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**INFLUÊNCIA DAS CARACTERÍSTICAS SOCIODEMOGRÁFICAS E DA OCUPAÇÃO DOS TEMPOS LIVRES NO DESEMPENHO NA PLATAFORMA DE TREINO COGNITIVO PRIMERCOG**

**THE INFLUENCE OF SOCIODEMOGRAPHIC CHARACTERISTICS AND LEISURE ACTIVITIES IN THE PERFORMANCE ON COGNITIVE TRAINING PLATFORM PRIMERCOG**

**INFLUENCIA DE LAS CARACTERÍSTICAS SOCIODEMOGRÁFICAS Y DE LAS ACTIVIDADES DE OCIO EN EL DESEMPEÑO EN LA PLATAFORMA DE ENTRENAMIENTO PRIMERCOG**

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## RESUMO

**Introdução:** A sociedade está a envelhecer rapidamente, conseqüentemente aumentando a prevalência de demências. Os défices cognitivos relacionam-se com inúmeras variáveis, sendo algumas delas apontadas como possíveis protetoras. Segundo a teoria da reserva cognitiva, a prática de atividades estimulantes ao longo da vida pode ter como efeito a diminuição do risco de demência. Neste contexto, a MediaPrimer está a desenvolver a plataforma de treino cognitivo *online* primerCOG, com um conjunto de onze atividades cognitivas estimulantes destinadas a seniores.

**Objetivo:** Analisar a influência das variáveis escolaridade e idade, e da ocupação dos tempos livres, no desempenho nas atividades do primerCOG.

**Métodos:** Investigação quantitativa não-experimental de carácter transversal. Amostra de 30 seniores cognitivamente saudáveis.

**Resultados:** Observaram-se associações positivas entre a escolaridade dos participantes e o nível máximo de desempenho em todas as atividades, verificando-se, por outro lado, uma associação negativa do desempenho na maioria das atividades com a idade dos participantes. Adicionalmente, verificou-se que os participantes que praticavam regularmente atividades de tempo livre cognitivamente estimulantes, tiveram melhores desempenhos nas atividades.

**Conclusões:** A confirmação das variáveis com influência no desempenho cognitivo em seniores cognitivamente saudáveis é útil para se compreender o desenvolvimento de demências. Futuramente será importante replicar o estudo com novas variáveis, como o número de horas diárias despendidas nas atividades ou o QI pré-mórbido do participante.

**Palavras-Chave:** Envelhecimento; Reserva Cognitiva; Déficit Cognitivo; Treino Cognitivo

## ABSTRACT

**Introduction:** Society is rapidly aging, and there is a consequent increase in the prevalence of dementia. Cognitive deficits are related to many variables, some of them are pointed out as possible protectors. According to cognitive reserve theory, practicing stimulating activities throughout life may lead to a decrease in the risk of dementia. In this context, MediaPrimer is developing primerCOG, an *online* platform for cognitive training, which includes eleven cognitive stimulating activities for seniors.

**Objective:** Evaluate the influence of variables age and education, and leisure activities, on maximum level achieved in primerCOG's activities.

**Methods:** Quantitative non-experimental and transversal design. Sample includes 30 cognitively healthy seniors.

**Results:** Positive associations were observed between the participants' level of education and the maximum level of performance in all activities. On the other hand, there was a negative association of performance in the majority of activities with the participants' age. Additionally, it was found that participants who regularly practiced cognitively stimulating leisure time activities performed better in activities.

**Conclusions:** Results confirm that some variables influence cognitive performance in cognitively healthy seniors, which may be useful to understand the development of dementia. In the future, it will be important to replicate the study with new variables, such as the number of hours spent per day in the activities or the participant's pre-morbid IQ.

**Keywords:** Aging; Cognitive Reserve; Cognitive Impairment; Cognitive Training

## RESUMEN

**Introducción:** La sociedad está envejeciendo rápidamente, aumentando la prevalencia de las demencias. Los déficits cognitivos se relacionan con muchas variables, algunas de las cuales han sido identificados como potenciales protectores. De acuerdo con la teoría de la reserva cognitiva, la práctica de actividades estimulantes durante toda la vida puede reflejar una disminución en el riesgo de demencia. En este contexto, MediaPrimer desarrolló la plataforma online para el entrenamiento cognitivo primerCOG, con un conjunto de once actividades estimulantes cognitivamente para personas mayores.

**Objetivo:** Analizar la influencia de las variables edad y el nivel de educación, y las actividades de ocio, en el nivel máximo alcanzado en las diversas actividades primerCOG.

**Métodos:** Investigación cuantitativa no experimental transversal. Muestra de 30 adultos mayores cognitivamente sanos.

**Resultados:** Se observaron asociaciones positivas entre la escolarización de los participantes y el nivel máximo alcanzado en todas las actividades, y por el contrario, una asociación negativa en la mayoría de las actividades con la edad de los participantes. Adicionalmente, se encontró que los participantes que regularmente practican actividades de ocio cognitivamente estimulantes, tienen un mejor rendimiento en las actividades.

**Conclusiones:** Los resultados confirman la existencia de variables que influyen en el desempeño cognitivo en ancianos cognitivamente sanos, que pueden ser útiles en la comprensión del desarrollo de la demencia. En el futuro será importante para replicar el estudio con nuevas variables, como el número de horas diarias dedicadas a actividades de ocio y CI premórbido del participante.

**Palabras Clave:** Envejecimiento; Reserva Cognitiva; Déficit Cognitivo; Entrenamiento Cognitivo

## INTRODUCTION

Over the last few decades, we have been witnessing substantial demographic changes, associated with significant restructuring processes, namely related to birth and mortality rates, and aging. The number of people over 60 years is expected to rise from about 841 million in 2014, to about 2 billion in 2050, worldwide (World Health Organization [WHO], 2014). It is estimated that in 2020, for the first time in history, the number of people over 60 will be higher than the number of children under 5 years. Portugal is registering one of the highest aging rates among EU countries. Recent projections indicate that this trend will continue, with the aging rate estimated to reach 307 older people per 100 young people by 2060, and that the elderly population will possibly represent about 35% of the total Portuguese population by 2060 (Instituto Nacional de Estatística, 2014).

Aging is a multidimensional process with a high level of subjectivity, dynamism and variability among individuals (Dobrzyn-Matusiak, Marcisz, Bak, Kulik, & Marcisz, 2014). For example, it has been reported that the normal biological and physiological changes associated with aging may occur at a slower pace in people who remain mentally and physically active (Michel, 2016).

The recurrence of clinical observation and literary documentation showing existing differences between the degree of cerebral pathology and the observed clinical manifestation (Stern, 2007) led to the emergence of the concept of Cognitive Reserve. For example, postmortem studies have shown histological changes compatible with moderate-stage Alzheimer's disease in individuals without corresponding symptomatic manifestations (Ince, 2001). Cognitive Reserve plays a crucial role in the aging trajectory of individuals, being related to maintaining a healthy cognitive status and functional capacity, and therefore keeping autonomy and having a better quality of life, for longer periods of time throughout life. Several variables have been associated with an increase in the Cognitive Reserve of individuals, namely education and the practice of some motivating and stimulating leisure activities (Sobral, Pestana, & Paúl, 2014).

Supporting Active and Healthy Ageing, our company, MediaPrimer - Tecnologias e Sistemas de Informação, Lda., in collaboration with Centro de Neurociências e Biologia Celular da Universidade de Coimbra, is developing the primerCOG platform. This is a technology-based platform with a solid scientific background, which aims to contribute to a healthy aging and provide an answer to the needs of stimulation, maintenance, monitoring and cognitive rehabilitation.

The objective of this study is to outline the influence of sociodemographic variables and occupation of leisure time in the performance of the primerCOG activities, using a sample of cognitively healthy senior population.

### 1. THEORETICAL FRAMEWORK

During the aging process, there are several cognitive changes that are seen as normal for the individual's ages. Biopsychosocial changes, occurring due to age progression, are associated with several factors, such as the genetic characteristics, lifestyle, education and the environment of each individual, and imply several repercussions. It is known that, as we get old, the decline in abilities and functions becomes substantially more visible and accentuated, and the vulnerability associated to elderly is aggravated.

Age has been pointed out as the main risk factor for the development of dementia, such as Alzheimer's Disease (AD), or Mild Cognitive Impairment (MCI) (Prince et al., 2013). Considering this, a significant increase in prevalence rates of dementia is predicted for the next decades. Currently, an estimate of 36 million people are diagnosed with Alzheimer's disease and, according to WHO, this number is expected to double by 2030, and to triple by 2050 (Michel, 2016). This urges for action and developing ways to prevent the cognitive decline. This situation is also expected in Portugal, with a considerable increase in the incidence and prevalence of dementia, associated with double population aging (Santana, Farinha, Freitas, Rodrigues, & Carvalho, 2015).

In Portuguese population, there are 160 287 estimated cases of dementia in people over 60 years of age, and there may be between 80 144 to 112 201 Alzheimer's patients. Data from IMSH (Intercontinental Marketing Services Health) indicates that only 76 250 patients are diagnosed with Alzheimer's disease and receiving anti-dementia treatment. (Santana et al., 2015).

It has been widely described that usual cognitive activity practice before dementia diagnostic, helps protecting and slowing down the normal cognitive decline associated with age. The intellectual challenges that a person faces throughout life allow the accumulation of reserves that, as aging occurs, will grant the use of alternative strategies (Sobral & Paúl, 2013).

The concept of reserve is fundamental and has been a focus of research interest, since it is often associated with the way the aging process happens. Reserve concerns the ability of the brain to tolerate a certain amount of injury without the onset of symptoms, and the increase in this capacity may result in a delay in the clinical expression of the neurodegenerative process (Sobral & Paúl, 2013). As already noted, there is often a discrepancy between the clinical manifestation of dementia, or even the absence of symptomatic manifestations, and the degree of cerebral pathology observed in postmortem studies. This data indicates the presence of possible protective factors, such as the reserve.

Reserve is not stable throughout life and depends on several factors, such as genetic, physical condition, socioeconomic level, education, professional occupation, leisure activities, and many others (Cosentino & Stern, 2012; Sobral & Paul, 2013).

The concept of reserve includes both the concepts of cerebral reserve and cognitive reserve. The former concerns a more passive aspect of the reserve and is based on the individual's quantitative or morphological characteristics, such as brain size or number of neurons (Cosentino & Stern, 2012). The latter, related to cognitive reserve, on the other side, is associated with an active reserve model, and is strictly related to a more efficient use of alternative brain networks and the ability to adapt to alternative operations or circuits (Sobral & Paúl, 2013), and may be often stimulated according to the activity of the individual throughout life. Among other

possibilities, a higher education and participating in motivating and stimulating leisure activities have been strongly associated with moderate gains in the cognitive reserve over the life span, resulting in a successful aging, particularly cognitive aging (Sobral & Paúl, 2013).

In cases of clinical diagnosis of either mild cognitive impairment or early-to-moderate dementia, keeping an active lifestyle that includes cognitive and social activities is critical to maintaining functionality and quality of life of both patients and their caregivers. Given the numerous benefits of cognitive training, it is important to invest in strategies that support active aging and that focus on prevention of cognitive decline, such as cognitive training platforms. In order to maximize the possible results, it is important to investigate which variables may influence the use of this kind of solutions.

MediaPrimer, in collaboration with Centro de Neurociências e Biologia Celular da Universidade de Coimbra, is developing primerCOG platform. This is a solid scientific and technological based platform, which aims to contribute to a healthy aging, through activities of cognitive stimulation, maintenance, monitoring and rehabilitation. primerCOG includes two different possibilities of user profiles - the healthy profile (cognitively healthy elderly adults) and the clinical profile (patients with medical diagnosis of neurodegenerative disease, e.g. Mild Cognitive Impairment and Alzheimer's Disease). The development team involved in primerCOG includes researchers and professionals in neurosciences, design and engineering.

primerCOG provides a set of activities focused on occupational health (Cálculos, Classificar Cartões, Colecionar Botões, Descobrir as Diferenças, Encontrar os Gémeos, Labirintos, Lista de Palavras, Na Mesma Ordem, Slot Machine, Torres e Vi ou Li Antes) that allows the cognitive training of memory, attention, executive functions, language and visuospatial ability and requires the ability to perform various tasks such as mental calculation, abstract reasoning, planning and problem solving, and others.

In the creation of primerCOG, in addition to ensuring that the final result was easy to use, we aimed to guarantee that this platform could meet the needs of all potential users. It was developed under a user centered methodology, exploring the user experience concept and adopting the principles of universal design. Changes resulting from the natural aging process were considered, which translated into a variety of characteristics to be assumed and respected on the definition of usability guidelines, and that may clearly interfere in fields such as interaction, navigation, information, functional model, graphical interface and content creation.

Thus, we can affirm that primerCOG has a clear understanding of the users for whom it was created and communicates its concept and objectives in a clear way, while it is appealing and easy to use.

At the moment, primerCOG platform is already functionally validated for elderly adults with a cognitively healthy profile (Teixeira, Costa, Alecrim, Freitas, & Santana, 2015), which allows us to confirm the suitability of cognitive training activities and the design applied to its users.

## 2. METHODS

Quantitative non-experimental and transversal design.

In the present transversal study, sociodemographic data and the cognitive evaluation of the participants were initially collected, followed by the intervention's period with the activities of the online cognitive training platform primerCOG.

### 2.1 Sample

The sample includes 30 institutionalized or day-care elderly, with a mean age of 73.73 years and a mean educational level of 9.53 years, of which 28 participants were women (Table 1).

**Table 1** - Characteristics of the sample regarding socio-demographic variables of education and age

<i>Variables</i>	<i>Levels</i>	<i>N</i>	<i>Mean (SD)</i>
Age	60 – 94 years		73.73 (9.86)
Education	1 – 16 years		9.53 (5.00)
	Basic Education (1 - 9 years)	43.3% (n = 13)	
	Secondary education (10 – 12 years)	20% (n = 6)	
	Higher education (Licentiate's degree)	36.7% (n = 11)	
Gender	Feminine	93.3% (n = 28)	

### 2.2 Data collection instruments

All the participants answered the following instruments in this exactly order: (i) sociodemographic questionnaire and inventory of leisure activities (both instruments were developed for this study); (ii) Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975; Freitas, Simões, Alves, & Santana, 2015) and (iii) Montreal Cognitive Assessment (MoCA; Nasreddine

et al., 2005; Freitas, Simões, Alves, & Santana, 2011). The last two instruments allowed to ensure the participants' healthy cognitive status, according to the normative data for the Portuguese population (Freitas et al., 2011, 2015).

### 2.3 Inclusion criteria

The inclusion criteria were: (i) Portuguese as native language; ii) 60 or more years; iii) regular performance in cognitive screening tests, according to normative values for Portuguese population; (iv) no clinical history of psychiatric or neurological pathology; (v) no records of alcohol or other substances abuse.

### 2.4 Procedures

After establishing contact with care institutions for the elderly and identifying the project's participants, the next step was to obtain their written informed consent. The study and all its sessions were conducted in an adequate environment and the conditions were standardized for all the participants.

Only users that have shown a regular cognitive performance for their education and age after conducting the initial evaluation were eligible for participation. This initial assessment was prior to the intervention phase, which consisted in executing cognitive training activities up to the Maximum Level Achieved (MLA).

primerCOG platform has a set of activities which stimulates several cognitive domains, such as: attention, executive functions, memory and visuospatial ability (others are in the implementation phase). All these activities have several levels of difficulty, and in this study, the goal was for each participant to execute each one of them, up to the highest level (MLA).

The intervention sessions with the activities lasted for an average duration of one hour and the average number of sessions was equal to six ( $M = 6.3$ ). The average number of cognitive activities from primerCOG platform performed per session was two ( $M = 2.36$ ).

### 2.5 Data analysis

The statistical program "Statistical Package for Social Sciences" (IBM, SPSS Version 20) was used for data analysis. Descriptive statistical analyses were performed to characterize the sample and the sessions. Pearson's Correlations allowed the analysis of the relationship between sociodemographic variables and MLA in cognitive training activities, and between leisure time occupation and MLA. Linear Regression Model (LRM) was also used to study the influence of education and age variables in MLA.

In order to interpret the correlation results, Cohen (1988) guidelines were used, considering values of .10, .30 and .50 as small, moderate and high effects, respectively. In the analysis of effect size in the regressions, the Cohen references were also used, and the coefficient of determination ( $R^2$ ) was interpreted, considering values of .02, .13 and .26 as small, medium and high, respectively.

## 3. RESULTS

In the cognitive screening tests that were given to the participants to ensure their healthy cognitive state, results were: in MMSE:  $M = 28.53 \pm 1.2$ , and in MoCA:  $M = 21.60 \pm 4.92$ . In addition to considering a normal individual cognitive performance as an inclusion criteria, it was found that the mean scores in this sample are above the reference values for the portuguese population (Freitas et al., 2011; Freitas et al., 2015).

### Influence of education and age on MLA in each activity

In general, there were positive and statistically significant correlations between MLA and education. Thus, the higher the education, the higher the MLA. Education statistically influenced MLA in almost all activities, with the exception of Torres activity ( $r = .279$ ,  $p = .135$ ), which is based on the well-known Tower of Hanoi task (TOH).

Concerning age, there were negative correlations between MLA and age, so the bigger the participant's age, the lower the MLA. The negative and statistically significant correlations between MLA and age were found for almost all activities, with the exception of Labirintos activities ( $r = -.163$ ,  $p = .389$ ) and Torres ( $r = -.100$ ,  $p = .600$ ). The correlation values between both education and MLA and age and MLA are shown in Table 2.

Table 3 shows the values of the LRM analysis for the different activities and for education and age.

**Table 2** - Pearson Correlations between education and MLA and between age and MLA in each of the eleven cognitive activities tested

	Education	Age
MLA Cálculos	$r = .819; p = .000^{**}$	$r = -.754; p = .000^{**}$
MLA Classificar Cartões	$r = .668; p = .000^{**}$	$r = -.435; p = .018^{*}$
MLA Colecionar Botões	$r = .641; p = .000^{**}$	$r = -.476; p = .008^{**}$
MLA Descobrir as Diferenças	$r = .436; p = .018^{*}$	$r = -.388; p = .038^{*}$
MLA Encontrar os Gêmeos	$r = .538; p = .002^{**}$	$r = -.556; p = .001^{**}$
MLA Labirintos	$r = .578; p = .001^{**}$	$r = -.163; p = .389$
MLA Lista de Palavras	$r = .561; p = .001^{**}$	$r = -.489; p = .006^{**}$
MLA Na Mesma Ordem	$r = .499; p = .005^{**}$	$r = -.474; p = .008^{**}$
MLA Slot Machine	$r = .689; p = .000^{**}$	$r = -.467; p = .009^{**}$
MLA Torres	$r = .279; p = .135$	$r = -.100; p = .600$
MLA Vi ou Li Antes	$r = .415; p = .023^{*}$	$r = -.483; p = .007^{**}$

\*  $p < .05$ . \*\*  $p < .01$ **Table 3** - Linear regression to analyze the influence of education and age in MLA in each cognitive training activity

	B	SE B	$\beta$	sig
<b>MLA Cálculos</b>				
$R^2 = .733; F(2, 27) = 40.878, p = .000$				
Age	-.056	.019	-.378	.006
Education	.465	.104	.569	.000
<b>MLA Classificar Cartões</b>				
$R^2 = .458; F(2, 26) = 10.977, p = .000$				
Age	.018	.025	.163	.467
Education	.479	.134	.791	.001
<b>MLA Colecionar Botões</b>				
$R^2 = .416; F(2, 26) = 9.613, p = .001$				
Age	-.013	.027	-.092	.642
Education	.439	.148	.580	.006
<b>MLA Descobrir as Diferenças</b>				
$R^2 = .208; F(2, 26) = 3.417, p = .048$				
Age	-.013	.017	-.178	.449
Education	.128	.093	.319	.180
<b>MLA Encontrar os Gêmeos</b>				
$R^2 = .361; F(2, 27) = 7.630, p = .002$				
Age	-.063	.036	-.356	.094
Education	.292	.197	.303	.150
<b>MLA Labirintos</b>				
$R^2 = .420; F(2, 27) = 9.765, p = .001$				
Age	.075	.038	.389	.057
Education	.887	.207	.835	.000
<b>MLA Lista de palavras</b>				
$R^2 = .339; F(2, 27) = 6.932, p = .004$				
Age	-.027	.027	-.210	.322
Education	.300	.148	.422	.053

	<i>B</i>	<i>SE B</i>	<i>β</i>	<i>sig</i>
<b>MLA Na mesma ordem</b>				
$R^2 = .286; F(2, 27) = 5.396, p = .011$				
Age	-.020	.017	-.256	.248
Education	.142	.093	.330	.140
<b>MLA Slot Machine</b>				
$R^2 = .475; F(2, 27) = 12.229, p = .000$				
Age	-.003	.023	-.021	.912
Education	.453	.124	.676	.001
<b>MLA Torres</b>				
$R^2 = .091; F(2, 27) = 1.346, p = .277$				
Age	.010	.016	.150	.544
Education	.137	.088	.378	.133
<b>MLA Vi ou Li Antes</b>				
$R^2 = .250; F(2, 27) = 4.492, p = .021$				
Age	-.025	.015	-.371	.107
Education	.062	.081	.170	.451

#### Influence of leisure time occupation on the performance of the primerCOG platform activities

86.7% of participants report reading habits, 93.3% television, 56.7% cinema, and 43.3% internet, at least once a week.

Positive but non-significant correlations were found between reading and cinema habits and MLA, in all activities. Correlations between use of internet and MLA was positive and statistically significant for all activities. Relatively to the variable "watching television", the association was negative in some activities and with statistical significance in the activities "Na Mesma Ordem" ( $r = -.433, p = .017$ ), "Slot Machine" ( $r = -.518, P = .003$ ) and "Vi ou Li Antes" ( $r = -.480, p = .007$ ). Pearson's  $r$  values are shown in Table 4.

**Table 4** - Pearson's correlations between leisure time occupation and MLA in the cognitive training activities

	<i>Reading</i>	<i>Television</i>	<i>Cinema</i>	<i>Internet</i>
MLA Cálculos	$r = .149; p = .432$	$r = -.222; p = .239$	$r = .090; p = .635$	$r = .632; p = .000^{**}$
MLA Classificar Cartões	$r = .190; p = .324$	$r = -.315; p = .096$	$r = .092; p = .634$	$r = .785; p = .000^{**}$
MLA Colecionar Botões	$r = .093; p = .626$	$r = .013; p = .944$	$r = .130; p = .494$	$r = .709; p = .000^{**}$
MLA Descobrir as Diferenças	$r = .230; p = .230$	$r = -.222; p = .248$	$r = .191; p = .321$	$r = .490; p = .007^{**}$
MLA Encontrar os Gémeos	$r = .169; p = .373$	$r = .037; p = .848$	$r = -.025; p = .894$	$r = .511; p = .004^{**}$
MLA Labirintos	$r = .174; p = .358$	$r = -.166; p = .381$	$r = .147; p = .438$	$r = .435; p = .016^*$
MLA Lista de Palavras	$r = .234; p = .214$	$r = -.212; p = .260$	$r = .330; p = .075$	$r = .615; p = .000^{**}$
MLA Na Mesma Ordem	$r = .137; p = .469$	$r = -.433; p = .017^*$	$r = .135; p = .476$	$r = .710; p = .000^{**}$
MLA Slot Machine	$r = .231; p = .219$	$r = -.518; p = .003^{**}$	$r = .240; p = .202$	$r = .674; p = .000^{**}$
MLA Torres	$r = .031; p = .872$	$r = -.292; p = .117$	$r = .019; p = .923$	$r = .431; p = .017^*$
MLA Vi ou Li Antes	$r = .201; p = .286$	$r = -.480; p = .007^{**}$	$r = .061; p = .749$	$r = .483; p = .007^{**}$

\*  $p < .05$ . \*\*  $p < .01$

#### 4. DISCUSSION

After conducting the functional validation of the primerCOG platform (Teixeira et al., 2015), in which the adequacy and feasibility to use cognitive training activities among the elderly were analyzed, the present paper investigates the influence of sociodemographic variables and leisure habits in the performance of participants in these activities.

Results obtained point to a positive and statistically significant correlation between the educational level of the participants and their cognitive performance in most activities, with an expected higher MLA in the participants with higher education, with the exception of the Torres activity. This activity presents positive values, they are not significant. In general, LRMs also allowed us to confirm these results by presenting moderate to high values of explained variance, and highlighting the statistically significant influence of education in participants' performance in most activities, with the exception of the Torres activity. In an earlier study, which aimed to understand the influence of sociodemographic variables in the performance of adults in a TOH task, results also indicated that, among several variables, education was the only one that had no influence on performance (Rönnlund, Lövdén, & Nilsson, 2001). The potential protective effect of education on neurodegenerative processes, namely in Alzheimer's disease, has been extensively investigated. Some studies have shown a lesser cognitive decline in higher educated individuals (Amieva et al., 2014). This trend can be explained by the level of premorbid intelligence and cognitive reserve, which are highly influenced by educational level. They act in a compensatory way by assisting the use of alternative networks after brain lesions related to dementia states occur (Amieva et al., 2014). The concept of premorbid intelligence has had a prominent interest in recent research as it was found essential to assess one's current performance and as a relevant asset to neuropsychological evaluation (Alves, Freitas, Martins, Santana, & Simões, 2013). A correct estimation of premorbid intelligence is important to evaluate the existence, nature and degree of potential cognitive decline (Alves, Martins, & Simões, 2010).

Concerning the age of participants, there were negative and statistically significant correlations between age and MLA in the cognitive activities. Therefore, it is expected that older participants will achieve a lower MLA than younger participants in all activities, except in Torres and Labirintos. Regarding LRM results, age alone does not significantly influence performance in general activities, with the exception of the Cálculos activity, in which performance significantly decreases as the participants' age increases. These results, namely the absence of statistical significance concerning age influence in other activities performance should be carefully interpreted, given the constraint of having a small sample size. This limitation may not allow sufficient representativeness of all age groups. Nevertheless, it is possible to identify a negative association between age and performance in cognitive tests, which is a consensual result among literature, and indicates that as individuals grow older, cognitive difficulties increase. In the study mentioned above, conducted by Rönnlund and colleagues (2001), the authors also confirm this negative relation between age and performance, even if it was only for Torres activity.

This study shows some results in compliance with literature, evidencing a greater influence of education in cognitive performance when comparing to the influence due to individual's age (Passos et al., 2015). However, given the high association of these two variables and consequently the possible presence of multicollinearity effects, more robust conclusions may only be reached after analyzing these variables independently, or investigating the effects of modelling these variables in cognitive performance.

Leisure habits have often been associated with differences in cognitive performance and development of dementia (Wang et al., 2013). Literature describes that practicing stimulant activities is related to a distinct pattern of development of dementia, sometimes identified as a protective effect. Hughes and colleagues (2010) conducted an investigation that described that cognitively stimulating activities are associated with a reduced risk of Alzheimer's development, in which the importance of reading was reinforced. Participants who indicated their preference in spending time reading and watching movies had consistently a better performance, though not significantly.

Occupation of leisure time browsing the Internet was significantly associated to all primerCOG activities, greatly contributing to a better performance. More and more, it is acknowledged that digital literacy is important and can help reducing the risk of cognitive decline, regardless of age and socioeconomic status of individuals (Xavier et al., 2014), and this finding may explain the participants' results on the present study. Also, familiarity with technological devices can contribute to more positive results in the execution of the activities, achieved by these participants.

Spending time watching television was negatively associated with the participant's performance in activities, and results were significant in "Na Mesma Ordem", "Slot Machine" e "Vi ou Li Antes". Hoang and colleagues (2015) evaluated a group of subjects over 25 years and studied their patterns associated with physical activity or watching television habits. They concluded that individuals who spent a long period of time watching television (> 3 hours / day) presented inferior performance in cognitive activities. This result may be easily understood if we consider that watching television is usually associated with a sedentary lifestyle, which increases the risk of cognitive impairment.

The outcome related to participation in stimulating activities such as reading, cinema or using internet, combined with the results that were obtained in education, indicates a possible relation with the concept of cognitive reserve. In fact, the most stimulated individuals presented better results in activities. This is a relevant conclusion because, as the concept of reserve suggests, and from what has already been described, individuals with higher educational level or the ones who practice stimulating occupational and leisure activities have a lower risk of developing dementia (Sobral & Paúl, 2013).



The set of results described in here indicates that there are indeed, variables that influence the performance of individuals in cognitive training tests. Knowing these variables and how they behave may be an important step to act in advance, to promote healthier behavior or to change certain habits that may be harmful. On the other hand, encouraging research in this area will also allow the adaptation of cognitive training activities according to certain characteristics considered important (e.g., the number of years of education of the subject), which will maximize the possible expected results.

## CONCLUSIONS

The aim of this study was to explore whether sociodemographic variables, such as education and age, and habits of leisure activities, could influence performance on cognitively healthy seniors, during their online cognitive training with primerCOG platform.

Results show that individuals with higher education usually have better performance in cognitive activities. On the other hand, these results indicate that there is a lower performance as age increases. However, the influence of age in performance is lower when compared with education. The results obtained are consistent with what has been described in literature, with cognitive performance being less influenced by age rather than by education.

Results concerning leisure time seem to indicate that participating in stimulating activities such as reading, cinema and browsing on the internet are associated with higher levels of performance in cognitive activities. On the contrary, seniors who spend most of their free time watching television showed lower results.

This study had some constraints, namely the reduced sample and the fact that it was not possible to measure time spent on leisure activities, which may be a relevant factor in similar studies.

This research field is gaining a great importance and, in the future, efforts shall be made in proving which variables may be associated with different levels of performance in cognitive training activities, once these results may reflect the individual's cognitive capacity or impairments. In addition to replicating the present study with a larger sample, it may be pertinent to add the study of other variables, such as the level of participants' IQ, which may relate to or overlap with the effects of education. It is also important to check the amount of time spent with leisure activities.

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