project that these participants originated. We also were not able to control if all participants received formal education in their actual geopolitical region of residence. These limitations should be addressed in future studies proving more control for results and enabling more generalization and interpretation of results.

Our finding reinforces prior work that highlights the importance of being aware and, ultimately, measuring and controlling for quality of education in countries with socioeconomic and cultural diversities. This address caution in comparing subjects based on standard patterns validated for a specific geopolitical region from a large and diverse country. This is especially important considering that years of formal education are known to impact scores and, the number of years does not necessarily reflect the quality of education.

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Table 1. Descriptive data and group comparison

	Southeast (SE)			Northeast (NE)		
	1-4 (n=31)	5-11 (n=55)	12+ (n=26)	1-4 (n=26)	5-11 (n=76)	12+ (n=24)
	M (SD)					
Age	74.48 (7.18)	70.72 (7.41)	66.96 (8.00)	71.23 (7.73)	69.06 (7.38)	67.25 (5.60)
SES	22.74 (6.40)*	22.87 (5.82)	33.96 (9.89)	18.30 (5.21)*	23.65 (8.81)	33.66 (9.52)
DRS-AT	35.20 (1.53)*	35.98 (1.00)*	36.07 (0.89)	33.21 (2.74)*	34.86 (2.76)*	35.16 (2.82)
DRS-IP	33.38 (3.09)*	34.87 (2.61)*	36.23 (1.90)*	31.61 (3.53)*	32.46 (3.80)*	34.95 (2.13)*
DRS-CT	5.55 (0.89)*	5.90 (0.44)*	6.00 (0.00)	4.73 (2.16)*	5.53 (1.42)*	6.00 (0.00)
DRS-CC	32.29 (4.12)	33.65 (3.51)	36.34 (2.48)	31.07 (4.98)	34.46 (4.93)	36.37 (4.14)
DRS-MM	22.23 (1.92)*	22.96 (1.88)*	23.53 (1.79)	19.34 (4.91)*	21.82 (3.25)*	23.12 (2.09)
DRS-TT	128.67 (6.02)*	133.34 (5.76)*	138.15 (3.96)	120.03 (12.43)*	129.16 (9.49)*	135.62 (6.41)
	N (%)					
Female	26 (76.5)	43 (78.1)	19 (73.1)	15 (57.7)	47 (61.8)	22 (91.6)

Subtitle: * p<0.05 for groups comparison across educational groups by region. Socioeconomic Status (SES); Dementia Rating Scale (DRS) and partial scores of Attention (DRS-AT), Initiation/Perseveration (DRS-IP), Construction (DRS-CT), Conceptualization (DRS-CC) and Memory (DRS-MM) and total score (DRS-TT).

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Table 2. Multiple group moderation path analysis for interaction effect between region and education upon cognition

	Estimate *b*	CI 95%	S.E.	*p-value*
DRS-AT	-0.120	-0.335;0.144	0.123	0.329
DRS-IP	-0.058	-0.212;0.094	0.077	0.454
DRS-CT	-0.208	-0.421;-0.020	0.102	0.041
DRS-CC	-0.053	-0.264;0.169	0.111	0.636
DRS-MM	-0.239	-0.474;-0.007	0.118	0.042
DRS-TT	-0.188	-0.389;0.017	0.103	0.068

Subtitle: Dementia Rating Scale (DRS) and partial scores of Attention (DRS-AT), Initiation/Perseveration (DRS-IP), Construction (DRS-CT), Conceptualization (DRS-CC) and Memory (DRS-MM) and total score (DRS-TT). CI: confidence interval; S.E.: standard error.

Table 3. Simple effects and effect sizes (*df* = 234)

	DRS-AT	DRS-IP	DRS-CT	DRS-CC	DRS-MM	DRS-TT
1-4 years						
F	12.157	4.543	8.763	1.816	19.867	22.607
p	0.001	0.034	0.003	0.179	0.000	0.000
r	0.222	0.140	0.190	0.087	0.280	0.300
5-11 years						
F	8.362	20.893	3.919	0.822	6.929	11.445
p	0.004	0.000	0.050	0.366	0.009	0.001
r	0.185	0.286	0.130	0.060	0.170	0.215
12+ years						
F	2.155	2.159	0.021	0.035	0.805	2.440
p	0.143	0.143	0.886	0.852	0.371	0.120
r	0.095	0.095	0.010	0.012	0.060	0.101

Subtitle: Dementia Rating Scale (DRS) and partial scores of Attention (DRS-AT), Initiation/Perseveration (DRS-IP), Construction (DRS-CT), Conceptualization (DRS-CC) and Memory (DRS-MM) and total score (DRS-TT); *p* significant; *r* effect size.

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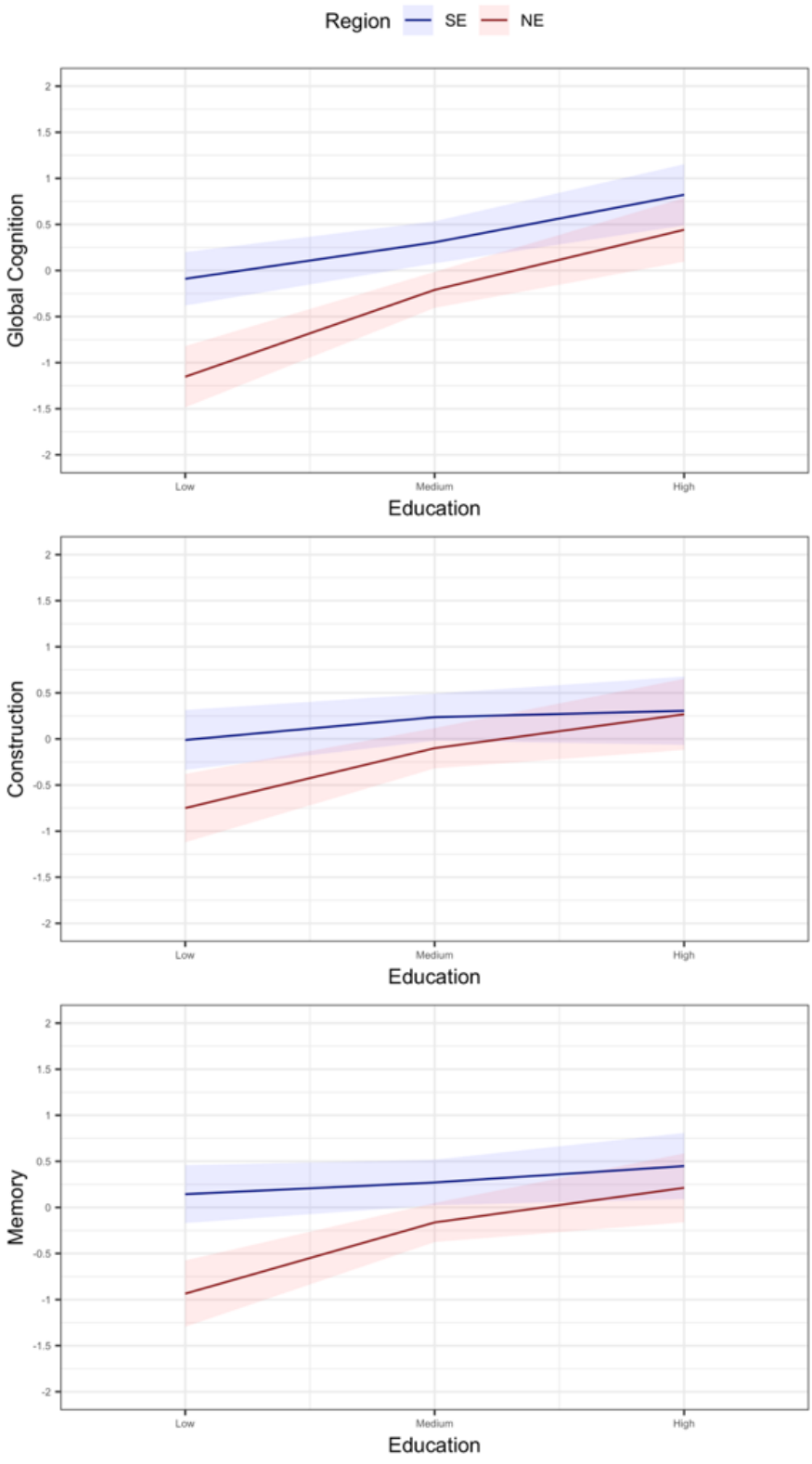

Figure 1. Interaction effect between education and region upon cognition. SE: southeast (blue); NE: Northeast (red). Low: 1-4 years; Medium: 5-11 years; High: 12+ years. Global Cognition: Dementia Rating Scale (DRS) total score; Memory: DRS Memory partial score; Construction: DRS Construction partial score. Line represents the effect and shading represents the upper and lower 95% confidence interval.

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