

Creativity and cognitive reserve in old age: an exploratory study in the Portuguese population

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Abstract: The present study aims to investigate the relationship between creativity, particularly divergent thinking, and cognitive reserve (CR), in a sample of older adults without cognitive impairment. 53 community-dwelling subjects met the inclusion criteria and were submitted to the Creativity Test (ProCriativ) and the Cognitive Reserve Questionnaire (CRQ). The correlational analysis revealed that ProCriativ's fluency and flexibility indexes were positively and significantly correlated with the CRQ. However, according to the backward stepwise regression analysis, only flexibility was a significant predictor of CRQ. Our results are in line with former studies that found a clear association between creativity and CR. Additionally, in other studies fluency and originality were also predictors of CR proxies besides flexibility. It is speculated that creativity could represent another indicator of CR. Further investigation is needed to corroborate the previous findings.

Keywords: Creativity, Divergent thinking, Cognitive reserve.

Criatividade e reserva cognitiva na idade avançada: um estudo exploratório na população portuguesa: O presente estudo teve como objetivo investigar a relação entre a criatividade, particularmente o pensamento divergente, e a reserva cognitiva (RC), numa amostra de pessoas com idade avançada e sem defeito cognitivo. 53 participantes provenientes da comunidade cumpriram os critérios de inclusão e foram avaliados através da Prova de Criatividade (ProCriativ) e do Questionário de Reserva Cognitiva (QRC). A análise correlacional revelou que os índices de fluência e flexibilidade da ProCriativ estavam positiva e significativamente correlacionados com o QRC. Contudo, segundo a análise de regressão, a flexibilidade foi o único preditor da RC. Estes resultados estão em conformidade com estudos prévios que encontraram uma clara associação entre a criatividade e a RC. Adicionalmente, em outros estudos a fluência e a originalidade foram também preditores dos indicadores de RC. Especula-se que a criatividade possa representar outro indicador da RC. Investigação adicional é necessária para corroborar estes resultados.

Palavras-chave: Criatividade, Pensamento Divergente, Reserva cognitiva.

Creativity is a complex, multifaceted and hard to define construct. In general terms, creativity can be conceptualized as a set of cognitive processes that facilitate the creation of innovative (i.e., original or atypical) and relevant (i.e., useful or functional) end products (Abraham, 2015; Beaty, Benedek, Silvia, & Schacter, 2016; Sternberg & Lubart, 1996). Creative thinking is commonly studied through divergent thinking (DT), an ability that involves the production of an unlimited number of novel and alternative ideas/solutions to an open-ended problem, which is particularly useful in the ideation stage of the creative process (Abraham et al., 2015; Meléndez, Alfonso-Benlliure, Mayordomo, & Sales, 2016). It is important to note, however, that DT represents an indicator of the creative potential rather than a construct that defines the entire creative process, once the latter also requires, for instance, convergent thinking (i.e., the ability to select the response that is most suitable for a given problem or task) (Meléndez et al., 2016; Runco & Jaeger, 2012; Snowden, Pringle, & Gabora, 2015).

Despite DT being previously thought to decline with aging, several new studies have shown that DT, specially its verbal component, remains mostly stable across lifespan, possibly due to the relative integrity of crystallized abilities (e.g., semantic memory and verbal skills) in old age (Barbey, 2018; Foos & Boone, 2008; Palmiero, Di Giacomo, & Passafiume, 2014; Palmiero, Nori, & Piccardi, 2017). According to the

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literature, reported differences between young and old people in DT tasks tend to dissipate when controlling some cognitive functions (e.g., working memory) and time restrictions (Foos & Boone, 2008; Roskos-ewoldsen, Black, & McCown, 2008).

Cognitive Reserve (CR) is a dynamic hypothetical construct defined as the brain's ability to cope with age or pathology-related changes through "differential recruitment of brain networks, which perhaps reflect the use of alternate cognitive strategies" (Stern, 2002, p. 451). This hypothetical *modus operandi* of CR (i.e., employment of alternative or more flexible strategies to cope with cognitive challenge) is thought to be somehow associated with executive functions (Tucker & Stern, 2011; Stern, 2009). There has been an increased effort to determine if there is a "common" CR network across subjects. In their meta-analysis, Colangeli et al. (2016) investigated which brain areas were related with specific CR proxies in healthy and unhealthy (Alzheimer's disease and mild cognitive impairment) older adults. Regarding healthy older adults, the authors found that activity in regions such as the dorsolateral prefrontal cortex, the anterior cingulate and the precuneus – brain areas implicated in executive and memory functions – was linked to CR proxies.

Subjects with higher levels of CR tend to be more resilient to age-related decline and neurodegenerative conditions like Alzheimer's disease (Stern 2012). This resilience may be determined by neural mechanisms underlying CR, specifically neural reserve and neural compensation (Barulli & Stern, 2013). Epidemiological evidence suggests the protective effect of person-specific variables (e.g., education, occupational attainment, leisure activities and cognitive function) in CR (Consentino & Stern, 2019). Given that CR cannot be directly quantified, the variables mentioned above serve as proxies of CR and have been used to estimate the level of CR (Stern, 2009). It is possible to build CR throughout life, including old age, with the proper environmental exposures; for instance, by engaging in social and cognitive stimulation activities (Evans et al., 2018; Krell-Roesch et al., 2019; Wilson et al., 2002).

The idea of studying the association between creativity and CR is relatively new and it was introduced by Palmiero, Giacomo and Passafiume (2016). Based on a theoretical assumption, the aforementioned authors propose that creativity can predict CR. After confirming their hypothesis, Palmiero et al. (2016) argue that creativity could represent a protective factor against cognitive decline and, therefore, if stimulated, enhance CR. In fact, there seems to be some overlap between brain regions important to executive functions that may support CR in healthy aging and DT aspects of creativity (Beaty et al., 2016; Colangeli et al., 2016; Palmiero et al., 2017). In this sense, it is reasonable to hypothesize that some of the cognitive processes implicated in performing creative tasks must be partially related to the ones involved in CR.

According to Colombo, Antonietti and Daneau (2018) creativity and CR may have, at least, three cognitive processes in common. Antonietti and Colombo (2013, 2016) describe the cognitive processes thought to entail creative thinking, namely: (a) widening (the ability to keep an open mind to a great deal of elements); (b) connecting (the ability to create novel associations between elements); and (c) reorganizing (the ability to shift between perspectives and to rearrange pre-existing relationships among elements). Colombo et al. (2018) reason that the use of alternative strategies to deal with age-related decline or brain dysfunction – a core feature of CR's definition that can be associated with cognitive flexibility – might involve underlying cognitive processes indissociable from the creative process, i.e., widening, connecting and reorganizing. The enlisted cognitive processes have an executive nature, for they require working memory, cognitive flexibility, monitoring and inhibitory control, and evidence shows that the prefrontal cortex has a great influence on creativity (Heilman, 2016). Concerning this idea, Beaty et al. (2016) emphasize the dynamic interaction between the default and executive control networks in creative thinking, especially when the task must meet specific requirements (e.g., a DT task in which the goal is to generate possible uses for a particular object). The spontaneous and free flow of ideas, associated with the default mode network, is constrained by executive mechanisms (e.g., controlled attention, inhibition and cognitive flexibility) that allow for goal-directed behaviour (Beaty et al., 2016; Beaty, Silvia, Nusbaum, Jauk, & Benedek, 2014).

Palmiero et al. (2016) and Colombo et al. (2018) found a positive association between verbal creativity – as measured by DT's core elements (e.g., fluency, flexibility and originality) – and CR proxies (e.g., vocabulary, digit span and similarities (WAIS-IV subtests), education, frequency of leisure activities and professional occupation). These authors speculate that creativity could be accounted as another proxy of CR. In addition, they drew some practical implications from these results, related with the advantages of incorporating verbal DT-based creative activities in cognitive stimulation programs in order to promote healthy aging.

To the best of our knowledge, only two studies (Palmiero et al., 2016; Colombo et al., 2018) have investigated the association between creativity and CR. Concerning creativity, we have focused only on DT, more specifically in its verbal component, since the available studies in this field of research assess

creativity through DT tasks. Therefore, the aim of the present study is to explore the relationship between DT and CR in a sample of Portuguese older adults without cognitive impairment. We hypothesize that there is a positive and significant association between both constructs.

METHOD

Participants

All subjects were recruited from four community centres located in the city of Funchal, Portugal. Subjects were included if they met the following eligibility criteria: (a) were at least 60 years old; (b) had a normal score in MMSE in order to rule out cognitive impairment; and (c) had enough visual and auditory acuity. We screened 71 subjects but only 53 were included. The sociodemographic characteristics of our sample are presented in Table 1.

Table 1. Sociodemographic characteristics of the sample (N = 53).

Variables	% (n) / M ± SD
Sex	
Women	94.3% (50)
Men	5.7% (3)
Age	72.66 ± 7.43
Years of formal education	3.87 ± 3.39
Marital status	
Single	18.9% (10)
Married	35.8% (19)
Divorced	7.5% (4)
Widowed	37.8% (20)
Professional occupation	
Unskilled workers	37.7% (20)
Skilled workers	58.5% (31)
Service Workers	1.9% (1)
Intellectual and scientific activity	1.9% (1)

Measures

Sociodemographic questionnaire. We've developed an *ad-hoc* questionnaire to collect sociodemographic data [e.g., sex, age, years of formal education, professional classification based on the National Institute of Statistics in Portugal (Instituto Nacional de Estatística (INE), 2011) and marital status].

Mini-Mental State Examination. The Mini-Mental State Examination (MMSE) is a 30-item cognitive screening instrument that assesses different cognitive domains, such as orientation, memory (registration and recall), attention and calculation, language and visual construction. We used MMSE's Portuguese version by Guerreiro (1998) with the following cut-off values, adjusted to the subjects' education level: illiterate subjects, subjects between 1-11 years of education and subjects with more than 11 years of education had to score above 15, 22 and 27 points, respectively, in order to rule out cognitive impairment. The maximum score is 30 points; higher scores suggest better cognitive functioning.

Creativity test. The Creativity Test (ProCriativ) (Pocinho & Garcês, 2018) comprises three timed items (Table 1) inspired in the Alternate Uses Test from Guilford (1967), the Instances Test from Wallach and Kogan (1965) and the *Prueba de Imaginación Creativa para jóvenes* (Creative Imagination test for young people) from Artola, Ancillo, Mosteiro, and Barraca (2004). This test measures four main DT components: fluency (number of responses), flexibility (number of different categories), elaboration (number of enriching details in the responses) and originality (number of infrequent responses). Former validation studies of the ProCriativ with younger samples have demonstrated its potential utility in measuring DT (Faria, Pernet, Teixeira, & Félix, 2018; Freitas, Jesus, Fernandes, & Martins, 2018; Lemos, Gomes, & Gouveia, 2018; Mendes, 2016; Pita, Santos, Abreu, Alho, & Pinto, 2018). This test is currently being validated for the older Portuguese population. In this study we have only used three DT elements – fluency, flexibility and elaboration.

Table 2. ProCriativ structure.

Item	Description	Time
1	Tell me all the different ways you could use a cardboard box.	2 minutes
2	Name all the green things you can think of.	2 minutes
3	Look carefully to this drawing. Imagine everything that could be happening in the drawing.	4 minutes

Cognitive Reserve Questionnaire. The Cognitive Reserve Questionnaire (CRQ) (Portuguese version from Sobral, Pestana & Paúl, 2014) is a simple tool used to quantify CR. CRQ consists of eight items, namely education, parental education, training courses, occupation, musical training, languages, reading and intellectual games. The maximum score is 24 points; scores equal or below six points represent a low level of CR and scores equal or above seven points indicate a medium-to-high level of CR. The CRQ showed high reliability (Cronbach's Alfa=.795) and adequate construct validity (Sobral et al., 2014).

Procedure

Whenever participants revealed interest in participating, researchers carefully explained the purpose of the study and written informed consent was obtained. All participants were selected based on the eligibility criteria listed above (participants section). Then, sociodemographic data was collected, and participants were assessed with the ProCriativ and the CRQ. Test administration lasted, approximately, 30 minutes.

Data analysis was performed using the IBM Software Statistical Package for the Social Sciences (SPSS) 25.0 and nonparametric statistics was used due to small sample size. Results were considered statistically significant when $p \leq .05$.

RESULTS

Table 3 shows the Spearman coefficients and their significance levels. The analysis showed that the CRQ's global score was positively and significantly correlated with fluency ($r_s = .328$; $p \leq .05$) and flexibility ($r_s = .574$; $**p \leq .01$) indexes of the ProCriativ, which means that CR has a positive association with fluency and flexibility aspects of DT.

Table 3. Spearman coefficients.

	CRQ
Fluency	.328*
Flexibility	.574**
Elaboration	.187

* $p \leq .05$; ** $p \leq .01$

After verifying linear regression's underlying assumptions, we performed a backward stepwise regression analysis in order to investigate the extent in which DT indexes – fluency and flexibility – predict CR (Table 4). For this purpose, CRQ's global score was considered the dependent variable and ProCriativ's fluency and flexibility indexes were defined as the predictors. The first model was statistically significant ($F(2,50) = 15.419$, $p < .001$) and explained 35.7% of variance ($R^2 = .381$; Adjusted $R^2 = .357$) of the CRQ's global score; however, since the fluency index lacked predictive value ($p > 0.05$), we decided to remove it from the analysis. The second model, also statistically significant ($F(1,51) = 30.703$, $p < .001$), was considered the best since it explained 36.4% of variance ($R^2 = .376$; Adjusted $R^2 = .364$) of the CRQ's global score. Overall, the analysis showed that the flexibility index alone has a greater ability to predict CR.

Table 4. Backward Stepwise Regression Analysis between predictors and CRQ's global score.

	<i>B</i>	β	<i>t</i>
Model 1			
Fluency	-.097	-.096	-.678
Flexibility	1.334	.672	4.755**
Model 2			
Flexibility	.613	.613	5.541**

* $p \leq .05$; ** $p \leq .01$

DISCUSSION

Creativity and CR are two very complex research concepts that can be seen as instrumental for future cognitive impairment prevention. The relationship between the two is still not very clear but the existing literature provides potential for further research (Colombo et al., 2018; Palmiero et al., 2016). Therefore, the purpose of the present study was not only to analyse the relationship between DT – an indicator of creative potential – and CR, in a sample of older adults without cognitive impairment, but also to contribute with additional insights about this topic.

The correlation analysis showed that fluency and flexibility were positively and significantly associated with CR, a finding that confirms our hypothesis and is also consistent with previous studies (Colombo et al., 2018; Palmiero et al., 2016). This suggests that the process of generating a greater number of responses or ideas from different categories – abilities that imply executive processes such as cognitive flexibility –, is related with higher levels of CR.

Regarding the regression analysis, it was found that flexibility was the only significant predictor of CR, despite, according to Colombo et al. (2018) and Palmiero et al. (2016), fluency and originality having also been identified as significant predictors of CR proxies. We hypothesized that this difference can be explained since CR involves not so much fluency but particularly cognitive flexibility, which is the core nature of the DT index flexibility. This idea is aligned with Colombo et al. (2018) when they acknowledged that one of the main characteristics of CR, i.e., the ability to use alternative cognitive strategies to deal with age-related cognitive decline or impairment due to brain pathology, can be related to the creative process, since the latter requires a great deal of cognitive flexibility. Considering that verbal DT tasks involve executive processes that, according to Tucker and Stern (2011) and Colangeli et al. (2016), may be related with CR, integrating these tasks in cognitive stimulation programs, designed to foster active aging, can contribute to promote CR. Colombo et al. (2018) and Palmiero et al. (2016) believe that creativity can be used as another indicator of CR, despite further investigation is needed to reinforce the previous findings.

This study showed that creativity and CR have some underlying relationship. However, given its exploratory nature, the present study has several limitations that need to be addressed in future research. The following recommendations should be taken into account: (a) to collect a larger and more balanced sample (e.g., in terms of sex distribution); (b) to conduct a brief clinical interview and to perform a detailed neuropsychological assessment to better characterize the cognitive functioning of the subjects in order to exclude subjects with cognitive impairment that are not normally detected by tests with ceiling effects like MMSE; (c) to use a validated DT measure for Portuguese older adults with composite and global scores, that includes verbal and visual components, and to take into consideration other DT elements (e.g., originality); and (d) to incorporate a more comprehensive measure of CR (e.g., Cognitive Reserve Index Questionnaire (CRIq)).

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