Sudeshna Roy
Research Student, Department of Home Science, University of Calcutta, Kolkata, West Bengal, India

Paromita Ghosh
Professor, Department of Home Science, University of Calcutta, Kolkata, West Bengal, India

Role of educational attainment of elderly persons in their cognitive efficiency: Testing the cognitive reserve hypothesis

Sudeshna Roy and Paromita Ghosh

Abstract
The study aimed to find the influence, if any, of educational attainment of elderly persons on their extents of cognitive efficiency. Stratified random sample of 320 non-institutionalized late adults (aged 60-90 years) of middle socio-economic status families in Kolkata was selected. Socio-economic status was inferred from the previous and / or current occupation of the participants / their spouse. The sample comprised 160 female and 160 male elderly. 64 each of the participants were – a) educated up to school level; b) professional diploma / certificate-holders; c) graduates; d) post-graduates; and e) professional degree-holders. General Information schedule was administered to gather background information from participants. P.G.I. Battery for Assessment of Mental Efficiency in the Elderly [8] was administered to assess participants' extents of cognitive efficiency in terms of rapidity of mental functions; general orientation and information; percept and motion equity; and depression. Mean and Standard Deviation values were computed. One-Way ANOVA was conducted. Results indicated significant influence of educational attainment of the elderly on their rapidity of mental functions. But in general orientation and information; percept and motion equity; and depression, the effect of education was not significant. Thus the "cognitive reserve" provided by education seems to be domain-specific in effect and not pervasive as widely thought.

Keywords: elderly persons; educational attainment; cognitive efficiency; cognitive reserve hypothesis

1. Introduction

The United Nations regards chronological age of 60 years as entry point of old age. However developed countries generally consider those individuals as elderly who are at least 65 years of age [16]. Investigators studying the role of education in cognitive functioning of the aged are mired in a debate on the adequacy of the Cognitive Reserve Hypothesis. The hypothesis posits that long-term and intense involvement in the process of education imparts individuals with a cognitive reserve (i.e. greater brain volume and dense interconnections of synapses) which protect the cognitive efficiency of the highly educated persons against geriatric decline [6, 7]. Most investigators in the field have presented evidences affirming the proposition of the Cognitive Reserve Hypothesis but a minority of researchers has dissented. So it would remain a vibrant area of research until the controversy is resolved. A brief overview of researches follows. Goswami *et al.* (2006) [5] found that variables including being illiterate were significantly related with cognitive defect for a sample of rural elderly in India. Ganguli *et al.* (1999) [2] conducted a study on elderly Indians who were mostly illiterate. Greater number of symptoms of depression was related with older age and illiteracy. Among illiterates, no gender difference in depression emerged. In literates, higher depression scores were found among women. Cognitive impairment and functional disability appeared to be independently related with higher depression scores after adjusting for age, gender and literacy of the sampled elderly. Evans *et al.* (1993) [1] revealed that low educational attainment predicted cognitive decline. They reported that elderly with fewer years of formal education had greater declines in cognitive functioning. Giri *et al.* (2016) [3] found the less educated elderly to be manifesting significantly more cognitive impairment. Park *et al.* (2013) [11] concluded that more years of schooling of elderly individuals was found to be significantly associated with decreased probability of cognitive impairment among them.

Correspondence
Sudeshna Roy
Research Student, Department of Home Science, University of Calcutta, Kolkata, West Bengal, India

Scarmeas and Stern (2004) [12] reviewed researches and opined that higher education and occupational attainment as well as increased participation in intellectual, socio-physical aspects of daily life were associated with slower cognitive decline in healthy elderly and might reduce the risk of Alzheimer's diseases. Tucker and Stern (2011) [14] also reported that persons with higher IQ and educational level experience less cognitive decline in old age as cognitive reserve comes to their aid. Wang et al. (2017) [15] reported that recurring contact with cognitive-reserve increasing factors during the life-course was associated with lower possibility of developing Dementia in late life even among individuals who were genetically vulnerable.

But some researches (e.g.Glymour et al., 2012; Mamatha, 2014) [4, 10] are challenging such claims. Glymour et al. (2012) [4] found small and domain-specific advantages of education on cognitive capacity for a sample of 4480 elderly. Mamatha (2014) [10] reported non-significant association between educational attainment of a sample of elderly individuals in India and their mental efficiency. It appears from the brief overview of pertinent researches that there is controversy regarding whether educational attainment of elderly persons really influence their extents of cognitive efficiency by acting as safeguards against cognitive decline. The present study attempts to help resolve the controversy.

2. Research Objectives
To find the influence, if any, of educational attainment of elderly persons on their extents of cognitive efficiency.

3. Methodology
3.1 Hypotheses
1. There is influence of educational attainment of elderly persons on their extents of rapidity of mental functions.
2. There is influence of educational attainment of elderly persons on their extents of general orientation and information.
3. There is influence of educational attainment of elderly persons on their extents of percept and motor equity.
4. There is influence of educational attainment of elderly persons on their extents of experienced depression.

3.2 Operational Definitions
i) **Educational attainment:** Here, it refers to the qualifications (degrees, diplomas etc.) that an individual has attained.

ii) **Cognitive efficiency**: It is the speed and precision of an individual's information-processing capacity. It encompasses memory capacity, alertness, ability of concentration, general orientation to time and place, general awareness, perceptual-motor functions (including depth perception and muscular co-ordination), motivation and extent of depressive symptomatology [8, 13]. Cognitive efficiency might be conceived as having four facets viz., rapidity of mental functions; general orientation and information; percept and motor equity; and depression. In this context, rapidity of mental functions refers to the quickness of recalling the names of common objects / places. General orientation and information means awareness of personal details, location and time; and extent of accurate recall of widely-known current information. Percept and motor equity means the ability to precisely copy / draw pictures thus manifesting eye-hand coordination. Depression refers to the tendency towards having sad mood, lack of motivation, helplessness,

hopelessness, inertia etc.; depression impairs cognitive efficiency [8].

3.3 Tools
The following standardized tools were used for data collection from participants:

i) **General Information Schedule**: Prepared by the present investigator and her research supervisor to gather background information from respondents. It comprised 11 items. Most items were closed-ended. Items pertained to name, address, age, gender, marital status, education, occupation, income, living arrangement and family background of respondents.

ii) **P.G.I. Battery for Assessment of Mental Efficiency in the Elderly or PGI-AMEE (1996)** [8]: It consists of 4 subtests. These are:-
1. **Set Test** - a verbal test in which the subject is required to recall upto 10 items each in 4 different common categories viz. Colours, animals, fruits and cities. Scores range from 0 to 40. Higher score indicates rapidity of mental functions hence greater mental efficiency. This subtest is negatively correlated with Measures of Percept and Motion Equity (-.21; p<.05; N=100) and Geriatric Depression Scale (-.24; p<.05; N=100). Set test is correlated with education of elderly subjects (.36; p<.01; N=100).

2. **Standard (Special) Ten Test** - comprises 10 simple statements to be responded to. These relate to orientation of the elderly person with respect to time, place and person. General information and those pertaining to recent and remote events are assessed. Only correct answers earn scores which range from 0 to 10. Higher score indicates greater mental (cognitive) efficiency. This subtest is positively correlated with Set Test (.35; p<.01; N=100) and negatively correlated with Measures of Percept and Motion Equity (-.33; p<.01; N=100) and Geriatric Depression Scale (-.37; p<.01; N=100). Special (Standard) Ten Test is highly correlated with education of elderly subjects (.72; p<.01; N=100).

3. **Measures of Percept and Motion Equity** – 5 drawings are given which have to be copied and 3 more have to be drawn by following written / verbal instructions. Range of error scores is 0 to 8. Higher the error scores the poorer the perceptual-motor capacity. This subtest is negatively correlated with the Set Test (-.21; p<.05; N=100) and Special (Standard) Ten Test (-.33; p<.01; N=100) and positively correlated with Geriatric Depression Scale (.26; p<.01; N=100). Scores on this subtest are negatively correlated with education of the elderly subjects (-.41; p<.01; N=100).

4. **(Geriatric) Depression Scale** – 20 questions with "Yes" and "No" answer-options are used to assess depression in the elderly. Item numbers 1, 7, 11 and 20 are reversed items while the rest are direct ones. Scores range between 0 and 20. It has split-half reliability coefficient of .82. It is negatively correlated with the Set Test (-.24; p<.05; N=100) and Special (Standard) Ten Test (-.37; p<.01; N=100). It is positively correlated with scores on Measures of Percept and Motion Equity (.26; p<.01; N=100). (Geriatric) Depression Scale is correlated negatively with education of elderly subjects (-.44; p<.01;

N=100). This subtest has been included as depressive tendencies lower subjects' motivation to do well on tests of mental (cognitive) efficiency. The battery is suitable for use with persons over 55 years of age. Norms are in means and standard deviations [8].

3.4 Sample
A stratified random sample of 320 non-institutionalized late adults (aged 60 -90 years) of middle socio-economic status families in Kolkata was selected. Socio-economic status was inferred from the previous and / or current occupation of the participants / their spouse. All the sampled elderly were married and had children. They were not seriously ill at the time of data collection. The sample comprised 160 female and 160 male elderly. 64 each of the participants were – a) educated up to school level; b) professional diploma / certificate-holders; c) graduates; d) post-graduates; and e) professional degree-holders.

4. Procedure
Data were collected individually from each elderly at their homes. The standardized test administered following the procedures described in test manual. Mostly, the elderly

responded by putting marks / writing on the answer sheets themselves. If they were unable then their responses were recorded by the investigator. However, the elderly respondents were requested to copy the designs in the third subtest (Measures of Percept and Motion Equity) of P.G.I. Battery for Assessment of Mental Efficiency in the Elderly [8] on their own. For inferring socio-economic status of respondents, manual of Socio-Economic Status Scale (Urban) by Kuppuswamy (1984) [9] was consulted. If the previous and / or current occupations of respondents / their spouses (cited in the General Information Schedule) corresponded to any of the occupations listed as semi-professional or professional by Kuppuswamy (1984), it was considered proof that the respondent belonged to middle socio-economic status. Participants' responses to important items in General Information Schedule were coded. Scoring of the standardized test viz., P.G.I. Battery for Assessment of Mental Efficiency in the Elderly [8] was done using procedures mentioned in test manuals. After data collection and scoring, mean and standard deviation were calculated and One-Way ANOVA was carried out.

5. Results and Discussion

Table 1: Descriptive Statistics for the Elderly (N=320) Categorized by Education.

Strata	Mean	Standard Deviation
Rapidity of Mental Function		
Graduate(N= 64)	31.3	11.78
Post Graduate(N=64)	36.36	7.58
Professional Degree(N=64)	36.96	5.41
Professional Diploma/Certificate(N=64)	31.29	14.89
Others i.e. School Educated (N=64)	32.27	9.88
General Orientation &Information		
Graduate(N=64)	8.42	2.98
Post Graduate(N=64)	9.26	1.75
Professional Degree(N=64)	9.28	1.67
Professional Diploma/Certificate(N=64)	8.71	1.89
Others i.e. School Educated (N=64)	8	2.5
Percept & Motor Equity		
Graduate(N=64)	0.81	1.34
Post Graduate(N=64)	0.77	1.2
Professional Degree(N= 64)	0.8	1.23
Professional Diploma/Certificate(N=64)	1	1.16
Others i.e. School Educated (N=64)	1.15	1.44
Depression		
Graduate(N=64)	7.52	3.75
Post Graduate(N=64)	7	3.68
Professional Degree(N=64)	6.68	3.74
Professional Diploma/Certificate(N=64)	6.29	4.31
Others i.e. School Educated (N=64)	8.15	3.81

Mean values (Table 1) show that rapidity of mental functions is maximum for the sampled professional degree-holding elderly followed by post-graduate elderly; it is least for the participating elderly who are graduates followed by those with professional diplomas and certificates. In mean of general orientation and information scores the sampled professional degree-holding elderly are highest followed by post-graduate elderly; the group of elderly termed others (having some amount of school education) show lowest mean in general orientation and information. Mean of error scores in percept and motion equity is maximum for the group of elderly termed as others (having some amount of school education) followed by the professional diploma / certificate holders; it is least for the participating professional degree-holding elderly. Mean of depression scores is highest for the

sampled elderly categorized as others (having some amount of school education); it is least for the elderly with professional diploma / certificates. Standard deviation values are moderate indicating more or less medium dispersion of scores on the pertinent cognitive efficiency variables for each stratum of the sample.

Table 2: Results of One-Way ANOVA - Independent Variable: Educational Attainment of the Elderly (N=320).

Dependent Variable	F	DF
Rapidity of mental functions	3.97 **	4, 315
General orientation and information	2.17	4, 315
Percept and motion equity	0.57	4, 315
Depression	0.96	4, 315

$**p<.01$

Results (Table 2) show that educational attainment of the sampled elderly persons has cast significant impact on their extent of rapidity of mental functions. Thus the first hypothesis (sub-section 3.1) is supported. However, the influence of education of the participant elderly on their extents of general orientation and information; percept and motion equity; and experienced depression are not significant. In fact education of the sampled elderly has been shown to have negligible impact on their extents of percept and motion equity; and experienced depression. So the second, third and fourth hypotheses (sub-section 3.1) are not tenable. So the present finding points towards domain-specificity of the influence of educational attainment of aged persons on their extents of cognitive efficiency. This is in line with the outcome reported by Glymour *et al.* (2012) [4]. Thus it could be that the influence of education as "reserve" against age-related deterioration in cognitive functioning is not as pervasive as most researchers [1, 2, 3, 5, 6, 7, 11, 12, 14, 15] think.

6. Conclusion
The cognitive reserve hypothesis has been partly verified in the present study. The present findings suggest domain-specificity in influence of educational attainment on cognitive efficiency of elderly. So the proposition of the Cognitive Reserve Hypothesis should not be considered as all-encompassing. Further researches could help refine the hypothesis. On a practical note, the less educated elderly persons need to be constantly intellectually stimulated by their family members so that their speed of cognitive functioning does not deteriorate a lot. Such stimulation might be provided by regularly talking with them, asking them to narrate past experiences, encouraging them to read newspapers; listen to news on radio; and watching T.V. news, entrusting them with duties to make daily shopping-lists and keep household-accounts, asking them to dial up and make phone calls to relatives etc.

7. References
1. Evans DA, Beckett LA, Albert MS, Hebert LE, Scherr PA, Funkenstein HH *et al.* Levels of education and change in cognitive function in a community population of older persons. Ann. Epidemiol. 1993; 3(1):71-77.
2. Ganguli M, Dube S, Johnston JM, Pandav R, Chandra V, Dodge HH. Depressive symptoms, cognitive impairment and functional impairment in a rural elderly population in India: A Hindi version of the Geriatric Depression Scale (GDS-H). Int. J. Geriatr. Psychiatry. 1999; 14:807-820.
3. Giri M, Chen T, Yu W, Lu Y. Prevalence and correlates of cognitive impairment and depression among elderly people in the world's fastest growing city, Chongqing, People's Republic of China. Clin. Interv. Aging. 2016; (11):1091-1098.
4. Glymour MM, Tzourio C, Dufouil C. Is cognitive aging predicted by one's own or one's parents' educational level? Results from the three-city study. Am. J. Epidemiol. 2012. aje.oxfordjournals.org/content/early/2012/04/01/aje.kwr509.full.
5. Goswami A, Reddaiah VP, Kapoor SK, Singh B, Dey AB, Dwivedi SN *et al.* Prevalence and determinants of cognitive impairment in rural elderly population in India. Helpage India-Research and Development Journal. 2006; 12(2):8-15.
6. Katzman R. Education and the prevalence of dementia and Alzheimer's disease. Neurology. 1993; 43(1):13-20.
7. Katzman R, Terry R, De Teresa R, Brown T, Davies P, Fuld P *et al.* Clinical, pathological, and neurochemical changes in dementia: A subgroup with preserved mental status and numerous neocortical plaques. Ann. Neurol. 1988; 23(2):138-144.
8. Kohli A, Verma SK, Pershad D. Manual for PGI Battery for Mental Efficiency in the Elderly (PGI-AMEE), National Psychological Corporation, Agra, 1996.
9. Kuppuswamy B. Manual of Socio-Economic Status Scale (Urban), Manasayan, Delhi, 1984.
10. Mamatha. Mental ability and adjustment among retired senior citizens. Masters thesis, University of Agricultural Sciences, Dharwad, 2014.
11. Park B, Park J, Jun JK. Cognitive impairment, depression, comorbidity of the two and associated factors among the early sixties in a rural Korean community. Plos One. 2013. http://journals.plos.org/plosone/article?id=10.371/journal.pone.0079460.
12. Scarmeas N, Stern Y. Cognitive reserve: Implications for diagnosis and prevention of Alzheimer's disease. Curr. Neurol. Neurosci. Rep. 2004; 4(5):374-380.
13. Silva L. The construct of cognitive processing and speed: Test performance and information processing approaches. Masters dissertation, University of New Mexico, 2009.
14. Tucker AM, Stern Y. Cognitive reserve in aging. Curr. Alzheimer Res. 2011; 8(4):354-360.
15. Wang HX, MacDonald SWS, Dekhtyar S, Fratiglioni L. Association of lifelong exposure to cognitive reserve-enhancing factors with dementia risk: A community-based cohort study. PloS. Med. 2017; 14(3):e1002251. https://doi.org/10.1371/journal.pmed.1002251.
16. World Health Organization. Definition of old age. 2013. http://www.who.int/healthinfo/survey/ageingdefnolder/en/.