HEALTH PSYCHOLOGY REPORT · VOLUME 10(4), 2022
ORIGINAL ARTICLE

Adelinda A. Candeias
A,B,C,D,E,F,G
Edgar Galindo
A,C,D,E

Cognitive aging: why we need creativity to increase cognitive preservation

BACKGROUND
In general terms, aging is associated with a decline in cognitive skills. Nevertheless, researchers are aware of the existence of persons quickly losing cognitive skills during aging, in contrast to others whose skills are preserved. Consequently, an increasing amount of research in the last years has been devoted to individual differences in decline and possible factors affecting cognitive preservation. Creative engagement seems to play a role as a protective factor against cognitive decline in the elderly.

PARTICIPANTS AND PROCEDURE
The current correlational study aims to analyze individual differences in terms of cognitive skills in elderly persons engaged or not engaged in creative daily activities. It is hypothesized that creative activities are correlated with higher preservation of cognitive skills in elderly persons. 80 elderly non-institutionalized persons living in the Alentejo region (Portugal) took part voluntarily in this study; 40 of them were male elderly (N = 40, ages from 65 to 90 years) and 40 were female elderly (N = 40, ages from 65 to 89 years). Cognitive skills were assessed with the Mini-Mental State Examination.

RESULTS
The results seem to show that creative activities are negatively correlated with cognitive decline in female and male elderly persons. The results of this study seem to emphasize the importance of activities of creative production and expression in the preservation of cognitive functions.

CONCLUSIONS
These results suggest the importance of creativity for cognitive preservation and the need to produce innovative strategies to increase and support creative production and expression in elderly persons.

KEY WORDS
cognitive preservation; cognitive decline; creativity; Mini-Mental State Examination; successful aging; engagement, inclusion

ORGANIZATION – School of Health and Human Development, Department of Medical Sciences and Health & Comprehensive Health Research Centre, University of Évora, Évora, Portugal

AUTHORS' CONTRIBUTIONS – A: Study design · B: Data collection · C: Statistical analysis · D: Data interpretation · E: Manuscript preparation · F: Literature search · G: Funds collection

CORRESPONDING AUTHOR – Prof. Adelinda A. Candeias, School of Health and Human Development, Department of Medical Sciences and Health & Comprehensive Health Research Centre, University of Évora, Apartado 94, 7002-554 Évora, Portugal, e-mail: aac@uevora.pt

TO CITE THIS ARTICLE – Candeias, A. A., & Galindo, E. (2022). Cognitive aging: why we need creativity to increase cognitive preservation. *Health Psychology Report, 10*(4), 257–265. https://doi.org/10.5114/hpr.2021.109537
RECEIVED 28.12.2020 · REVIEWED 03.05.2021 · ACCEPTED 24.06.2021 · ONLINE PUBLICATION 28.09.2021

BACKGROUND

The progressive aging of the world population is a source of concern for scientists, because aging appears to be associated with cognitive and physical decline, a fact producing negative social, economic and psychological consequences for the individual, for his/her family and for society (Darwish et al., 2018). In Portugal, the sixth country in the world in terms of the aged population (Eurostat, 2016; Pordata, 2016), national agencies forecast that 32% of the total population will be elderly persons in 2060 (Instituto Nacional de Estatística, 2014; Direção Geral da Saúde, 2017). In spite of the existence of diverse initiatives to promote healthy aging in Portugal, the road to achieve a state of full well-being with dignity for elderly persons is still long. Aging is a process occurring differently in each individual, since it depends on various factors, for instance gender, culture, SES, etc. (Tucker-Drob & Salthouse, 2011). Consequently, a closer investigation of the factors contributing to the individual variability, especially concerning the preservation of cognitive reserve during life, seems to be necessary. In general terms, aging seems to be associated with a decline in cognitive skills. This belief has fostered research on individual differences in response to moderators of cognitive aging in the last decade. Aging researchers have noticed that cognitive skills diminish quickly with increasing age in some persons, while others conserve intact skills.

One of the greatest problems related to the aging process is the so-called cognitive decline (CD), a state defined as a continuous loss of executive functions (Giebel et al., 2015), substantially limiting the initiative and performance of daily life tasks, comfort, and longevity of elderly persons (Yassuda & Abreu, 2006).

Cognitive decline affects skills such as memory, reasoning, processing velocity and spatial visualization, and can start at the beginning of adult age in healthy adults (Tucker-Drob & Salthouse, 2011). Age-related deficits are evident in diverse areas of cognitive functioning. An open question is whether all these deficits are due to a common cause affecting different functions or each deficit is related to a different development process, which would point to the existence of different causes affecting different functions (Baltes & Lindenberger, 1997). Approaches of "shared influence" are based on two observations: on the one hand, many cognitive variables show moderate or strong negative correlations with adult age and, on the other hand, all cognitive variables show moderate or strong positive correlations among them. These facts suggest that age-related deficits are found in a number of cognitive variables, i.e., a multidimensional cognitive decline.

At the first level, research on individual differences (see Tucker-Drob & Salthouse, 2011, for a broad review) is based on transversal studies, showing the existence of a cognitive decline in several domains at the beginning of adult life. At the second level, research is based on longitudinal studies, showing the onset of a decline only in the middle or in the late adult age. This discrepancy has been associated with factors such as sociocultural/historical differences, influencing cognitive functioning (Flynn, 1987), or the non-aleatory selection of participants in both types of studies (Lindenberger et al., 2002). Inconsistencies in the aging process observed in a group of elderly persons are supposed to reflect qualitative differences in the cognitive functioning of an old brain. It means that persons in the same age group can use differently the existing resources, according to his/her executive processing, due to the existence of individual differences in the population (De Felice & Holland, 2018). For example, studies comparing the cognitive functioning of young and old people show that old age is not necessarily associated with a low performance, nor is youth associated with a high performance. Elderly persons with a high cognitive performance showed a higher level of education and crystallized intelligence when compared to other elderly persons. This fact shows that old adults with higher "cognitive reserve" (i.e., higher levels of education and intelligence) cope better with the environment at a behavioral level and therefore suggests that they can cope better with age-related neurobiological changes (Saliasi et al., 2015). In this context, the environment of the person constitutes a fundamental factor to understand the individual differences in aging, at a behavioral and at a neurological level. Variations in cerebral plasticity seem to be at work in the hypothesis of cognitive reserve: the brain adapts and changes constantly in response to the environment, influencing then the processes of learning and memory (Wang et al., 2017). Now, an increase in cognitive stimulation reinforces synaptic links, while physical activities reinforce non-neuronal components of the brain (Churchill et al., 2002, as cited by Wang et al., 2017), facts showing once again the importance of the way of living as a whole. So, studies using neuroimage techniques found that persons with a high level in profession and education, with frequent social and physical activities, can cope better with neurological damage caused by aging (e.g., Scarmeas et al., 2003). In spite of the fact that genetic factors play an important role in the aging processes, it has been shown that, even in persons with a genetic predisposition, constant exposure during the lifespan to factors increasing cognitive reserve is associated with a reduction in dementia risk in elderly people. It seems, then, that the way of living and the practice of activities are always related to cognitive preservation in elderly, independently of existing biological factors (Wang et al., 2017). Cognitive stimulation is associated not only with a reduction of cognitive decline, but also with a reduction of the risk for depression disorders and to amelioration of autonomy in the elderly.

Creativity, a cognitive process associated with divergent thinking, is considered a fundamental, necessary instrument for making decisions for the solution of often unpredictable problems of daily living (Basadur et al., 2000; Cropley, 2006). The cognitive decline associated with aging can include a decrease in divergent thinking, and consequently a diminution of the capacity to make decisions and solve daily problems (Sasser-Coen, 1993; Thornton & Dumke, 2005). Consequently, an approach to active aging must also include the preservation of divergent thinking and the development of creativity (Massimiliano, 2015; Sasser-Coen, 1993). In this line of thinking, Fisher and Specht (1999, as cited by Flood & Phillips, 2007) found that creative expression can reinforce cognitive skills in the elderly, and Csikszentmihaly (2013) suggests activities of creative expression such as handicrafts and choral singing to foster a creative personality and the development of skills.

The present study aims to analyze the possible differences in cognitive decline between a group of elderly persons engaged in daily creative activities and a similar group not engaged in daily creative activities. Specifically, this correlational study aims to identify individual differences in cognitive skills and executive functions between a group of persons engaged in a lasting creative activity, such as embroidery and choral singing, and a group without such practices. The main hypothesis is that a correlation exists between creative activities and the preservation of cognitive skills in elderly persons.

PARTICIPANTS AND PROCEDURE

PARTICIPANTS

Portugal is the country in the European Union (EU) with the fourth highest percentage of the elderly population, over 65, with a percentage of 22.1% of people over 65 in 2020, and Alentejo is the oldest region in the country, with 25.6% of the population over 65 years old (Eurostat, 2021). Participants were recruited in the Alentejo region, in two small villages and in the main city of the region. We chose two small villages with long traditions in artistic and creative activities. These activities are carried out in specific institutions that ensure the development of skills, the evaluation and recognition of the products developed and their dissemination. These institutions were developed after 1975 to ensure the preservation of local artistic and creative products and ensure the involvement of local populations in their preservation.

Eighty elderly non-institutionalized persons living in the Alentejo region (Portugal) took part voluntarily in this study; 40 of them were male elderly (N = 40, ages from 65 to 90 years) and 40 were female elderly (N = 40; ages from 65 to 89 years). It is thus a non-probabilistic, intentional, convenient sample (Marôco, 2009).

Two groups were formed from the sample: GA – elderly persons working daily in artistic activities (N = 40; 20 men and 20 women), and GB – elderly persons without any artistic activities in their daily living (N = 40; 20 men and 20 women). The men from the GA group have at least 10 years of continuous practice of choral singing and are all part of the same institution and from the same village. The women from the GA group have at least 10 years of continuous practice of embroidery and are all part of the same institution and from the same village. Seniors from group B live in the main city of the region and participate in sporadic artistic, creative and leisure activities, without the preoccupation of a continuous and deliberate practice. Seniors with some kind of organic or chronic disease are excluded from the sample.

Each group was divided into three age levels: 1) from 65 to 70 years, 2) from 71 to 80 years, and 3) from 81 to 89 years (see Tables 1 and 2). During the analysis of data, each group was divided into a female sub-group and a male subgroup, in order to look for gender differences.

Table 1

Sample distribution in terms of age levels: women

Group	Age level	Frequency	Relative frequency	Accumulated frequency
Group A	1 (65-70 years)	3	15.0	15.0
	2 (71-80 years)	12	60.0	75.0
	3 (81-89 years)	5	25.0	100.0
	Total	20	100.0	
Group B	1 (65-70 years)	10	50.0	50.0
	2 (71-80 years)	6	30.0	80.0
	3 (81-89 years)	4	20.0	100.0
	Total	20	100.0	

Additionally, participants were classified in terms of educational level: 1) from 0 to 4 years, 2) from 5 to 9 years, 3) from 10 to 12, and 4) from 13 to 17 years (see Tables 3 and 4).

No differences between groups were found in terms of the educational level (see Tables 3 and 4).

MEASURES

Mini-Mental State Examination. Cognitive skills were assessed with the Mini-Mental State Examination (MMSE) developed by Folstein et al. (1975) to evaluate cognitive changes in elderly, in the Portuguese version of Guerreiro et al. (1994). It consists of 30 questions evaluating 6 areas: 1) orientation (10 questions), 2) retention (3 items), 3) attention and calculation, (5 items), 4) evocation (3 items), 5) language (5 lines), and 6) constructive skill (1 item, a copy of a design). Correct use of the MMSE implies adding information on the educational level of the participant (Oliveira et al., 2018). A maximal score of 30 points can be attained. The score thus obtained by a participant must then be adjusted according to the educational level to obtain an official total MMSE score, taking into account the following operational values:

0-2 education years: 22 points,

3-6 education years: 24 points,

≥ 7 education years: 27 points.

In the current study, the following codes were used in order to identify each evaluated area:

OrientaG – general points for orientation,

RetG – general points for retention,

AtCalcG – general points for attention and calculation,

EvocaG – general points for evocation,

LingAG – points for language, line A,

LingBG – points for language, line B,

LingCG – points for language, line C,

LingDG – points for language, line D,

LingEG – points for language, line E,

Design – points for constructive skills.

Table 2

Sample distribution in terms of age levels: men

Group	Age level	Frequency	Relative frequency	Accumulated frequency
Group A	1 (65-70 years)	3	15.0	15.0
	2 (71-80 years)	12	60.0	75.0
	3 (81-89 years)	5	25.0	100.0
	Total	20	100.0	
Group B	1 (65-70 years)	10	50.0	50.0
	2 (71-80 years)	6	30.0	80.0
	3 (81-89 years)	4	20.0	100.0
	Total	20	100.0	

Table 3

Sample distribution in terms of educational level: women

Group	Educational level	Frequency	Relative frequency	Accumulated frequency
Group A	1 (0-4 years)	13	65.0	65.0
	2 (5-9 years)	6	30.0	95.0
	4 (13-17 years)	1	5.0	100.0
	Total	20	100.0	
Group B	1 (0-4 years)	6	30.0	30.0
	2 (5-9 years)	9	45.0	75.0
	3 (10-12 years)	3	15.0	90.0
	4 (13-17 years)	2	10.0	100.0
	Total	20	100.0	

Table 4

Sample distribution in terms of educational level: men

Group	Educational level	Frequency	Relative frequency	Accumulated frequency
Group A	1 (0-4 years)	13	65.0	65.0
	2 (5-9 years)	6	30.0	95.0
	4 (13-17 years)	1	5.0	100.0
	Total	20	100.0	
Group B	1 (0-4 years)	6	30.0	30.0
	2 (5-9 years)	9	45.0	75.0
	3 (10-12 years)	3	15.0	90.0
	4 (13-17 years)	2	10.0	100.0
	Total	20	100.0	

Table 5

Comparison of mean values obtained by the female sub-group

Group	*N*	*M*	*SD*	*t*	*df*	*p*
Group A	20	27.95	2.01	4.46	38.00	< .001
Group B	20	23.00	4.54	4.46	26.18	< .001

Table 6

Comparison of mean values obtained by the male sub-group

Group	*N*	*M*	*SD*	*t*	*df*	*p*
Group A	20	25.75	3.88	2.49	38.00	.017
Group B	20	22.40	4.58	2.49	36.99	.017

PROCEDURE

Before beginning the study, participants were informed about the objectives and written consent was obtained under the guarantee of confidentiality. A sociodemographic questionnaire was applied in order to obtain relevant information concerning educational level and age of participants. Afterwards, two groups (A and B) were formed, taking into account the engagement (or non-engagement) of each one in creative activities in daily life. The application of the MMSE followed in the private sphere, in a familiar environment for the participant.

A statistical analysis followed, using IBM SPSS Statistics 24.0 for Windows (hereinafter SPSS), in order to obtain a mean comparison using the *t*-test and Pearson correlations between variables under study.

RESULTS

Comparisons of means obtained by participants and of correlations of the variables educational level, age and MMSE scores were carried out, in order to determine whether creative engagement has some influence on cognitive decline.

A comparison of the means obtained by female Groups A and B reveals that Group A has a higher value than Group B. This difference is statistically significant (see Table 5).

A comparison of the means obtained by male Groups A and B reveals that Group A has a higher value than Group B. This difference is statistically significant (see Table 6).

A comparison of the means obtained by participants of each female or male sub-group in every evaluated area shows that: female Group A obtained in general higher scores than female Group B, except in the area LingAG, where B participants obtained a higher score than A participants, but the difference was not significant (see Table 7).

Concerning the male sub-group, Group A obtained higher scores in AtCalcG ($M = 4.15$, $p = .008$), EvocaG ($M = 2.35$, $p < .001$), LingBG ($M = 1.00$, $p = .003$), LingCG

Table 7

Comparison of means obtained by the female sub-group in different tested areas of the MMSE

Area	Group	*N*	*M*	*SD*	*t*	*df*	*p*
Design	Group A	20	0.65	0.49	1.94	38.00	.060
	Group B	20	0.35	0.49	1.94	38.00	.060
LingEG	Group A	20	0.80	0.41	1.71	38.00	.096
	Group B	20	0.55	0.51	1.71	36.33	.096
LingDG	Group A	20	1.00	0.00	2.18	38.00	**.036**
	Group B	20	0.80	0.41	2.18	19.00	**.042**
LingCG	Group A	20	2.85	0.37	1.80	38.00	.080
	Group B	20	2.60	0.50	1.80	34.74	.081
LingBG	Group A	20	0.95	0.22	0.59	38.00	.560
	Group B	20	0.90	0.31	0.59	34.69	.561
LingAG	Group A	20	1.95	0.22	−1.00	38.00	.324
	Group B	20	2.00	0.00	−1.00	19.00	.330
EvocaG	Group A	20	2.35	0.99	2.55	38.00	**.015**
	Group B	20	1.45	1.23	2.55	36.26	**.015**
AtCalcG	Group A	20	4.55	0.76	3.86	38.00	**< .001**
	Group B	20	2.75	1.94	3.86	24.67	**.001**
RetG	Group A	20	2.95	0.22	1.99	38.00	.054
	Group B	20	2.60	0.75	1.99	22.32	.059
OrientaG	Group A	20	9.85	0.49	2.40	38.00	**.021**
	Group B	20	8.95	1.61	2.40	22.50	**.025**

Note. MMSE – Mini-Mental State Examination; Design – points for constructive skills; LingEG – points for language, line E; LingDG – points for language, line D; LingCG – points for language, line C; LingBG – points for language, line B; LingAG – points for language, line A; EvocaG – general points for evocation; AtCalcG – general points for attention and calculation; RetG – general points for retention; OrientaG – general points for orientation.

(M = 2.85, p < .001), and RetG (M = 2.70), but the last one was non-significant (p = .846). Group B (M = 0.95) obtained significantly higher scores than Group A (M = 0.60) only in LingDG (see more in Table 8).

Finally, an analysis of the predictors of cognitive preservation was performed through an evaluation of the total results obtained by participants in MMSE. Age, education level and Group (creative activities or not) were considered as dependent variables. A stepwise linear regression analysis identified as predictors of cognitive preservation the variables Group and age. Educational level was excluded (Table 9).

These results seem to show that creative activities are negatively correlated with cognitive decline in female and male elderly persons. Age appears as an expected predictor of cognitive decline.

DISCUSSION

A comparison of the means obtained by participants shows that Group A has substantially higher scores than Group B. Therefore, engagement in creative activities seems to act by protecting female and male elderly persons against cognitive decline. The analysis of the predictors for cognitive decline shows that creative activities and age are important predictors of the variability. Exclusion of the possible direct influence of the MMSE results of age and educational level in each participant shows that the most important factor contributing to the participants' performance is the daily engagement in creative activities. These global results coincide closely with the results of other studies, suggesting that artistic creative activities foster skills and efficacy (Candeias et al., 2019; Flood & Phillips, 2007).

A possible explanation of these findings can be found in the article by Carpenter et al. (2020), who studied the role of distraction on creativity in different ages and found that greater age-related vulnerability to distracting information enhances older adults' creativity, when the distracting information is relevant to the target creativity. The authors concluded that when individuals are less able to ignore

Table 8

Comparison of means obtained by the male sub-group in different tested areas of the MMSE

Area	Group	*N*	*M*	*SD*	*t*	*df*	*p*
OrientaG	Group A	20	9.25	0.91	−0.59	38	.559
	Group B	20	9.40	0.68	−0.59	35	.559
RetG	Group A	20	2.70	0.92	0.19	38	.846
	Group B	20	2.65	0.67	0.19	34	.846
AtCalcG	Group A	20	4.15	1.66	2.78	38	.008
	Group B	20	2.60	1.84	2.78	37	**.008**
EvocaG	Group A	20	2.35	0.74	4.42	38	**< .001**
	Group B	20	1.10	1.02	4.42	34	**< .001**
LingAG	Group A	20	2.00	0.00	–	–	–
	Group B	20	2.00	0.00	–	–	–
LingBG	Group A	20	1.00	0.00	3.19	38	**.003**
	Group B	20	0.65	0.49	3.19	19	**.005**
LingCG	Group A	20	2.85	0.49	3.84	38	**< .001**
	Group B	20	2.00	0.86	3.84	30	**.001**
LingDG	Group A	20	0.60	0.51	−2.84	38	.007
	Group B	20	0.95	0.22	−2.84	26	.008
LingEG	Group A	20	0.50	0.51	0.00	38	1.00
	Group B	20	0.50	0.51	0.00	38	1.00

Note. MMSE – Mini-Mental State Examination; OrientaG – general points for orientation; RetG – general points for retention; AtCalcG – general points for attention and calculation; EvocaG – general points for evocation; LingAG – points for language, line A; LingBG – points for language, line B; LingCG – points for language, line C; LingDG – points for language, line D; LingEG – points for language, line E.

Table 9

Predictors of cognitive preservation

Variable	*R*	R^2	Adjusted R^2	β	*p*
Group	.59[a]	.34	.33	−.63	< .001
Age	.76[b]	.58	.56	−.49	< .001

Note. [a]Predictors – group; [b]predictors – group, age.

relevant distractions, this information can facilitate more idea generation, giving consequently to older adults a higher capacity to capitalize on distraction when performing tasks involving creativity.

One more possible explanation is given from a neurological point of view by Adnan et al. (2019) in a paper exploring the functional connectivity patterns among default and executive control brain regions associated with creative thought. The study compared the functional coupling of default and executive control regions of the brain in young and old adults. The results showed that the functional coupling of default and executive control regions supports creative cognition in older adulthood, i.e., increased neuronal network efficiency was associated with creative ability in older adults (not in young adults). Pąchalska (2020) suggests one more explanation from the perspective of clinical neuroscience based on the works of Luria, who believes that the creative possibilities of people depend simultaneously on neuronal and socio-cultural factors. From this point of view, it could be possible to conclude that the participants in the current study performing creative activities not only had a better neuronal functioning, but also were embedded in important traditional socio-cultural activities, a factor acting against cognitive decline.

CONCLUSIONS

The results of this study seem to emphasize the importance of the activities of creative expression in the

preservation of cognitive functions (Flood & Phillips, 2007), a value that must be added to the already known effect of ameliorating the well-being and quality of life in the elderly (Carrascal-Domínguez & Solera, 2014). Creative processes have usually been considered recreational activities for elderly. Their role in the cognitive preservation of the elderly has become a central research topic, and consequently a public health topic, only in the last decade. The current study shows that female and male elderly individuals engaged in daily creative activities have a clear advantage in the performance of the MMSE tasks. Engagement in creative activities seems to be a better predictor of cognitive preservation in the elderly (from 65 to 90 years) than educational level, a fact also found by other studies (e.g., Palmiero et al., 2016). Consequently, the inclusion of creative activities in programs to preserve cognitive skills for elderly persons is highly recommended, in the prevention of cognitive decline associated with age-related degenerative diseases (Butler et al., 2018; Giebel et al., 2015; Young et al., 2015This research has limitations concerning the characteristics of the sample (chosen for convenience). On the other hand, it is still necessary to investigate more deeply other kinds of intellectual activities helping elderly persons combat cognitive decline and the possible differential contribution of different categories including, of course, creative activities.

References

Adnan, A., Beaty, R., Silvia, P., Spreng, R. N., & Turner, G. R. (2019). Creative aging: Functional brain networks associated with divergent thinking in older and younger adults. *Neurobiological Aging, 75*, 150–158. https://doi.org/10.1016/j.neurobiolaging.2018.11.004

Baltes, P. B., & Lindenberger, U. (1997). Emergence of a powerful connection between sensory and cognitive functions across the adult life span: a new window to the study of cognitive aging? *Psychology and Aging, 12*, 12–21. https://doi.org/10.1037/0882-7974.12.1.12

Basadur, M., Pringle, P., Speranzini, G., & Bacot, M. (2000). Collaborative problem solving through creativity in problem definition: Expanding the pie. *Creativity and Innovation Management, 9*, 54–76. https://doi.org/10.1111/1467-8691.00157

Butler, M., McCreedy, E., Nelson, V. A., Desai, P., Ratner, E., Fink, H. A., Hemmy, L. S., McCarten, J. R., Barclay, T. R., Brasure, M., Davila, H., & Kane, R. L. (2018). Does cognitive training prevent cognitive decline? A systematic review. *Annals of Internal Medicine, 168*, 63–68. https://doi.org/10.7326/M17-1531

Candeias, A. A., Medina-Pereira, A., Vasques, A., Arvanas, C., Acácio, M., Jardim, R., & Graça, S. (2019). Impacto da criatividade no declínio cognitivo: um estudo em mulheres portuguesas [Impact of creativity in cognitive decline: a study on Portuguese women]. In Candeias, A. (Ed.), *Desenvolvimento ao longo da vida: Aprendizagem, bem-estar e inclusão* [Lifelong development: Learning, well-being and inclusion] (pp. 315–334). Universidade de Évora.

Carpenter, S. M., Chae, R. L., & Yoon, C. (2020). Creativity and aging: Positive consequences of distraction. *Psychological Aging, 35*, 654–662. https://doi.org/10.1037/pag0000470

Carrascal-Domínguez, S., & Solera, E. (2014). Creatividad y desarrollo cognitivo en personas mayores [Creativity and cognitive development in erderly persons]. *Arte, Individuo y Sociedad, 26*, 9–19. https://doi.org/10.5209/rev_ARIS.2014.v26.n1.40100

Cropley, A. (2006). In praise of convergent thinking. *Creativity Research Journal, 18*, 391–404. https://doi.org/10.1207/s15326934crj1803_13

Csikszentmihalyi, M. (2013). *Creativity: The psychology of discovery and invention.* Harper Collins.

Darwish, H., Farran, N., Assaad, S., & Chaaya, M. (2018). Cognitive reserve factors in a developing country: Education and occupational attainment lower the risk of dementia in a sample of Lebanese older adults. *Frontiers in Aging Neuroscience, 10*, 277. https://doi.org/10.3389/fnagi.2018.00277

De Felice, S., & Holland, C. A. (2018). Intra-individual variability across fluid cognition can reveal qualitatively different cognitive styles of the aging brain. *Frontiers in Psychology, 9*, 1973. https://doi.org/10.3389/fpsyg.2018.01973

Direção-Geral da Saúde (2017). *Estratégia nacional para o envelhecimento ativo e saudável 2017-2025* [National strategy for an active and healthy aging 2017-225]. Retrieved from https://www.sns.gov.pt/wp-content/uploads/2017/07/ENEAS.pdf

Eurostat (2016). *Healthy life years.* Retrieved from https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20190204-1

Eurostat (2021). *More than a fifth of the EU population are aged 65 or over.* Retrieved from https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210316-1

Flood, M., & Phillips, K. D. (2007). Creativity in older adults: a plethora of possibilities. *Issues in Mental Health Nursing, 28*, 389–411. https://doi.org/10.1080/01612840701252956

Flynn, J. R. (1987). Massive IQ gains in 14 nations: What IQ tests really measure. *Psychological Bulletin, 101*, 171–191. https://doi.org/10.1037/0033-2909.101.2.171

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12*, 189–198. https://doi.org/10.1016/0022-3956(75)90026-6

Giebel, C. M., Sutcliffe, C., & Challis, D. (2015). Activities of daily living and quality of life across differ-

ent stages of dementia: a UK study. *Aging & Mental Health, 19*, 63–71. https://doi.org/10.1080/13607863.2014.915920

Guerreiro, M., Silva, A. P., Botelho, M. A., Leitão, O., Castro-Caldas, A., & Garcia, C. (1994). Adaptação à população portuguesa da tradução do Mini-Mental State Examination (MMSE) [Adaptation to Portuguese population of Mini Mental State Examination]. *Revista Portuguesa de Neurologia, 1*, 9–10.

Instituto Nacional de Estatística (2014). *Projeções de população residente* [Projections of resident population]. INE.

Lindenberger, U., Singer, T., & Baltes, P. B. (2002). Longitudinal selectivity in aging populations: Separating mortality-associated versus experimental components in the Berlin Aging Study (BASE). *Journals of Gerontology, 57*, 474–482. https://doi.org/10.1093/geronb/57.6.p474

Marôco, J. (2009). *Análise estatística com o SPSS Statistics* [Statistical analysis with SPSS Statistics]. Sílabo.

Massimiliano, P. (2015). The effects of age on divergent thinking and creative objects production: a cross-sectional study. *High Ability Studies, 26*, 93–104. https://doi.org/10.1080/13598139.2015.1029117

Oliveira, T., Starkweather, A., Ramesh, D., Fetta, J., Kelly, D. L., Lyon, D. E., & Sargent, L. (2018). Putative mechanisms of cognitive decline with implications for clinical research and practice. *Nursing Forum, 53*, 271–279. https://doi.org/10.1111/nuf.12247

Pąchalska, M. (2020). Lurian approach and neuropsychology of creativity. *Lurian Journal, 1*, 77–108. https://doi.org/10.15826/Lurian.2020.1.1.7

Palmiero, M., Di Giacomo, D., & Passafiume, D. (2016). Can creativity predict cognitive reserve? *The Journal of Creative Behavior, 50*, 7–23. https://doi.org/10.1002/jocb.62

Pordata (2016). *Retrato de Portugal* [A portrait of Portugal]. Fundação Francisco Manuel dos Santos.

Saliasi, E., Geerligs, L., Dalenberg, J. R., Lorist, M. M., & Maurits, N. M. (2015). Differences in cognitive aging: Typology based on a community structure detection approach. *Frontiers Aging Neuroscience, 7*, 35. https://doi.org/10.3389/fnagi.2015.00035

Sasser-Coen, J. (1993). Qualitative changes in creativity in the second half of life: a life-span developmental perspective. *The Journal of Creative Behavior, 27*, 18–27. https://doi.org/10.1002/j.2162-6057.1993.tb01383.x

Scarmeas, N., Zarahn, E., Anderson, K. E., Hilton, J., Flynn, J., Van Heertum, R. L., Sackeim, H. A., & Stern, Y. (2003). Cognitive reserve modulates functional brain responses during memory tasks: a PET study in healthy young and elderly subjects. *NeuroImage, 19*, 1215–1227. https://doi.org/10.1016/s1053-8119(03)00074-0

Thornton, W. J., & Dumke, H. A. (2005). Age differences in everyday problem-solving and decision-making effectiveness: a meta-analytic review. *Psychology and Aging, 20*, 85–99. https://doi.org/10.1037/0882-7974.20.1.85

Tucker-Drob, E. M., & Salthouse, T. A. (2011). Individual differences in cognitive aging. In T. Chamorro-Premuzic, S. von Stumm, & A. Furnham (Eds.), *The Wiley-Blackwell handbook of individual differences* (pp. 242–267). Wiley-Blackwell.

Wang, H. X., MacDonald, S. W., Dekhtyar, S., & Fratiglioni, L. (2017). Association of lifelong exposure to cognitive reserve-enhancing factors with dementia risk: a community-based cohort study. *PLoS Medicine, 14*, e1002251. https://doi.org/10.1371/journal.pmed.1002251

Yassuda, M. S., & Abreu V. P. S. (2006). Avaliação cognitiva [Cognitive assessment]. In E. V. Freitas, L. Py, F. A. X. Cançado, J. Doll, & M. L. Gorzoni (Eds.), *Tratado de geriatria e gerontologia* [Treatise on geriatrics and gerontology] (pp. 1252–1266). Koogan.

Young, R., Camic, P. M., & Tischler, V. (2015). The impact of community-based arts and health interventions on cognition in people with dementia: a systematic literature review. *Aging & Mental Health, 20*, 337–351. https://doi.org/10.1080/13607863.2015.1011080