AIMS Medical Science, Volume 3(1): 77-95.
DOI: 10.3934/medsci.2016.1.77
Received 30 September 2015,
Accepted 7 January 2016,
Published 9 January 2016

http://www.aimspress.com/journal/medicalScience

Research article

Cognitive Reserve in Patients with Mild Cognitive Impairment: The Importance of Occupational Complexity as a Buffer of Declining Cognition in Older Adults

Feldberg Carolina [1,] *, Hermida Paula D [3], Maria Florencia Tartaglini [3], Stefani Dorina [3], Somale Verónica [2], and Allegri Ricardo F [1]

[1] Department of Cognitive Neurology, Neuropsychology and Neuropsychiatry, Institute for Neurological Research (FLENI) National Scientific and Technical Research Council (CONICET), Montañeses 2325, C1428BUC, Buenos Aires, Argentina;
[2] Institute of Neurosciences of Buenos Aires (INEBA) Buenos Aires, Argentina;
[3] Institute of Cardiology Research "Prof. Dr. Alberto C. Taquini" (ININCA-UBA- CONICET), Buenos Aires, Argentina

* **Correspondence:** E-mail: cfeldberg@hotmail.com; Tel: +54-911-4777-3200

Abstract: Cognitive reserve is the ability to optimize performance through differential recruitment of brain networks, which may reflect the use of alternative cognitive strategies. Work is one of the most important sources of cognitive stimulation during adulthood. Mild cognitive impairment (MCI) represents an intermediate status between normal aging and dementia. As a consequence, this is considered a risk group regarding cognition. In order to study the probable association between occupational complexity and cognitive performance in a group of patients with MCI, a non-probabilistic intentional sample was dispensed on a group of 80 patients. Occupational complexity was explored by the Questionnaire on Agency of Labor Activity (CAAL, according to its acronym in Spanish) and a set of neuropsychological tests, which assessed cognitive performance in different areas: memory, attention, language and executive function, were administered. Results reveal that occupational complexity is associated to cognitive performance of elderly adults with MCI. With respect to working with Data, an increase in neuropsychological tests that demand high levels of attention and imply processing speed and working memory can be noted. Regarding the

complexity of working with People, an association between the level of occupational complexity and an increase in verbal abilities and verbal reasoning can be seen. On the other hand, working with Things could be associated with better performance in specific areas of cognition such as visuospatial abilities. These results add up as empirical evidence to the fields of cognitive neurology and gerontology and to the cognitive reserve hypothesis, showing how complex environments can enhance cognition in old age. It adds evidence that help to understand which psychological, social and labor factors intervene in the cognitive reserve of an elder adult in cognitive risk.

Keywords: intellectual quotient; labor complexity; mild cognitive impairment; cognitive reserve

1. Introduction

1.1. Mild cognitive impairment and cognitive reserve

World Health Organization [1] suggests that in recent years there has been a rise in life expectancy and a decline in the fertility rate, which has produced an increase in the proportion of people over 60 years in the general population. The aging population can be considered a success of public health policy and the socio-economic development, but also a challenge to society. The growth of this age group will cause an exponential increase of the prevalence of neurodegenerative diseases and other common pathologies in this stage of life. Research studies that will help prevent cognitive impairment and promote a healthy life style are of great importance in the near future.

Therefore, it is important to specifically understand the modifications that take place in each life stage as a consequence of the aging process. Among the changes that may occur in the elders, one that worries older adults most, are the ones related to cognition. A proper cognitive function is important for the maintenance of independence in the carrying out of daily and instrumental activities, such as financial management, taking medications, driving vehicles, or daily life skills like remembering appointments or learning how to use a computer. As the proportion of adults over age 60 is projected to increase compared to the population in general, it has become increasingly important to better understand the cognitive changes that accompany the aging process [2]. Since cognitive disorders are some of the main symptoms of dementia, the appearance of these difficulties is not only an alert to the subjects in this age group, but is also an indicator of possible intervention for health professionals who work in this field.

With regard to cognitive disorders of the elderly, it is possible to establish a continuum from normal to dementia, where it is possible to locate amid an intermediate diagnostic construct named Mild Cognitive Impairment (MCI). MCI is defined as a condition that, in some cases, can be found in between normal and pathological aging, or as a condition that seems to delimitate a group of

people with cognitive symptoms who find themselves in a situation of severe risk if compared to the situation observed in the general population who might develop a dementia, specially Alzheimer's [3–5].

The diagnose criterion of MCI proposed by Petersen [6] embraces: (a) subjective memory complaints, (b) normal development of daily life activities, (c) normal general cognitive performance, (d) memory impairment diagnosed by tests with normative data performed on people who have the same age and educational level, and (e) non-existent dementia.

There are different sub-types of MCI that depend on what cognitive functions are affected. Thus, Petersen and Negash [7], take the previous classification proposed by Petersen [6] (amnesic MCI, non-amnesic MCI and multi-domain MCI) and established the following nomenclatures: amnesic MCI (MCI of amnesic type with unique domain, with exclusive affection of memory); amnesic multi-domain MCI (amnesic multi-domain MCI, other functions affected apart from memory); non-amnesic MCI (only one function affected different to memory); and non-amnesic multi-domain MCI (non- amnesic multi-domain MCI, more than one function affected different to memory).

Most developed studies towards the last years define MCI as a possible transition stage between normal aging and the early stages of dementia. Although sometimes people who have diagnosed MCI do not develop dementia. Prospective studies indicate that there are high chances to develop dementia [8,9]. Individuals with MCI are in cognitive risk and it is of great importance to identify the aspects of lifestyle that can provide tools to slow the appearance of clinical indicators of the disease.

The hypothesis of Cognitive Reserve (CR) provides the necessary theoretical framework when trying to find answers regarding the role that lifestyle has in the protection of cognition of elderly adults. This theory defends that the brain has the capacity of protecting its synaptic network connections when a person is exposed to enriched environments [10]. The notion that apparently there exists a reserve that protects the brain from cognitive damage comes from the observation made by different researches that point out that occasionally there is no direct relation between brain damage and clinical manifestations of an injury [10,11]. The CR theory establishes that different aspects of lifestyle give an individual a wealth of abilities that allow him to face more effectively the changes that occur in an anatomic-physiological level of his brain as a consequence of brain injury or a neurodegenerative disease, slowing the clinical manifestation of the pathological process [12]. Several studies have suggested that differential susceptibility to dementia level is related to variables such as education, literacy, IQ, and engagement in leisure activities. The concept of cognitive reserve posits that individual differences in how tasks are processed might provide differential reserve against brain pathology [13].

One of the main challenges when studying the CR in elderly adults has to do with the search of means that allow to objectively asses this multiple construction. At present study, the CR goes towards an integrative approach, where this concept is understood as the result of a different set of factors where each one performs a specific contribution. These factors include various aspects that are related to the social and culture sphere in which an individual is developed, such as the economic status, the education, the main job held through adulthood and the participation in leisure activities [14].

Among the factors that constitute the CR, one of the most studied is the key role that education has as a protector of cognitive impairment in the elderly. A higher educational level is generally associated to a better performance [15–17]. But, if we compare the time that a subject invested in the educative system with the time spent in the labor market, it is important to analyze the role that the Occupational Complexity (OC) has in the CR.

In adulthood, work provides one of the most important sources of cognitive stimulation. Several studies [18,19] suggest that participation in cognitively stimulating activities contributes to cognitive reserve. Moreover, if the CR is based on the level of efficiency and flexibility of cognitive systems, it seems likely that the frequent use of these network systems involved in the resolution of intellectual challenges would be associated with a higher levels of CR [11]. Therefore, as posed by Schooler Mulatu & Oats [20], individuals that are exposed to more complex work environments increased cognitive flexibility which provides them higher levels of cognitive stimulation and better opportunities for the construction of the CR.

1.2. Occupational complexity (OC) and cognitive Reserve (CR)

In the framework of the hypothesis of CR, several investigations indicate the importance that work has as a protector factor of cognition during the elderly stage of life. It is also important to point out that although people spend most of their time in the working environment, the actual knowledge with regard to the existing connection between the OC and the cognitive performance is limited if compared with other variables, such as educational level or free time usage [21,22].

Several researches have tried to identify the role that OC has as an indicator of cognitive impairment in the elderly separated from other factors that constitute the CR such as educational level or intelligence [23]. However, the associations that constitute this relation are not clear; and despite the fact that there are some discrepancies [24,10] regarding the modulating role that OC might have with respect to cognition in the elderly, it has been suggested that stimulating environments add up to a subject's CR, which protects him from anatomic-pathologic changes that may take place as a result of the aging process or brain injuries [25,26].

Kohn and Schooler [27] were the pioneer authors to assess the existent relation between work and cognition. In an investigation that aims to obtain information about the influence that occupational conditions have on cognitive functions, the authors observed that enriched and challenging environments that demand complex activities produce an increase in the cognition flexibility as simpler working environments diminish this intellectual ability. Recently, Schooler, Mulatu and Oates [26] establish that elderly adults exposed to complex environments, works or recreational activities have the opportunity to continue exercising their cognition abilities, which help them preserve them for a longer period of time.

Among the several aspects involved in the occupational activity, one of the tasks that shows to have greater efficiency to maintain cognition in the elderly has to do with working complexity regarding the interaction with Data, People and Things. Several studies [28,29] suggest that

challenging works can be associated with a lower risk of manifesting performance weakening, especially in the activities that imply greater intellectual effort, interaction with other individuals and communication.

This benefit in the cognition sphere is not only evidenced in elderly normal adults, but also in studies that analyze the impact that occupational activity has on individuals with cognitive symptoms. Researches performed in patients with Alzheimer´s Disease [30–32] conclude that occupational activity is related to cognitive status of subjects. This is an objective indicator of the effect that exposure to complex and enriched environments has in the brain. Several studies point out that those individuals who perform labor activities with higher interpersonal interaction and intellectual challenge manifest the apparition of symptoms related to Alzheimer's more slowly than those who are exposed to less cognitive demand but a higher physical effort [22,33].

Another source of proof that allows testing the hypothesis of CR comes from the study of functional images that show that those individuals that have a greater CR might tolerate higher pathological damage. The positron emission tomography (PET) is one of the most widely used methods and has provided higher evidences. Using this investigation method, several authors have been able to assess the role that different psycho-social factors related to environmental complexity have with respect to CR. These authors observed that in patients with equal degree of dementia and pathological damage but with a higher CR provided due to a complex labor task [12], higher educational level [15], higher premorbid IQ [34], or higher intellectual and social participation and the performance of physical activities [35], mild clinical manifestations of the disease are experienced. These findings support the forecast that individuals with a higher CR can tolerate a higher pathological damage [36].

To sum up, although there exists an important theoretical framework coming from clinical, observational and image research with regard to the impact that OC has as a protector of cognition in healthy elderly adults or with diverse pathological alterations of cognition such as Alzheimer's, there is not so many scientific pieces of evidence that assess the role that this variable has in individuals with MCI. Declination in cognitive performance is one of the main problems associated with an unsuccessful and unhealthy aging. Complementary, it can be added that in a study conducted by Petersen et al. [37] 16% of people without neurological pathology whose ages were between 70 and 89, developed amnesic MCI having found that 83% of participants with MCI progress to dementia. So as a result of population aging, it would be an in increased of seniors in the general percentages, producing a progressively increase in the incidence of diseases that affect cognition. Therefore, the detection and early diagnosis of MCI as an early and prodromal stage of Alzheimer's disease (AD) and other dementias, is relevant. Consequently, a central paradigm in research on MCI is the seeking of markers and indicators that help the early diagnosis and estimation of prognosis [38]. The occupational trajectory of an individual and more specifically, OC might become an early predictor variable to be considered in subjects in cognitive risk such as patients with MCI. Having data on this issue would also clarify how a person's job contributes to the development or alteration of cognitive

efficiency and its CR, and it can promote the planning of intervention strategies that minimize detrimental consequences of work organization on the individual.

Therefore in the framework of cognitive reserve, the aim of the current research is to assess the possible relationship between complexity of occupational trajectory and cognitive performance in a group of patients with MCI. It is expected that there exists a connection between occupational trajectory and cognitive performance, considering occupational complexity as one of the probable neuro-protector factors of the cognitive performance in the elderly age.

2. Method

2.1. Design and setting

This was a retrospective correlation cross-sectional study of outpatients with MCI. The study was performed in the Institute of Neurosciences of Buenos Aires (INEBA, according to its acronym in Spanish), the Acute Care Hospital "Abel Zubizarreta," and the Institute for Neurological Research (FLENI), all of them located in the City of Buenos Aires, Argentina.

2.2. Subjects

The sample was made up by 80 patients who met the inclusion criteria for MCI [39].

The inclusion criteria were:

1. The individual was neither normal nor demented.

2. There was evidence of cognitive impairment, shown by either objectively measured decline over time or subjective report of decline by self or informant in conjunction with objective cognitive deficits.

3. Activities of daily living were preserved and complex instrumental functions were either intact or minimally impaired. In this study, we considered evidence of cognitive deficit as when one of the objective neuropsychological tests showed at least 1.5 SD below the mean value for age- and education-matched healthy subjects.

Patients were excluded from the cohort if they had cerebrovascular disorders (defined by a score of 5 or higher on the Hachinski Ischemic Score) [40] or a history of neurological or major psychiatric disease or unstable general medical conditions. The criteria were provided and evaluated by a cognitive neurologist.

2.3. Procedures

Each subject underwent an individual uniformed structured evaluation that lasted 90 minutes approximately. The study was performed with the approval of the institutional review board. The

research was performed in compliance with the Helsinki Declaration [41]. Written informed consent was given by all participants.

2.4. Measures

A set of assessment techniques which comprises preset protocol used in the Service of Cognitive Neuroscience of INEBA, FLENI and Zubizarreta Hospital was administered. The same fall within the guidelines suggested by the Argentinean Neurological Society for patients in cognitive risk [42]. The assessment, which includes the collection of socio-demographic and psychosocial data and neurological and clinical history, was also explored. Cognitive state was established through the application of a comprehensive neuropsychological battery. The instruments used are listed below:

a. Initial test: includes a semi-structured interview performed in order to obtain socio-demographic information by means of a basic data questionnaire. Questions on the clinical history and the functional level of the patient were made. Short screening cognitive tests like the Mini-Mental State Examination [43] and Clock Test [44] were incorporated and the general mood of the patient was assessed through Beck's Depression Inventory [45] and HADS-A (Hospital and Anxiety Depression Scale) [46]. The level of impairment of the patient was determined using the Global Dementia Rating (CDR—Clinical Dementia Rating) [47]. Functional Level of the patient was assessed with Katz ´s Basic Activities of Daily Living Scale-Adapted [48] and the Instrumental Activities of Daily Living Test [49].

b. Neuropsychological test: Patients were assessed with an extensive neuropsychological battery that included, Logic Memory from the Signoret Memory Battery [50] Verbal Learning Test Spanish-Complutense (TAVEC, according to its acronym in Spanish) [51], Boston Naming Test [52] Verbal Fluency Test [52], the "Trail making test parts A and B" [53], and several subtest from the WAIS III were selected: Digit Span, Vocabulary, Analogies, Matrix Reasoning and Cubes III [54].

c. Occupational complexity: Older adults main lifetime occupation was evaluated retrospectively using the Occupational Trajectory Questionnaire on Labor tasks Agency (according to its acronym in Spanish CAAL) where main job held in middle age was assessed. The CAAL was constructed and published [55] after Kohn and Schooler's [56] Psychological Effects of Occupational Conditions Interview. Kohn and Schooler's [56] classification was constructed on the basis of the Dictionary of Occupational Titles, 3rd edition U.S. Department of Labor (DOT) [57].The DOT [57] is a catalog of occupations used in the United States between 1939 and 1977. In the fourth edition of the DOT, published in 1977, more than 12,000 occupations were rated based on observations by job analysts. The DOT classifies occupations based on a 9-digit code (i.e., 092.227-010, primary school teacher). The fourth, fifth, and sixth digits represent occupational complexity with data, people, and things, respectively. In the DOT, the most complex jobs are coded "0"; for ease of comprehension Kohn and Schooler (1983) scores have been reversed so higher scores reflects greater complexity.

Complexity ratings are summarized in Table 1.

Table 1. Description of occupational complexity levels with data, people, and things.

Data	People	Things
8 Synthesizing	9 Mentoring	6 Operating controlling
7 Coordinating	8 Negotiating	5 Driving Operating
6 Analyzing	7 Instructing	4 Manipulating
5 Compiling	6 Supervising	3 Tending
4 Computing	5 Diverting	2 Feeding off bearing
3 Copying	4 Persuading	1 Handling
2 Comparing	3 Speaking- Signaling	
1 Reading	2 Receiving instructions-helping	
	1 Serving	

Reference from the Dictionary of Occupational Titles. Rating scales have been reversed for the current study, so a higher score reflects greater complexity.

2.5. Statistic analysis of information

The data correspondent to the psychosocial variables and the specific aspects of the labor path are presented by means of percentages values of means and standard deviations in agreement to the variables score levels. The Pearson (r) correlation coefficient was used to assess the relation between labor complexity and cognitive performance obtained in the neuropsychology tests.

3. Results

Table 2 shows the socio-demographic profile and the MCI diagnose of the interviewees.

Table 2 depicts the arithmetic mean and standard deviations and percentages that correspond to the variables that describe the socio-demographic profile of the interviewees and their particular labor situation. The results indicate that the average age is of 76.59 years old (SD = 6.6) and the educational level reached of 11.3 years (16/2) (SD = 3.71). The higher percentages are: female gender (68%), Argentine nationality (89%), married civil status (56%), and widow (28%).

Regarding the position in the organization, the main percentage was employees (44%), this percentage was divided as follows: 31% administrative tasks and secretaries, 13% managerial positions, 15% workman, and the rest of the sample was made up of independent workers 26% and owners 15%. The average amount of years spent in the labor position was of 28.75 years (SD = 17.44) and the average amount of hours weekly spent in the labor environment was of 41, 43 (SD = 13.61).

According to the abbreviated version of the Index of Economic Social Level [58], responses recorded on education and occupation showed that all study subjects belong to middle socioeconomic level.

In relation to the diagnose classification of the subjects, 81% of the sample was diagnosed with amnesic multi-domain MCI and 23% with unique domain MCI.

Table 2. Sociodemographic data.

Variables	
Gender M/F (n, %)	25/55 (32/68)
Age (years) (mean, SD)	76.59 ± 6.6
Education (years)(mean, SD)	11.30± 3.71
Nationality (n, %)	Argentine 72 (89)
	Foreign 8 (11)
Marital status (n, %)	Single 2 (4)
	Married 46 (56)
	Widow 23(28)
	Divorced 5 (6)
	Living in couple 4 (6)
Occupation (n, %)	Ordenance worker 20 (25)
	Clerk 27 (34)
	Seller 11 (15)
	Teacher/professor 7 (9)
	Independent professional 6 (7)
	Executive 5(6)
Place in the organization (n, %)	Owner 12 (15)
	Manager 7 (8)
	Sector Chief 4 (5)
	Employee 15 (19)
	Secretary 10 (12)
	Workman 11 (15)
	Independent professional 21 (26)
Years at work(mean, SD)	28.75 ± 17.44
Hours at work(mean, SD)	41.43 ± 13.61
Productive sector (n, %)	Primary sector of industry 1 (1)
	Secondary sector of industry 18 (23)
	Tertiary sector of industry 59 (74)
	Quaternary sector of industry 1 (1)
Diagnostic (n, %)	Amnesic MCI single domain 19 (23)
	Ammnesic MCI multiple domain 48 (58)
	Non amnesic MCI single domain 5 (7)
	No amnesic MCI multiple domain 8(12)

Table 3 shows the arithmetic mean and the standard deviation of the scores obtained in the general tests and in the variable of occupational complexity and cognitive performance, as well as the correlation coefficient.

The results obtained in Table 3 indicate the following correlations:

Table 3. Means and standard deviations on cognitive test performance (z score) with Occupational Complexity with Data, People and Things.

Neuropsychological Tests (Puntaje z)	M	DS	Correlation (r) Complexity with Data	Correlation (r) con Complexity with People	Correlation (r) con Complexity with Things	Correlation (r) con General Complexity
General Tests						
MMSE	27.54	2	0.17	0.126	0.16	0.20
CDR	0.5	0.95	0.07	0.135	0.16	0.07
Clock Test	6.33	1.06	0.14	0.06	0.05	0.20
BDI	6.43	4.38	0.14	0.08	0.06	0.09
HAD A	2.57	3.21	0.17	0.04	0.23	0.02
Memory						
Logic Memory Immediate Recall	−1.29	1.61	0.04	0.02	−0**.26***	0.04
Logic Memory Delay Recall	−1.19	1.55	0.07	0.025	−0**.34****	0.01
TAVEC1-5	−1.43	0.99	0.24	0.11	0.08	0.08
TAVEC RI	−1.18	0.99	0.12	0.18	0.00	0.06
TAVEC RD	−1.36	1.18	0.26	0.29	0.03	0.17
TAVEC REC	−0.53	1.01	0.07	0.10	0.054	0.01
Atenttion						
Digits Forward	−0.20	1.5	0.045	0.07	−0.12	0.01
Digits Backward	−0.16	1.1	**0.23****	0.12	−0.07	**0.25****
TMT A	−0.91	0.078	**0.28***	0.10	0.12	**0.30****
Language						
Boston	−1.06	1.19	0.19	0.27	0.21	0.15
Semantic Fl.	−0.05	1.1	0.11	0.08	0.14	0.05
Phonological Fl.	−0.06	1.11	0.05	0.07	0.10	0.14
Vocabulary	0.17	0.67	0.41	**0.32****	0.03	**0.45****
Executive Functions						
Analogies	−0.63	0.84	**0.34****	**0.29****	−0.26	**0.40****
Matrix Reasoning	−0.265	0.86	0.21	0.02	0.16	0.09
Cubes	−0.43	0.71	0.19	0.13	**0.22***	**0.26****
TMT B	−1.20	1.17	**0.29****	0.18	0.05	**0.26****

r = Pearson correlations. ***** $p < 0.05$, ****** $p < 0.01$. **Significant values are shown in bold.**

A positive correlation can be seen between Occupational Complexity with Data and the neuropsychological tests Digits Backward ($r = 0.23$, $p < 0.01$), TMTA ($r = 0.28$, $p < 0.05$), TMTB ($r = 0.29$, $p < 0.01$) and Analogies WAIS III ($r = 0.34$, $p < 0.01$).

When assessing Occupational Complexity with People the following positive correlations are observed with the means of: Vocabulary WAIS III ($r = 0.32$, $p < 0.01$) and Analogies WAIS III ($r = 0.29$, $p < 0.01$).

In the comparison of Occupational Complexity with Things, and the neuropsychological test, a negative association is seen with Logic Memory Immediate Recall ($r = -0.26$, $p < 0.05$) and Logic Memory Differed Recall ($r = -0.34$, $p < 0.01$), and a positive association with Cubes ($r = 0.22$, $p < 0.05$) can be noted.

Finally, when analyzing the General Complexity of Occupational trajectory, the following positive correlations with neuropsychological tests were evidenced: Digits Backward WAIS III ($r = 0.25$, $p < 0.01$), TMTA ($r = 0.30$, $p < 0.05$), TMTB ($r = 0.26$, $p < 0.01$), Analogies WAIS III ($r = 0.40$, $p < 0.01$), Vocabulary WAIS III ($r = 0.45$, $p < 0.01$) and Cubes WAIS III ($r = 0.26$, $p < 0.01$).

4. Discussion

Cognitive Reserve has been described by some authors as the brain capacity to tolerate in a better way the effects of a determined pathology associated to dementia. That is to say, a person with a richer cognitive reserve is able to tolerate a higher amount of neuropathology before the clinical symptoms become to manifest. This ability is developed as a consequence of the life experiences an individual goes through his entire life cycle such as education or labor tasks. The increasing interest towards the cognitive reserve has its roots on the fact that it might become a protector before the manifestation of Alzheimer's and other dementias [59].

MCI is a pre-condition to dementia, the presence of this diagnosis is an important indicator regarding the likelihood of conversion, involving the presence of higher cognitive impairment. A group of patients of this study are vulnerable to cognitive impairment. Several psycho-social factors, such as the educational level, the intervention in physical and leisure activities have been studied over the last years in order to detect the soothing factors of the cognitive impairment in the elderly stages of life [60-62] .The role that OC has with respect to the subject's cognitive reserve has been studied in the framework of environmental complexity.

The current study, inserted in the framework of the theory of CR intended to find the possible association between the levels of OC and the cognitive performance in a group of elderly adults who have been diagnosed MCI. The data obtained, with a certain error margin, support the established hypothesis. OC is associated to cognitive performance of elderly adults with MCI. It is important to point out the impact that occupational complexity has as a modulator factor of cognition in the elderly. Consistently, with the results presented, OC, principally with respect to Data and People, comes out to be an indicator of the CR of an individual [63]. So, labor activities which are complex

and more challenging from an intellectual point of view are associated with more benefits before the possibility of developing MCI in the elderly age.

With respect to the complexity of working with People, there can be seen an association between the level of complexity of the labor tasks held as a young adult and an increase in verbal abilities and verbal reasoning. The results are also in line with published literature that suggests the protective role that occupation might have on cognition, especially those that involve interaction with People [17,64]. In these lines of thought, Andel and colleagues [64], proposed that complexity of work with people might have a positive influence on later life´s cognition, where cognitive problems may be attenuated with participation in social activity. These are also consistent with the fact that jobs that involve interaction with people generally need social skills development where language and communication play a central role. This benefit is seen in jobs where the interaction with others is necessary for the full development of the work activity, like in teaching, selling or in the health field like the abilities needed for being a doctor, a psychologist or a social worker. These findings are clinically significant, especially for individuals whose jobs involve little social interaction. Andel and colleagues [64] suggest that participating in social activities, such as clubs or organizations, could be as beneficial on cognitive health as engaging in complex interaction with others in an occupational setting. This might be a complementary intervention in subjects in cognitive risk like MCI patients.

With respect to working with Data, it is observed that there is a positive association in the tests: Digits Inverse (WAIS III), TMT AB, indicating the cognitive benefit that complex work with data has as regard to the tasks that demand high levels of attention and imply processing speed and/or working memory. These skills are usually needed for jobs and professions that require large data management and analysis, like being an executive secretary, an accountant or a researcher.

Complexity of work with Things was almost not related to cognition as measured in the neuropsychological test administered. Nevertheless, an inverse association is observed between Logic Memory (Signoret Memory Battery,) and working with Things. In previous studies [65,66], this complexity dimension was found to provide a relatively poor representation of general complexity of work and lower reliability of measurement [68]. But a possible interpretation of the obtained results could support the idea that individuals who have manual jobs are in a higher cognitive risk if compared to employees that work with their intellect [69], especially in cognitive tasks that imply psychological functions like episodic and semantic memory or verbal abilities like the ones require for story recall. However, in the present study, complex work with Things was positively associated with Cubes (WAIS III), as it might be inferred that complex manual activities might have a positive effect in specific areas of cognition like visuospatial abilities. Some activities, where specific manual skills are required, like the ones trained for being a sculptor, a dentist, a tailor or a jeweler, might enhance some specific aspects of cognition.

Another fact that is worth analyzing is that not significant correlations were observed between OC and the recall of a word list (TAVEC), this is a surprising finding. A probable justification derived from it, can be the little variability obtained by the interviewed subjects in test scores; 81%

of patients were diagnosed as Amnesic MCI single Domain (23%) or Amnesic MCI multi-domain (58%), both diseases imply the presence of pathological changes in memory. This difficulty was objectified through the neuropsychological assessment conducted. Then it is suggested that further analysis of this phenomenon may be taken into account in future studies that have a larger and more heterogeneous sample. However, based on the analysis performed, it could be proposed as a question, if the exposure to complex work environments is a factor strong enough to attenuate the pathological changes that occur in the field of memory in patients with MCI.

Nevertheless, in general, the presented results, coincide with the ones obtained in other investigations that declare the importance of the labor task as protectors of cognition. Working environmental complexity is one of the main promoters of CR of individuals. In connection to what the expression “use it or lose it” establishes, stimuli that come from daily life activities would facilitate the maintenance of cognitive functions in elderly adults for there exists a tight relation between the level and the kind of activity and the cognition performance in the elderly [70,71].

Some of the limitations of the study are that the interviewees were not selected through a probabilistic sampling and the number of subjects tested was smaller than the one desired. For this reason, the results cannot be generalized to other populations. Because of this, it is proposed to study the likely influence of other variables such as age and education in the cognitive performance of the elderly [72]. It is suggested, therefore, to continue the study, correcting these obstacles, thus performing a multiple regression analysis to assess the likely differential weight of the predictor variables "age", "education" and "occupational complexity" in determining the criterion variable "cognitive performance" of the elderly. It would also be interesting to analyze other aspects related to the aging process and cognitive impairment; if the onset of MCI was later in terms of chronological age in participants with greater complexity for instance. Thus, through these complementary analysis, it could be weighed that the role OC has as a modulator factor of cognition in subjects with MCI.

Nevertheless, this first research provides information on the positive impact that performance of complex labor tasks has on cognition, especially those activities that have to do with the interaction with Data and People. And, the fact that statistically significant associations were found between occupational complexity and cognition within this small sample, underscores the potential strength of the association. The presented results suggest that OC may positively influence cognition all along the entire life span and deserves further investigation as a proxy of CR.

5. Conclusion

The CR hypothesis posits that individuals with higher CR are able to better maintain cognitive function despite the level of pathology accumulated in the brain as a consequence of neurological diseases of various origins. These compensatory approaches and strategies are thought to be a direct result of various life experiences such as high occupational, educational attainment, leisure activities, and intelligence. One approach to testing the CR hypothesis is to analyze the probable association

between a CR proxy (e.g. occupation) and cognitive performance. So, as it has been presented in this study, CR hypothesis can be the key point to clarify about the disjunction between the degree of brain damage and its outcome. Regarding the multiple factors that make the CR, this study sums up empirical evidences about the role that occupational complexity and main lifetime job might have on cognition. Consequently it adds empirical evidence that enriches the fields of Labor psychology and Gerontology. As a result, one of the possible applications of this study in the clinical field, is in the promotion of healthy cognitive habits. It emphasizes the importance to awareness older adults and middle age adults about the role that being expose to cognitive rich environments has on cognitive healthy aging. Therefore, it is proposed, that occupational complexity could be a central component in the construction of the CR. As exposed in the study, through adulthood, work is one of the most important environments where the individual can receive constant cognitive stimulation that promotes the formation of rich synaptic networks, which are the biological basis of CR. Since not all work tasks and environments are complex enough to propose cognitive challenges that stimulate mental functions such as memory, language, attention and executive functions, it is extremely vital that both, in the public and private sphere, programs are promote that enlighten about the role that continued education and leisure actives have as a complementary form of stimulation through the aging process. Therefore the creation of complementary spaces of cognitive stimulation, especially for those individuals who perform manual or unchallenging cognitive activities, can modulate the cognitive slowing curve which decreased functional independent level involvement. Finally, through the diffusion by health professionals about the importance of staying cognitively active throughout the entire lifespan, healthy aging is promote.

Conflict of Interest

Authors declare there are no conflicts of interests.

Acknowledgments

The infrastructure, material and equipment needed for the development of the present study were provided by Institute for Neurological Research (Foundation to struggle against Neurological Childhood Diseases, FLENI according to its Spanish acronym). Also, the present project is attached to the project “Occupational trajectories, education and implementation of recreational activities: their role as neuroprotective factors of cognition in old age and its impact on the conversion of MCI to dementia” financed by INEBA (Buenos Aires Neuroscience Institute) Foundation EIFI 10, (2012–2014), allowance and directed by Dr. Carolina Feldberg.

The authors thank the authorities of INEBA, FLENI and Institute of Cardiology Research “Prof. Dr. Alberto C. Taquini” (UBA-CONICET) the interest and the support provided for conducting this research.

References

1. Organización Mundial de la Salud (2015) .*Informe mundial sobre envejecimiento y la salud*. Ginebra: OMS Ediciones.
2. Drag LL, Bieliauskas LA (2009) Contemporary review 2009: cognitive aging. *J Psychiatr Neurol* 23: 75-93.
3. Artero S, Petersen R, Touchon J, et al. (2006) Revised criteria for mild cognitive impairment: validation within a longitudinal population study. *Dement Geriatr Cogn* 22: 465-470.
4. Petersen RC, Doody R, Kurtz A, et al. (2001) Current concepts in mild cognitive impairment. *Arch Neurol* 58: 1985-1992.
5. Saunders NLJ, Summers MJ (2011) Longitudinal deficits to attention, executive, and working memory in subtypes of mild cognitive impairment. *Neuropsychology* 25: 237-248.
6. Petersen RC (2004) Mild cognitive impairment as a diagnostic entity. *J Intern Med* 256: 183-194.
7. Petersen RC, Negash S (2008) Mild Cognitive Impairment: An Over-view. CNS Spectrums 13: 45-43.
8. García-Herranz S, Díaz-Mardomingo M, Peraita H (2014) Evaluación y seguimiento del envejecimiento sano y con deterioro cognitivo leve (DCL) a través del TAVEC. *Ann Psicol* 30: 372-379.
9. González Palauau F, Buonanotte F, Cáceres MM (2015) Del deterioro cognitivo leve al trastorno neurocognitivo menor: Avances en torno al constructo. *Neurol Arg* 7: 51-58.
10. Dıaz-Orueta U, Buiza-Bueno C, Yanguas-Lezaun J (2010) Reserva cognitiva: evidencias, limitaciones y líneas de investigación futuras. *Rev Esp Geriatr Gerontol* 45:150-155.
11. Stern Y (2002) What is the cognitive reserve? Theory and research application of the reserve concept. *J Int Neuropsychol Soc* 8: 448-460.
12. Stern Y, Alexander GE, Prohovnik I, et al. (1995) Relationship between lifetime occupation and parietal flow: implications for a reserve against Alzheimer's disease pathology. *Neurology* 45: 55-60.
13. Allegri RF, Taragano FE, Krupitzki H, et al. (2010) Role of cognitive reserve in progression from mild cognitive impairment to dementia. *Dement Neuropsychol* 4: 28-34.
14. Rodriguez Álvarez M, Sanchez Rodriguez JL (2004) Reserva cognitiva y demencias. *Ann Psicol* 20: 175-186.
15. Garibotto V, Borroni B, Kalbe E, et al. (2008) Education and occupation as proxies for reserve in aMCI converters and AD: FDG-PET evidence. *Neurology* 71: 1342-1349.
16. Amieva H, Mokri H, Le Goff M, et al. (2014) Compensatory mechanisms in higher-educated subjects with Alzheimer's disease: a study of 20 years of cognitive decline. *Brain* 137: 1167-1175.
17. Orrell M, Sahakian B (1995).Education and dementia. *BMJ* 310: 951-952.
18. Andel R, Kareholt I, Parker MG, et al. (2007) Complexity of primary lifetime occupation and cognition in advanced old age. *J Aging Health* 19: 397-415.

19. Adam S, Bonsang E, Grotz C, et al. (2013) Occupational activity and cognitive reserve: implications in terms of prevention of cognitive aging and Alzheimer's disease. *Clin Interv Aging* 8: 377-390.
20. Schooler C, Mulatu MS, Oates G (1999) The continuing effects of substantively complex work on the intellectual functioning of older workers. *Psychol Aging* 14: 483-488.
21. Finkel D, Andel R, Gatz M, et al. (2009) The role of occupational complexity in trajectories of cognitive aging before and after retirement. *Psychol Aging* 24: 563-573.
22. Kroger E, Andel R, Lindsay J, et al. (2008) Is complexity of work associated with risk of dementia? The Canadian Study of Health and Aging *Am J Epidemiol* 167: 820-830.
23. Potter GG, Helms MJ, Plassman BL (2008) Association of job demands and intelligence with cognitive performance among men in late life. *Neurology* 70: 1803-1808.
24. Marquie JC, Duarte LR, Bessières P, et al. (2010) Higher mental stimulation at work is associated with improved cognitive functioning in both young and older workers. *Ergonomics* 53: 1287-1301.
25. Schooler C (1984) Psychological effects of complex environment during the life span: A review and theory. *Intelligence* 8: 259-281.
26. Schooler C, Mulatu MS, Oates G (2012) Occupational self-direction, intellectual functioning, and self-directed orientation in older workers: Findings and implications for individuals and societies. *Am J Sociol* 110: 161-197.
27. Kohn ML, Schooler C (1987) The reciprocal effects of substantive complexity of work on intellectual flexibility. A Longitudinal assessment. *Am J Sociol* 84: 24-52.
28. Bosman H, Van Boxtel MPJ, Ponds A, et al. (2003) Mental work demands protect against cognitive impairment: MAAS prospective cohort study. *Exp Aging Res* 29: 33-45.
29. Marioni RE, Proust-Lima C, Amieva H, et al. (2014) Cognitive lifestyle jointly predicts longitudinal cognitive decline and mortality risk. *Eur J Epidemiol* 29: 211-219.
30. Andel R, Crowe M, Kareholt I, et al. (2011) Indicators of job strain at midlife and cognitive functioning in advanced old age. *J Gerontol B Psychol Sci Soc Sci* 66: 287-291.
31. Smyth KA, Fritsch T, Cook TB et al. (2004) Worker functions and traits associated with occupations and the development of AD. *Neurology* 63: 498-503.
32. Serrano C, Taragano F, Allegri RF, et al. (2007) Factores predictores de conversión en Deterioro Cognitivo Leve. *Rev Neurol Argent* 32: 75-93.
33. Andel R, Crowe M, Pedersen NL, et al. (2005) Complexity of work and risk of Alzheimer disease: a population study of Swedish twins. *J Gerontol B Psychol Sci Soc Sci* 60: 251-258.
34. Alexander GE, Furey ML, Grady CL, et al. (1997) Association of premorbid intellectual function with cerebral metabolism in Alzheimer's disease: implications for the cognitive reserve hypothesis. *Am J Psychiatry* 154: 165-172.

35. Scarmeas N, Zarahn E, Anderson KE, et al. (2003) Association of life activities with cerebral blood flow in Alzheimer disease: implications for the cognitive reserve hypothesis. *Arch Neurol* 60: 359-365.
36. Scarmeas N, Stern Y (2004) Cognitive reserve: implications for diagnosis and prevention of Alzheimer's disease. *Curr Neurol Neurosci Rep* 4: 374-380.
37. Petersen RC, Caracciolo B, Brayne C, et al. (2014) Mild cognitive impairment: a concept in evolution. *J Intern Med* 275: 214-228.
38. Lojo-Seoane C, Facal D, Juncos-Rabadan O (2012) Previene la actividad intelectual el deterioro cognitivo? Relaciones entre reserva cognitiva y deterioro cognitivo ligero. *Rev Esp Geriatr Gerontol* 47: 270-278.
39. Winblad B, Palmer K, Kipivelto M, et al. (2004) Mild Cognitive Impairment: beyond controversies, towards a consensus: report of the International Working Group on Mild Cognitive Impairment. *J Intern Med* 256: 240-246.
40. Hachinski VC, Lassen NA, Marshall J (1974) Multi-infarct dementia: a cause of mental deterioration in the elderly. *Lancet* 2: 207-210.
41. Asociación Médica Mundial (2001) Declaración de Helsinski. Principios éticos para las investigaciones médicas en seres humanos. *Rev Neurol Argent* 26: 75-77.
42. Allegri RF, Arizaga RL, Bavec CV, et al. (2011) Enfermedad de Alzheimer. Guía de práctica clínica. *Rev Neurol Argent* 3: 120-137.
43. Folstein MF, Folstein SE, McHugh PR (1995) “Mini mental state” a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res* 12: 189-198.
44. Sunderland T, Hill JL, Mellow AM (1989) Clock drawing in Alzheimer’s disease: A novel measure of dementia severity. *J Amer Geriat Soc* 37: 725-729.
45. Beck AT, Ward CH, Mendelson M, et al. (1961) An inventory for measuring depression. *Arch Gen Psychiatry* 4: 53-63.
46. Zigmond AS, Snaith RP (1983) The hospital anxiety and depression scale. *Acta Psychiatr Scand* 67: 361-370.
47. Hughes CP, Berg L, Danziger WL et al. (1982) A new clinical scale for staging of dementia. *B J Psychiatry* 140: 566-572.
48. Katz S (1983) Assessing self-maintenance: Activities of daily living, mobility, and instrumental activities of daily living. *J Am Geriatr Soc* 31:721-727.
49. Lawton MP, Brody EM (1969) Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist* 9: 179-186.
50. Signoret JL, Whiteley A (1979) Memory battery scale. *Intern Neuropsych Soc Bull* 2: 2-26.
51. Benedet MJ, y Alejandre MA (1998) *Test de Aprendizaje Verbal España-Complutense (TAVEC)*. Madrid: TEA Ediciones.
52. Allegri RF, Mangone CA, Rymberg S, et al. (1997) Spanish version of the Boston naming test in Buenos Aires. *Clin Neuropsychol* 11: 416-420.

53. Reitan RM (1958) Validity of the Trail Making Test as an indication of organic brain damage. *Percept Mot Skills* 8: 271-275.
54. Wechsler D (2002) WAIS III: Test de Inteligencia para adultos. Buenos Aires: Ed. Paidos.
55. Feldberg C, Stefani D Somale MV, et al. (2015) Traducción y validación del Cuestionario sobre Agenciamiento de la Actividad Laboral, en sujetos argentinos. *Rev Neurol Argent*: In press.
56. Kohn ML, Schooler C (1983) Work and personality: An inquiry into the impact of social stratification. Norwood, NJ: Ablex.
57. U.S. Department of Labor (1965) Dictionary of Occupational Titles. Washington, D.C.: Government Printing Office.
58. Germani G, Grimson WR, De Blanco AC, et al. (1972) Investigación epidemiológica en entidades psiquiátricas. *Bol Oficina Sanit Panam* 79: 572-578.
59. Dıaz-Orueta U, Buiza-Bueno C, Yanguas-Lezaun J (2010) Reserva cognitiva: evidencias, limitaciones y líneas de investigación futuras. *Rev Esp Geriatr Gerontol* 45: 150-155.
60. Cotman CW, Engesser-Cesar C (2002) Exercise enhances and protects brain function. *Exerc Sport Sci Rev* 30: 75-79.
61. Wang HX, Karp A, Winblad B, et al. (2002) Late-life engagement in social and leisure activities is associated with a decreased risk of dementia: A longitudinal study from the Kungsholmen Project. *Am J Epidemiol* 155: 1081-1087.
62. Verghese J, LeValley A, Derby C, et al. (2006) Leisure activities and the risk of amnestic mild cognitive impairment in the elderly. *Neurology* 66: 821-827.
63. Smart EL, Gow AJ, Deary IJ (2014) Occupational complexity and lifetime cognitive abilities. *Neurology* 83: 2285-2291.
64. Andel R, Silverstein M, Kareholt I (2015) The role of midlife occupational complexity and leisure activity in late-life cognition. *J Gerontol B Psychol Sci Soc Sci* 70: 314-321.
65. Schooler C (1984) Psychological effects of complex environments during the life span: A review and theory. *Intelligence* 8: 259-281.
66. Schooler C, Mulatu MS, Oates G (2004) Occupational self-direction,intellectual functioning, and self-directed orientation in older workers: Findings and implications for individuals and societies. *American Journal of Sociology* 110: 161-197.
67. Miller AR, Treiman DJ, Cain PS, et al. (1980) Work, jobs, and occupations: A critical review of occupational titles. Washington, DC: National Academy Press.
68. Gow AJ, Avlund K, Mortensen EL (2014) Occupational characteristics and cognitive aging in the Glostrup 1914 cohort. *J Gerontol B Psychol Sci Soc Sci* 69: 228-236.
69. Boots EA, Schultz SA, Almeida RP, et al. (2014) Occupational complexity and cognitive reserve in a middle-aged cohort at risk for Alzheimer's Disease. *Arch Clin Neuropsychol* 29: 245-255.
70. Avolio BJ, Waldman DA (1990) An examination of age and cognitive test performance across job complexity and occupational types. *J Appl Psychol* 75: 43-50.

71. Van der Elst W, Van Boxtel MP, Jolles J (2012) Occupational activity and cognitive aging: a case-control study based on the Maastricht Aging Study. *Exp Aging Res* 38: 315-329.
72. Fritsch T, McClendon MJ, Smyth KA, et al. (2001) Effect of educational attainment on clinical expression of Alzheimer´s disease: Results from a research registry. *Am J Alzheimers Dis Other Demen* 16: 369-376.

AIMS Press