

Occupational Complexity and Leisure Activities in Cognitive Aging

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Abstract: Human beings possess a considerable reserve capacity that allows them to benefit from exposure to highly enriched environments. The hypothesis of environmental complexity states that those individuals involved in activities that require greater cognitive demands keep their cognitive abilities undamaged despite the passing of time. The aim of this review is to present an analysis of the results obtained from empirical research made between 1980 and 2014 in Europe and America, focusing on the impact that cognitive reserve has on older adults.

This review will demonstrate how environmental complexity and the importance of engaging in recreational activities influence individuals' lives and their cognitive healthy aging. Bibliography was obtained systematically, through a defined search strategy of several data bases. Ninety one scientific articles were selected in agreement with the appropriateness they keep with the objective of the present research.

In regard to pharmacological treatment, there is little evidence that cholinesterase inhibitor drugs affect progression to dementia or improve cognitive performance of patients with MCI. Complementarily, mixed results have been reported from different research lines that use cognitive training. Besides, there is increasing evidence that consider the role of environment and lifestyle as protective factors for the development of Alzheimer's disease from MCI. The review sheds some suggestions for future research related to the studied topics and for professional intervention in the area of gerontology.

Keywords: Activity theory, cognitive functioning, environmental complexity, leisure activities, professional intervention, work complexity.

INTRODUCTION

During the last few decades, a notorious growth can be observed in world-wide population of people aged 65 and over. This phenomenon, known as population aging, is the result of the increase in life expectancy and the decline on both: mortality and birth rate [1]. Considering this situation, science is facing the challenge of achieving optimal quality lifefor human being.

With old age, a series of changes and events appear with particular characteristics. Among the general changes individuals go through, the one with the strongest impact is evidenced in the sphere of cognitive functions [2]. The prevalence of cognitive disorders in old age population increases with the passage of time and "the maintenance of a healthy cognitive functioning" has become an issue that concerns senior citizens. In relation to this, an on-going effort has been carried out by professionals who work in this area in order to identify those factors that would contribute to keep cognition's efficiency during the old age. Cognitive disorders and dementia represent nowadays an important global problem to health systems. Due to the global population aging this situation is likely to worsen in the future, particularly in developing countries [3].

Human beings possess a considerable cognitive reserve that allows them to benefit from exposure to highly enriched environments. This idea has been set by the hypothesis of environmental complexity, which formulates that complexity is determined by existing stimuli and the different kinds of demand they establish [4, 5]. From this point of view, those individuals involved in activities that require greater cognitive demands are considered to keep their abilities over time, while the ones exposed to less enriched environments are prone to suffer affections in this health area. Then, it is possible to associate activities performed on a daily basis with different levels of cognitive efficiency during the old age [6]. Several investigations [5, 7] have studied the relation between involvement in activities and efficiency in cognitive tasks, proving that the more an individual engages in social, physical and intellectual activities, the greater cognitive efficiency he will have in a wide variety of tasks.

Based on the hypothesis of environmental complexity, Mulatu and Schooler [8] made a research on the influence that occupational conditions have with regards to cognitive functions. On one hand, they observed that enriched and challenging environments that require a complex kind of activity produced an increase in cognitive flexibility; on the other hand, simpler working environments reduced intellectual activity. These findings are consistent with the results obtained by investigations [5, 9] performed in the area of animal neurobiology, which showed that exposure to enriched environments elevates the intellectual functioning during the life of different species.

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The concept “cognitive reserve” has been defined by Dennis and colleagues [10] as the strategies and abilities achieved by a high level of education and a high work complexity that allow an individual to have a greater number of neurons and an enrichment of synaptic density. This concept emphasizes the fact that individuals process information in different ways when developing different tasks. This process of stimuli differentiation coming from the environment could provide different levels of protection with regards to neurodegenerative disorders. The development of the ability of cognitive reserve is associated to genetics’ predisposition and the exposure to enriched environments, where school, occupation and leisure activities lead a major role [11].

A tight relation exists between the level and kind of activity and cognitive functioning during the old age. The expression that best summarizes the relation seems to be “Use it or lose it”; so, stimulation from daily activities would make it easier for adults to keep their cognitive functions. Even more, a higher level of education is generally associated with works and activities which are complex and challenging for the cognitive functions in question [12, 13].

When the word “activity” is mentioned, it does not only make reference to work, but also to tasks performed during free time and recreation. Education is very important in this aspect because it stimulates the development of diverse abilities and interests, leading an individual towards the acquisition of pastimes or hobbies [14]. The cultural aspect of the activity performed should also be considered, especially with older adults. Generally, they have plenty of spare time and need to get involved in activities different than the ones they are used to. Those activities should be recreational, gratifying, and, if possible, useful for society.

Finally, different theories [15, 16] that discuss the process of human aging make special emphasis when mentioning the importance of getting involved in community activities at this stage of life. Several scientific investigations [17, 18] point out that successful aging depends on the possibility of leading an active life; and that allowing the presence of senior citizens in the performance of social roles proves to be an effective way to achieve that goal. Involvement in activities is a central factor to grant a successful aging. Cognitive reserve associated with the ability neurons have to establish connection nets will promote the use of alternate cognitive strategies. These processes allow an individual to face the cognitive changes produced as a consequence of the normal aging stage more efficiently. At the same time, in agreement to the theory of the complex environment, the more diverse the stimuli are, the more important the decisions to take and the considerations to bear in mind will be. Complex environments benefit cognitive efficiency and motivate the development of intellectual abilities all along an individual’s vital cycle.

The aim of this review is to present an analysis of the results obtained from empirical research made between 1980 and 2014 in Europe and America. Focusing on the impact that cognitive reserve has on older adults, this review will demonstrate how environmental complexity and the importance of engaging in recreational activities influence

individuals’ lives and have effects on their cognitive healthy aging.

METHOD

Bibliography was localized systematically, through a search strategy defined for several data bases: MEDLINE, PubMed (U.S. National Library of Medicine, National Institutes of Health), Redalyc (Red de Revistas Científicas de América Latina y el Caribe) [Net of Scientific Magazines of Latin America and the Caribbean] and Dialnet (Universidad de La Rioja, from Spain), Oxford Journals (by Oxford University Press) and Social Psychology Network. Ninety one scientific articles were selected in agreement to the appropriateness they keep with the objective of the present research. Several scientific studies prove the following hypothesis: an active and enriched lifestyle can have effects on cognition of elder citizens.

Bibliography was obtained systematically, through a defined searching strategy from several data bases. Ninety one scientific articles were selected in agreement to the appropriateness they keep with the objective of the present research.

Scientific articles and books published between 1980 and 2014 were consulted. The search criterion was adjusted to the objective of the revision and included several scientific research investigations in order to make a qualitative analysis a posteriori. A hundred and thirty investigations were found, of which 91 were selected in agreement to the appropriateness they keep with the objective of the present investigation. The key words used were: old age, leisure activities, working complexity, cognitive functioning, and healthy aging, among others.

RESULTS

The selected bibliography was analyzed in a qualitative way and systemized in 2 different axes with the intention of being able to explore and examine each of the topics that intervene with the proposed objectives herein, which are the following:

Cognitive Enrichment and healthy aging

Definition

The concept “healthy aging” is related to others like active, positive or successful aging. Naaldenberg and colleagues [19] define the afore mentioned notion as “the constant process of obtaining benefits from physical, social and mental activities in order to perform an active role in society with the aim of achieving an independent and good quality of life.” Added to this, Alongi and colleagues [20] consider that public health professionals should ensure that every citizen is in good health conditions so as to live a long life with the best cognitive independence possible.

Cognitive aging is of considerable importance when making reference to healthy aging. The main aspects of healthy cognitive functioning include: memory, language, attention, executive functions, gnosias and praxias. In 2005, the Critical Evaluation Study Committee [21] adopted a

more comprehensive definition of “healthy cognitive aging”. This definition states that cognitive health should be considered not only as the non-existence of a disease, but also as the comprehensive development of the cognitive structure, which makes it possible for an adult to lead an active social role, maintain a real sense of purpose, allow his independent functioning of abilities, the recovery from injuries and to cope with residual functional deficits.

Several factors have an effect on cognitive aging. Education, intelligence and sensory abilities are among the most important ones. The fact that an interindividual variability increases with age is not surprising, especially when considering the uncountable amount of stimuli that can strongly influence the aging process of cognition. Ardila [22] described increases in cognitive heterogeneity amidst the elder citizens through greater score dispersions on the testing of intelligence. Dispersions were not the same in all domains because the assessing of executive functioning and attention varied from those assessing visuoconstruction and general knowledge. Individuals with lower scores also showed greater heterogeneity [5].

Personal and Social Experiences Crossing the Barriers of Biological Constrains

Hertzog and colleagues [23], frame the topic of cognitive enrichment analyzing development in terms of a life span and from a bio-psycho-social point of view. They were influenced particularly by the thoughts of Paul Baltes and colleagues [24]. This perspective recognizes, specially two important postulates: a) biological aging creates boundaries that limits the performance of a human being, but, b) the performance can be modeled and enhanced during a life span.

Following these outlines, Hertzog and colleagues [23] raised the question about how malleable the biologically boundaries are (considering, for example, the intervention of pharmacology or genetic engineering.) In order to answer this problem, neural plasticity hypothesis evidences that it is possible for old brains to grow new neurons, synaptic connections and new vasculature. Despite the fact that neural plasticity is narrowed in the old age, nowadays it is recognized that old brains have more capacity than discovered by previous research [26].

Cognitive, social and physical activities stimulate the health of cognition in a specific group of people. Studies performed in animals prove that, on the contrary to general believes, the brain can create new nerve cells even during the old age [7-27]. One of the results obtained by these studies was that the growth of new nerve cells can be increased by a stimulating environment, oestrogen and exercising. Besides, investigations also proved that human brains are capable of adapting to new stimuli even during the aging process, and that elder citizens can store a “functional reserve” of cognitive abilities [28]. Those individuals who had acquired information of general knowledge through their lives are demonstrated to be more able to adapt to new experiences in old age. This condition of easily adapting to unknown environments has been seen in old individuals who are socially active [29].

There was one common result obtained from different studies performed over old people: those who participate in

activities that stimulate their brains (reading, playing, listening to music or visiting museums) are less prone to contracting Alzheimer’s disease [30, 31]. These results are equivalent to the ones obtained in other studies: exercises such as problem solving or playing memory games improve both cognitive and physical general well-being of patients going through the first stages of Alzheimer’s. A different investigation proved that the development of complex tasks - no matter whether working or during free time - has positive effects on elder individuals’ cognitive processes [32].

Despite the fact that biological aging forces human beings to behave in particular ways, plenty of studies show that performance can be of high quality even in old people [33, 34]. Hertzog and colleagues [23] present a model of cognitive aging where they state that the changes that take place in the field of cognition are not necessarily related to those limits imposed by biology. On the contrary, this statement indicates that in any moment of life individuals do not normally make use of their maximum performance potential.

The mentioned authors suggest that there is a “behavioral plasticity”, which arises from the upward or downward movements produced by the cognitive performance of a subject. These movements are the consequence of the continuous reshaping done while an individual adapts to a new context, biological state, health condition, and/or cognition behavior. The combination of personal and social experience is what narrows the different cognitive trajectories through the aging process. The authors assume that individuals have some potential for improvement which produces plasticity and can be modeled by many factors that change with the passage of time. As a result, each person grows old in their own way.

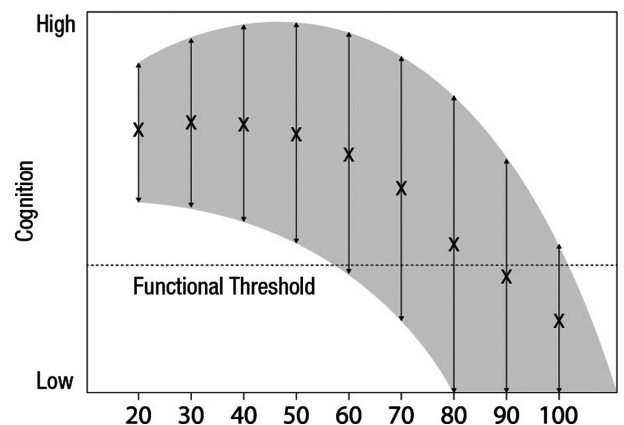


Fig. (1). Hertzog and colleagues (2009) depiction of the zone of possible cognitive development across adult life span for a given individual. The crosses represents the general development for an individual in typical circumstances. The upper and lower curves indicate the optimal and suboptimal boundaries that define the zone of possibility. Upperward and downward movements at a given age (arrows) are influenced by biological, behavioral, and environmental influences. The functional threshold indicated with a dotted line, shows a point at which cognition will be compromised.

Different research groups [35, 19] analyzed the reason that causes upward movements in the possible area of development. In agreement to these studies, several factors influence in a higher or lesser intensity that take place during

the old age, where social and biological aspects intertwine outlining cognition in adulthood.

Pharmacological Interventions

The growing awareness of Mild Cognitive Impairment (MCI) has given place to the development of therapies aimed at preventing Alzheimer's disease. The first pharmacological studies performed with the intention of treating patients with drugs for amnesic MCI in a period ranging from 6 months to 3 years were mostly unsuccessful [36]. The behavior of MCI as a means of a therapeutic target for regulatory approval cannot be stated clearly [37]. Diverse clinical trials made with cholinesterase inhibitors have been undertaken on MCI, although with variable results obtained [38-41].

The Memory Impairment Study made with donepezil, vitamin E and placebo resulted into the following; the group under treatment with donepezil reduced the risk of contracting AD for the first 12-month period, but the effect does not reach 36 months. A longer response remains at 24 months in the ApoE4 carrier subgroup [39]. Galantamine [40] and rivastigmine studies in the treatment of MCI have not provided support for the use of acetylcholinesterase inhibitors in preventing progression of MCI to dementia [41]. Inhibitors made with a base of cholinesterase are not recommended for treatments of MCI due to the fact that apparently, this therapy does not prove to have lasting benefits. A 2012 review and meta-analysis of available studies concluded that in patients with MCI there was little evidence that treatment with cholinesterase inhibitors affected progression to dementia or improved cognitive test scores, and that there was significant evidence of an increased treatment-associated adverse events, particularly gastrointestinal [42].

Some important data in regards to pharmacological treatment of cognitive deficits in old age comes from the significant contribution made by "The Alzheimer's Disease Neuroimaging Initiative (ADNI)." This study was developed in order to provide biomarkers that predict the progression from normal aging or mild cognitive impairment (MCI) to dementia, especially in Alzheimer's disease (AD). In this study, 812 participants were enrolled from 59 different centers (188 with mild AD, 229 with MCI and 229 normal subjects). Apart from providing information about biochemical and imaging biomarkers of cognitive decline, the ADNI also provides important data about clinical factors like pharmacological interventions in patients with cognitive deficits [43]. Schneider and colleagues [44] report the changes in cognition and every day activities of patients with MCI and AD that participate in the study.

The assessment tools included were: Assessment Scale-cognitive subscale (ADAS-cog), Mini-Mental State Examination (MMSE), Clinical Dementia Rating (CDR) scale, and Functional Activities Questionnaire. The MCI patients were divided into 3 groups and were compared at a baseline and 2-year outcomes. The 3 groups were divided as follows: those who received no treatment, those receiving cholinesterase inhibitor (ChEI) only, and those receiving a combined treatment. The AD patients were separated into two groups only; those who received ChEIs and those who received combined treatment [44]. Looking at the percentages obtained in the analysis performed, it can be noted that, at baseline,

44.0% of MCI patients received ChEIs; 11.4%, memantine hydrochloride; and 53.5%, neither. When these percentages are compared with the ones presented in other studies conducted between 2003-2009 that analyze the drugs used for the treatment of mild (AD), the ChEI and memantine rates are quite similar. However, when compared to the NIH National Alzheimer's Coordinating Center (NACC) during 2009, the rates found in the ADNI study are quite higher [44].

An important conclusion provided by this study is that in the assessment tools referred above, the MCI patients who received ChEIs had worse scores on average and showed a more severe decline than those who did not. Another important fact is that their scores deteriorated more rapidly and they were very similar to AD patients [44]. These results provide additional evidence regarding the limited treatment options that physicians have regarding pharmacological intervention in patients with cognitive deficit; and show that although it is not recommended by the US Food and Drug Administration, many physicians frequently prescribe ChEIs and memantine earlier, especially when patients are relatively more severely impaired.

As it was demonstrated in the investigations analyzed, it can be concluded that, currently, no drugs or other treatments for mild cognition are approved by the Food and Drug Administration (FDA.) Nevertheless, MCI is a wild field to be researched and clinical studies with anti-amyloids are being studied in order to become treatments that may improve symptoms, prevent, or delay progression towards dementia.

Evidences indicate that the importance of environment and lifestyle are factors that influence the development of Alzheimer's from MCI. These "protectors" comprehend premorbid IQ, education, and involvement in both leisure and social activities [45]. Promising findings have been reported from investigations that make use of cognitive training in MCI [46, 47, 48, 49]. Apparently, the success of cognitive training depends on the severity that takes place between a normal aging process and dementia. These conclusions obtained from individuals that possess mild cognitive impairment need to be the subject of further testing in order to be confirmed [50].

The use of exercise programs ranging in duration from 6 to 12 months in two randomized trials of patients with MCI was associated with modest improvement in some cognitive measures in two studies [51], but not in the others [52]. Complementarily the pharmacological interventions proposed to enhance cognition, in the following sections evidence relevant to verify the hypothesis that occupational complexity and leisure time activities can improve cognitive development over the adult's life course will be reviewed.

Environmental Complexity and Cognitive Aging. The Present Investigation Analyzes the Importance of Working Areas and the Involvement of Older Adults in Recreational Activities During Free Time

Occupational Trajectories

Definition

The benefit for the well-being of the community has its roots in occupational wellness, which is in turn reflected in the contribution of personal skills and talents a human being can offer society. An individual can feel meaningful when he

expresses his work through paid or unpaid activities made for the benefit of the community [53]. Wilcock [54] defined occupation in terms of every single activity people do or become for functional purposes; social, physical, mental and spiritual reasons for survival; for health; for meeting obligations; for choice or habit, as well as for finding meaning and purpose.

Johnson and colleagues [55] state that the elder tend to maintain their lifestyle and, consequently, their routine practices connected to their daily occupations during the working day. Social activities are related to the general welfare, considering that they provide opportunities that allow confirmation of the role and identity [56]. Therefore, in relation to the different psychological and social aspects that can act as buffer factors of cognitive decline in old age, occupation may be particularly important in order to examine the possible associations between intellectual stimulation and cognitive impairment.

Although it is true that most people spend most of their time working, the level of understanding of the actual relationship that occurs between involving in an occupational activity and enforcing cognition is not complete. In the framework of the theory of environmental complexity, Schooler, Mulatu and Oates [57] postulate that older adults who are exposed to complex environments, work or recreational activities, receive the opportunity to continue exercising their cognitive abilities; as a consequence, they preserve their cognition's proper functioning for a longer period. Several investigations [58, 59] that consider the afore mentioned theory works as a neuro-protector component of aging, defend that even though a kind of work represents challenges to the cognitive functions in question, individuals are less prone to manifest a reduction in their cognition's performance; specially by doing activities that imply a high intellectual effort, such as interaction with other people and communication [60].

Occupational Complexity

When discussing the relationship between working activity and cognition, a main aspect refers to work complexity. Kohn and Schooler [62] explained the effect of complexity of work on cognitive functioning in normal subjects. They examined the reciprocal causal relationship between work and intellectual functioning through life time. The general hypothesis of the earlier studies on the effects of work complexity and intellectual functioning [63] suggested that the complexity of an individual's environment is defined by its stimuli and the characteristics they demand.

They suggested that the most important distinctive of complex environments was the presence of diverse stimuli. These settings present to the individual the necessity of making a great number of decisions that require several considerations to be taken into account. These demands are the ones that transform simple environments into complex ones. On the other hand, simple surroundings should be rewarding enough in comparison with the commitment needed to insure the continuance of relatively high levels of cognitive functioning.

To support the environmental complexity hypothesis, Kohn and Schooler [61] and Schooler Mulatu and Oates [63] derived a factor score from self-reports about complexity of

work with data, people and things modeled after the Dictionary of Occupational Titles, 3rd edition (U.S. Department of Labor) [64]. The results shed new evidence about the impact that substantive complexity of work has on intellectual flexibility and cognitive functioning [65].

The central source of evidence for the general hypothesis, established by the Kohn-Schooler [62] research program on the psychological effects of occupational conditions, proves that complex environments have a positive effect on individuals' cognitive functioning; whereas simpler ones leave negative consequences on human beings. The core findings of the program were derived from a structural equation model based on studies of a longitudinal survey made with data collected from a representative sample of American men in 1964 and from a subsample of the same men re-interviewed in 1974. The use of non-recursive reciprocal effects models permitted to state that there is a causal connection between job conditions and intellectual functioning. These causal associations have been replicated in studies on women [66] and in a variety of cross cultural settings [67, 68].

Following this line of thought, a study performed by Finkel and colleagues [69] evaluates the association between complexity of the main lifetime occupation and changes in cognitive ability later in life. They managed to develop their investigation by analyzing information about the complexity of working with data, people, and things and on four cognitive factors (verbal, spatial, memory, and speed).

The results indicated that the individuals with complex works demonstrated higher mean performance on the verbal, spatial, and speed factors. The latent growth curve analyses indicated that, after correcting the educational matrix, complexity showed differences in cognitive performance and the rate of cognitive change; especially when a non-interrupted engagement was implemented in people who received help in order to facilitate their verbal functions before retirement.

In the clinical setting, Bosman and colleagues [58] found that higher mental work demands were associated with lower risk of cognitive impairment. Potter, Helms and Plassman [59] concluded that greater general intellectual effort, human interaction and communication were associated with better cognitive performance. At the same time, studies made with patients that suffered from dementia [70, 71, 72] provided empirical evidence with regards to the existent association between complex environments during the working path of individuals and their cognitive condition. Those whose tasks involve high personal interaction and intellectual activity, evidence a delay in the manifestation of characteristic symptoms of Alzheimer's; while the ones involved in tasks with low cognitive demand and high physical activity show cognitive disorders earlier in life [73].

Fritsch and colleagues [74] point out that other aspect that influences cognitive performance, when compared to the working path, is education. They observed that, generally, there is a positive association between high educative levels and the development of complex works. At the same time, education would reduce the risks of having Alzheimer's or would retard the appearance of cognitive symptoms that characterize the disorder. The level of education a person

has, associated to the working path, provide due account of an important variety percentage observed in older adults' cognitive behavior. The level of education is an indicator of the subject's cognitive reserve.

Leisure Activities and Cognitive Aging

Definition

The activity theory was formally introduced by the investigation of Lemon, Bengston and Petersen [75]. A later version of the activity theory was presented by Rowe y Kahan [76] in an attempt to identify the main factors that enhance "successful aging". Menec [77] defined active engagement as productive activity, paid or unpaid, which pursues the maintenance of interpersonal relations. The proper functioning of cognitive abilities in old age, even if activities are performed so as to avoid the inevitable consequences of the passing of time, is subject of study in the field of gerontology.

Studies developed in the field of leisure activities [78, 79, 80] provide complementary evidence to the ones already presented by the investigations made in the area of working activities. Schooler & Mulatu [81] made a research on the relation that exists between performing activities during free time and cognitive functions. They contrasted two groups (one composed of middle-aged adults and the other of senior adults) while they were making leisure activities of different complexity levels and intellectual performance. The authors found meaningful results that defend the relation that exists between the involvement in complex leisure activities and the intellectual functioning in both groups. In accordance to the authors, the fact that a person makes complex activities during his free time improves the intellectual effectiveness, while less complex activities worsens it.

Social Engagement and Cognition in Old Age

In the field of recreational activities, The key importance of social activities as a way to grant neuro-protection during the old age is vital to mention. There is empirical evidence that supports the idea that social engagement has beneficial results on cognition in old age [82, 83]. Social engagement has typically been defined in rather broad terms. A socially engaged individual is one who is socially active and maintains numerous social connections [84].

One of the first studies that examined the relationship between social engagement and cognitive decline was conducted by Bassuk and colleagues [85]. The authors used a composite index that included indicators of social participation and social networks. Cognition was assessed four times, during a 12-year period, with a brief mental status test. The results showed that the people with higher engagement experienced less cognitive decline. Taking as source information from the Berlin Aging Study, Lövdén and colleagues [83] found similar results. They stated that engagement in social activities improves the cognitive status of human beings. The results showed that different levels of participation in social activities gave an approximation of the decline rate in perceptual speed, but the initial levels obtained from perceptual speed did not predict changes in social activity participation.

The results from Cherry and colleagues [86] are in line with epidemiological studies and highlight the importance of social participation in relation to cognitive health of older adults. The results of this study suggest that current social engagement measures are proxy variables for activity level or everyday functioning.

In a bibliographical review performed by Hertzog and colleagues [23] it was informed that there are limits imposed on clinical-pathologic research that refer to the relationship between social engagement and cognition in adulthood. They indicated that it is difficult to state an association between indicators of social engagement and Alzheimer's disease pathology [87]. The main problem in the study of the relationship between these two variables is that the decline in social participation of the elderly, may be caused by the presence of cognitive disorders, and many times it is difficult to determine which is the reason and what is the effect in the implication's chain.

There are many aspects that modulate the relationship between aging and cognition, like depressive symptomatology, cognitive and physical activity. After analyzing many studies that control for some [84, 85, 88, 89] or all [82, 90, 91] of these factors, Hertzog and colleagues [23] concluded that there is a possibility that social participation is an index of behavioral or neural plasticity. He defended that when the elder are engaged in active social lifestyles, they can experience compensations for degenerative changes that take place in their neural system because of the passing of time, which, as a consequence, affect their cognitive functioning. The main reason to defend this theory derives from a clinical-pathologic research that gave as result that the size of an individual's social network modifies the relation of neurofibrillary tangles to different levels as people age [87]. As the social network's size increased, a decrease could be observed in the density of tangles with semantic memory and working memory. These results indicate that neural systems that develop and maintain a large social network could compensate the effects for Alzheimer's disease on cognitive systems, perhaps by attracting alternate neural systems to cooperate in the support of cognitive functioning.

CONCLUSION

According to the revision done taking as source the scientific literature written over the last thirty years, it can be concluded that:

- There is vast scientific production that supports the normal course of intellectual development when adulthood is reached, and it can be positively influenced if an enriched cognitive lifestyle is lead. That is to say, complexity of work and participation in leisure social activities can work as attenuators for cognitive decline during old age. What is more, not only the ability to have an independent life can be extended; but also neurodegenerative disorders can be postponed.
- While biology outlines the broad contours of cognition through the aging process, several studies describe the role that exposure to complex environments has in the design of different cognitive

trajectory lines in old age. New concepts, like “behavioral plasticity”, are stated in order to capture the interface between social factors and biology in the aging process.

- Regarding the treatment of cognitive deficits in old age, there is little evidence that cholinesterase inhibitor drugs, affect progression to dementia or improve cognitive performance. When referring to the treatment of MCI no drugs are specifically approved by the FDA. Different research lines have shown mixed results obtained from studies performed using cognitive training in MCI. An increasing amount of evidence indicates the importance of environment and lifestyle as protective agents for the development of Alzheimer’s disease from MCI. Among the “protectors” are included: premorbid IQ, level of education reached, performance of leisure activities and engagement in social tasks.
- Among the social factors that modulate cognition in old age, environmental complexity plays a key role with respect to work and leisure activities in older adults. Complex environments benefit cognitive performance in old age and motivate the individuals to develop intellectual abilities; apart from promoting the generalization of those abilities to other areas of life.
- The results of the outlined studies confirm that intellectually demanding jobs are associated with better cognitive performance, suggesting that individuals may benefit cognitively when they have the opportunity to participate in complex activities.
- In connection to recreation in old age, the reviewed studies show empirical evidence suggesting that increased participation of older adults in leisure activities is associated with a lower risk of cognitive decline in old age. When a human being engages in leisure activities he is reducing his cognitive decline while unconsciously building his cognitive reserve and reducing exposure to chronic stress, fighting social isolation and promoting a healthy lifestyle.
- Regarding cognition, there is empirical evidence from clinical pathologic studies that support the hypothesis that social engagement has beneficial effects in the neuropathology of the aging process.
- Taking into consideration the implications for the clinical setting, it is vital that health professionals who work with older adults highlight the benefits that activity has on the entire life cycle and especially in old age. If an active, engaged person includes enhancing activities as complements of his routine, then cognitive enrichment results will be even more positive. Health professionals should focus their recommendations so as to motivate patients to focus their attention in the sustainability and maintenance of their cognitive abilities. In this aspect, the promotion of intellectual activities should be included. There are some actions which are especially important for elder citizens, preferably, those performed in social contexts.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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