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Emotion regulation and executive functions in young and older Brazilian adults

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Abstract | **Introduction/objective:** The healthy aging process involves changes in neurobiological functions at various levels and is associated with a slight impairment in various cognitive domains, such as executive functions (EF), as well as the enhancement of emotional skills. The objective of this study was to compare the use of emotion regulation (ER) strategies in young adults (YA) and older adults (OA) and explore the association between ER skills and EF between age groups. **Method:** Participants were 40 YA between 18 and 39 years of age (50% women) and 40 OA > 60 years old (50% women), residents in the Federal District, Brazil. Phonological Verbal Fluency (FAS), semantic and switching (animals and fruits) and action tests were administered, along with the Stroop Test. **Results:** There was a statistically significant correlation of the Cognitive Reappraisal (CR) strategy and both semantic and switching verbal fluency tests in YA, and between the CR strategy and the FAS test and the Stroop Test in OA. That is, executive performance showed a direct relationship with ER in both groups, with greater use of cognitive reappraisal by older adults. **Conclusions:** The results of this study highlight the relevance of continuing to investigate the relationship between these abilities and analysing in greater depth their alterations during the aging process.

Keywords: Emotion regulation, cognitive reappraisal, emotion suppression, executive functions, aging.

Regulación emocional y funciones ejecutivas en jóvenes y adultos mayores brasileños

Resumen | **Introducción/objetivo:** El proceso de envejecimiento saludable implica cambios en las funciones neurobiológicas a varios niveles y se asocia con un ligero deterioro en diversos dominios cognitivos, como las funciones ejecutivas (FE), así como con una mejora de las habilidades emocionales. El objetivo de este estudio es comparar el uso de estrategias de regulación emocional (RE) en jóvenes y adultos mayores y explorar la asociación entre habilidades de RE y FE entre los grupos etarios. **Método:** Participaron 40 jóvenes entre 18 y 39 años (50 % mujeres) y 40 adultos mayores de > 60 años (50 % mujeres), todos residentes en el Distrito Federal (Brasil). Se administraron las pruebas de Fluidez Verbal Fonológica (FAS), semántica y de cambio (animales y frutas) y de acciones, junto al Test de Stroop. **Resultados:** Hubo una correlación estadísticamente significativa entre la estrategia de reevaluación cognitiva (RC) y las pruebas de fluidez verbal semántica y de cambio en jóvenes y entre la estrategia de RC y la prueba FAS y el Test Stroop en adultos mayores. Eso es, el desempeño ejecutivo mostró relación directa con la RE en ambos grupos, con mayor uso de la RC por parte de los adultos mayores. **Conclusiones:** Los resultados de este estudio resaltan la pertinencia de continuar investigando la relación entre estas habilidades y analizar con mayor profundidad sus alteraciones durante la edad adulta y el proceso de envejecimiento.

Palabras clave: Regulación emocional, reevaluación cognitiva, supresión de emociones, funciones ejecutivas, envejecimiento

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Executive functions (EF) serve as an umbrella term to encompass the set of higher order mental abilities essential for goal-directed behaviour and include planning, temporal sequencing, resisting interference, holding attention, learning, making decisions, and regulating behaviour, among other skills necessary for everyday life (Chung et al., 2014; Diamond, 2013).

The tasks' inherent characteristics can also activate fundamental neural processes associated with EF, stemming from either emotional (hot EF) or purely cognitive (cold EF) stimuli (Colautti et al., 2022). The conceptual framework of hot and cold EF entails the incorporation of additional brain regions, such as those associated with motivation and emotions, including the insula, amygdala, and limbic system (Sharpe & Schoenbaum, 2016). Furthermore, it encompasses the consideration of relevant affective and contextual factors in these behavioural response capabilities (Colautti et al., 2022).

Emotion Regulation (ER) is an essential mechanism for the behavioural adaptation of the individual to environmental stimuli according to the demands of the setting, aiding the process of self-regulation throughout the lifespan. ER is understood as being the family of strategies and skills that can be used to control the occurrence, duration and intensity of expression of emotion, through control of expressive behaviour (Aldao et al., 2015; Gross, 1998). ER strategies can also be distinguished in terms of when they impact the emotion-generative process as: "antecedent-focused", referring to the assessment and modulation of emotional antecedents; and "response-focused", centring on the modulation of emotional responses. Four groups of regulation processes involving antecedent strategies can be defined: situation selection, situation modification, attentional deployment and cognitive change. The modulation of emotional response, however, is a response-focused strategy (Gross, 1998; McRae & Gross, 2020).

Based on these processes, Gross and John (2003) initially defined two different skills used commonly in everyday life for enacting ER and their associated experiential, behavioural, physiological, affective and social systems. This draws on the concept of emotional expression, as a behaviour enacted after evaluation of an emotion generated in response to emotional cues that are modulated and culminate in an ER strategy. These strategies include the more widely reported Cognitive Reappraisal (CR) - a form of cognitive reframing of a situation so as to change its emotional impact; and Expressive Suppression (ES) - a form of modulating emotional response to change emotional expression after response tendencies have already been generated. These strategies were selected for further investigation because they can portray individual differences between sample groups and serve to exemplify antecedent-focused and response-focused strategies (John & Gross, 2004; McRae & Gross, 2020). Also, regarding ER, age has been shown to play a key role in its development and use, despite declines in other domains with advancing age. Typically, older adults (OA) reduce the use of suppression, establishing CR as the most used strategy in a "healthier" pattern of ER (John & Gross, 2004).

Additionally, senescence is accompanied by aging-related impairment in different cognitive domains, including episodic and working memory, as well as EF, even in neurologically-healthy individuals (Andrade & Andrade, 2022). The process of human aging is associated with a host of consequences which vary according to the individual in terms of biological, psychological and social dimensions, as well as rate of change. The aging process is influenced by genetic and environmental factors, culminating in physical, cognitive and reproductive declines (World Health Organisation [WHO], c2023).

According to the WHO (c2023), healthy aging is a continuous process of optimising opportunities to maintain and improve physical and mental health, independence, and the quality of life throughout the life course. Moreover, among the population group over 80 years of age, the number of years lived with some level of disability has increased exponentially, particularly in recent decades (WHO, c2023). These perspectives highlight the need to define typical levels of cognitive protection and emotional control, with a view to maintaining functioning and ensuring continued quality of life throughout adulthood. Thus, it is of vital importance to define and contrast the executive influences on emotional processes to plot the characteristics of these concepts from a developmental and maturation perspective. This approach can help contribute with the neuropsychological findings of the constructs with regards to human aging. However, there is a dearth of studies elucidating the influence of EF on the preference for a given ER strategy considering age, given the peak of EF in younger adulthood (2nd-3rd decades of life). Therefore, the objective of the present study was to compare the use of ER strategies in young adults (YA) and older adults (OA), and explore the association between ER skills and EF to reveal potential disparities in cognitive-executive abilities between age groups by analysing performance in a battery of neurological tests. A satisfactory level of EF, albeit with age-related declines, is expected to support more developed ER in OA, given that EF are core abilities for other processes in human life, playing a mediating role in exercising ER.

Method

This is a cross-sectional, descriptive, and quantitative study, approved by the Human Subjects Ethics Committee of the Faculty of Ceilândia of the University of Brasilia - CEP/FCE (Opinion nº. 5.376.249). All participants signed a written informed consent in accordance with the ethical guidelines for research with human subjects (466/2012 CNS/MS Resolution).

Participants

The study recruited a cohort of 85 individuals residing in the Federal District of Brazil to participate in this research, comprising 45 OA and 40 YA. Of the initial 45 OA selected, 40 met the inclusion criteria and agreed to take part in the study. Thus, the final study sample included a total of 80 participants.

Inclusion criteria were: presenting no neurological or psychiatric conditions; speaking Portuguese as

a mother tongue; and having no uncorrected visual or hearing deficits. The exclusion criteria were: having a previous or current history of alcoholism or use of illicit drugs; the use of poorly fitted dental prosthesis; and the use of benzodiazepines or other medications which could potentially affect cognitive-linguistic performance. Individuals whose scores on the brief assessment were suggestive of cognitive impairment and indicated depression or dependence for activities of daily living were also excluded.

Measures and procedure

The following screening instruments were applied:

- General assessment questionnaire: self-report instrument devised specifically for the study. The questionnaire collected identification details, sociodemographic data, information on previous and current health status, on the presence of emotional and cognitive symptoms, list of medications in use, and any complementary studies performed.
- **The Hospital Anxiety and Depression Scale (HADS)**. A self-report scale to identify cases (possible and probable) of mild anxiety and/or depression disorders in non-clinical populations. It was administrated in the YA, according to the cut-off points defined for the Brazilian population: ≥ 8 for anxiety and ≥ 9 for depression (Castro et al., 2006).
- **Mini-Mental State Exam (MMSE).** A cognitive screening instrument applied to OA, with a cutoff point for the Brazilian population of 24 points (Bertolucci et al., 1994).
- **Geriatric Depression Scale (GDS).** 15-item version, adapted for the Brazilian population by Almeida and Almeida (1999), with a cutoff point above 6 points.
- **Instrumental Activities of Daily Living (IADL) Inventory.** Measured using the scale proposed by Lawton and Brody (1969) that assesses the presence or absence of difficulties in tasks that involve maintaining an independent life.

Executive functions were evaluated with neurological scales widely used for assessing OA. As outlined by Faria et al. (2015) in a literature review, EF evaluation can be restricted to two tests when brief tools are employed that combine assessments of different domains, providing an analysis of EF that covers different interrelated executive skills, namely:

- **Verbal Fluency (VF) Test.** A simple, quick-to-apply instrument, which entails naming as many words as possible belonging to a given semantic group or beginning with a specific letter in one minute. The test measures attention, semantic memory, EF and language (Strauss et al., 2006). The FAS Phonemic verbal fluency, Semantic and Switching verbal fluency (Animals and Fruits), and Action verbal fluency versions were used. Participant performance was based on the total number of words produced, switching categories and word pairs (Animals and Fruits).
- **Stroop Test.** This instrument requires the participant to state, as quickly as possible, the colour printed for each stimuli presented. The Colour-Word version containing 3 tasks was applied: Colours, Words and Stroop Effect. Each task consists of a paper board for which participants are asked to identify the colours printed for each item, arranged on 6 lines with 4 items per line with the same spacing for all boards. On the last board (Stroop effect), participants are asked to identify the words printed in different colours. The tasks measure inhibitory control and EF aspects, such as cognitive flexibility and susceptibility to interference (Strauss et al., 2006). The parameters measured included time (seconds) taken to complete the task, number of errors and self-corrections.
- **Emotion Regulation Questionnaire (ERQ).** Is a 10-item self-report measure of two emotion regulation strategies: cognitive reappraisal (ERQ-CR) and emotion suppression (ERQ-ES) (Gross & John, 2003). The version linguistically-adapted for the Brazilian adult population was used (Boian et al., 2009). The instrument carries reliable indicators for the two domains

Table 1. Demographic and clinical characteristics of the sample

Variable	Total	YA	OA	*p*-value
Sample size	80	40	40	-
Percentage female	52.5%	50%	55%	-
Age (years)		26.77 ± 6.82	68.00 ± 7.02	**0.001***
Education (years)		15.42 ± 2.42	14.68 ± 4.16	0.333
HADS-Anxiety		7.55 ± 2.78	-	-
HADS-Depression		4.87 ± 2.31		
GDS (/15)		-	1.65 ± 1.31	-
MMSE (/30)		-	26.85 ± 2.48	-
IADL		-	7.65 ± 0.73	-

Note: *t*-test for independent samples. HADS = Hospital Anxiety and Depression Scale; GDS = Geriatric Depression Scale; IADL = Instrumental Activities of Daily Living Inventory; MMSE = Mini-Mental State Exam; OA = older adults; YA = young adults.

Table 2. Comparison of performance of participants on emotion regulation questionnaire and neuropsychological tests

Variable	YA	OA	*p*-value	*partial* $\eta 2$
ERQ-CR	28.77 ± 6.65	35.02 ± 5.18	**0.001***	0.220
ERQ-ES	15.22 ± 5.15	17.55 ± 5.95	0.066	0.043
FAS-total	40.17 ± 11.19	33.27 ± 10.01	**0.005***	0.098
FAS-F	14.17 ± 4.87	11.35 ± 4.04	**0.006***	0.093
FAS-A	13.47 ± 3.80	10.17 ± 4.43	**0.001***	0.141
FAS-S	12.52 ± 3.92	11.75 ± 3.30	0.342	0.012
Animals	21.65 ± 4.78	17.12 ± 5.81	**0.001***	0.156
Fruits	17.13 ± 3.33	13.87 ± 5.56	**0.001***	0.158
Switching	16.15 ± 3.32	12.30 ± 3.79	**0.001***	0.230
Pairs	7.82 ± 1.69	6.05 ± 1.76	**0.001***	0.212
Actions	18.75 ± 4.67	14.75 ± 6.33	**0.002***	0.117
Stroop 1-Time (secs)	13.72 ± 2.56	19.62 ± 5.32	**0.001***	0.338
Stroop 1-Errors	0.00 ± 0.00	0.12 ± 0.40	0.054	0.047
Stroop 1-Self-corrections	0.05 ± 0.22	0.05 ± 0.22	1.000	0.000
Stroop 2-Time (secs)	15.55 ± 2.99	27.30 ± 10.50	**0.001***	0.367
Stroop 2-Errors	0.00 ± 0.00	0.10 ± 0.37	0.099	0.034
Stroop 2-Self-corrections	0.17 ±0.38	0.20 ± 0.56	0.087	0.001
Stroop 3-Time (secs)	23.10 ± 5.02	39.92 ± 15.49	**0.001***	0.354
Stroop 3-Errors	0.07 ± 0.34	0.80 ± 1.26	**0.001***	0.135
Stroop 3-Self-corrections	0.47 ± 0.84	0.92 ± 1.18	0.054	0.047

Note: *t*-test for independent samples. CR = Cognitive reappraisal; ERQ = Emotion Regulation Questionnaire; ES = Emotion suppression; FAS = Phonemic fluency test; OA = older adults; YA = young adults. Partial $\eta 2$ = measure of effect size.

of ER (CR and ES) and has satisfactory internal consistency and temporal stability for application in older Brazilians, as reported by Batistoni et al. (2013).

Recruitment began by distributing informational flyers at the University of Brasília and surrounding areas, complemented by community-based word-of-mouth promotion. Participants were selected by convenience. For selection, the subjects interested in taking part in the study were provided with the exclusion/inclusion criteria and indicated to researchers whether they were eligible. Upon confirmation, data collection was carried out at a scheduled time.

The data collection procedure entailed application of the questionnaire in two stages, according to sample age. For the young adult group, the questionnaire was

Table 3. Pearson's correlation coefficients among executive and emotion regulation measures in young adults

Variable	CR	ES	FAS-total	FAS-F	FAS-A	FAS-S	Animals	Fruits	Switching	Pairs	Actions	Stroop 1-T	Stroop 2-T	Stroop 3-T
CR	1													
ES	0.16	1												
FAS-total	0.07	-0.19	1											
FAS-F	0.15	-0.13	**0.91****	1										
FAS-A	0.02	-0.23	**0.86****	**0.70****	1									
FAS-S	0.00	-0.14	**0.85****	**0.67****	**0.61****	1								
Animals	0.23	-0.05	**0.44****	**0.48****	**0.35***	**0.32***	1							
Fruits	**0.57****	-0.06	0.23	0.28	0.27	0.04	**0.53****	1						
Switching	**0.41***	0.01	0.28	0.29	0.25	0.19	**0.56****	**0.39***	1					
Pairs	**0.44****	0.04	0.26	0.26	0.26	0.17	**0.59****	**0.40***	**0.95****	1				
Actions	-0.03	0.09	**0.49****	**0.45****	**0.37***	**0.46****	**0.35***	0.13	0.18	0.19	1			
Stroop 1-T	0.09	0.07	-0.26	-0.27	-0.26	-0.15	**-0.33***	**-0.32***	-0.29	**-0.32***	-0.23	1		
Stroop 2-T	0.10	0.00	-0.04	0.08	-0.10	0.08	**-0.34***	-0.09	**0.41***	**-0.46***	-0.07	**0.69****	1	
Stroop 3-T	-0.12	0.08	0.10	0.03	-0.10	0.15	-0.01	-0.08	-0.16	-0.20	-0.12	0.26	**0.35***	1

*$p < 0.05$; **$p < 0.01$. Note: CR = Cognitive Reappraisal; ES = Emotion Suppression; FAS = Phonemic fluency test; Stroop T = Stroop Time.

Table 4. Pearson's correlation coefficients among executive and emotion regulation measures in older adults

Variable	CR	ES	FAS-total	FAS-F	FAS-A	FAS-S	Animals	Fruits	Switching	Pairs	Actions	Stroop 1-T	Stroop 1- E	Stroop 2-T	Stroop 2-E	Stroop 3-T	Stroop 3-E
CR	1																
ES	-0.00	1															
FAS-total	**0.35***	0.12	1														
FAS-F	0.07	0.03	**0.74****	1													
FAS-A	**0.41***	0.04	**0.84****	**0.39***	1												
FAS-S	**0.36***	0.24	**0.75****	0.3	**0.54***	1											
Animals	0.10	0.07	**0.47****	**0.47****	**0.34***	0.27	1										
Fruits	0.11	0.13	**0.36***	**0.37***	0.20	0.28	**0.59****	1									
Switching	0.14	-0.25	**0.34***	0.29	0.18	**0.36***	**0.54****	**-0.47****	1								
Pairs	0.12	-0.15	**0.37***	**0.34***	0.22	**0.31***	**0.55****	**-0.44****	**0.91****	1							
Actions	-0.03	-0.16	**0.47****	**0.48****	0.29	**0.32***	**0.41***	0.24	0.29	**0.31***	1						
Stroop 1-T	-0.30	0.09	**-0.40***	-0.26	-0.25	**-0.47****	-0.08	-0.14	-0.23	**-0.31***	-0.17	1					
Stroop 1-E	0.09	-0.06	-0.11	-0.14	-0.05	-0.08	-0.17	-0.18	-0.12	-0.15	**-0.34***	0.25	1				
Stroop 2-T	**-0.34***	0.12	0.00	0.08	0.00	-0.10	-0.03	-0.12	-0.05	-0.06	0.06	**0.52***	**0.33***	1			
Stroop 2-E	-0.09	0.11	0.19	0.09	0.01	**0.40***	-0.13	0.06	0.08	0.05	0.12	-0.30	-0.05	0.30	1		
Stroop 3-T	**-0.33***	-0.30	-0.18	0.08	-0.22	**-0.33***	-0.03	0.00	-0.08	-0.07	0.11	0.16	-0.01	0.20	-0.14	1	
Stroop 3-E	**-0.40***	-0.14	0.03	0.22	-0.08	-0.07	0.12	0.18	0.09	0.06	0.08	0.24	0.31	**0.50****	-0.01	**0.60****	1

*p < 0.05; **p < 0.01. Note: CR = Cognitive Reappraisal; ES = Emotion Suppression; FAS = Phonemic fluency test; Stroop E = Stroop Errors; Stroop T = Stroop Time.

applied at the Laboratory of Human Communication and Orofacial Functions of the Faculty of Ceilândia of the University of Brasília, whereas the OA group completed the questionnaire at home in a quiet room without disturbance. Participants that agreed to take part underwent: (1) a short interview, collecting demographic data, together with other relevant aspects associated with the profile and objectives of the present study; (2) application of the neuropsychological instruments to elicit the cognitive processes involved in EF, the VF tests, and the Stroop Test; (3) all participants (YA and OA) were asked to complete the ERQ. The individual sessions for data collection, involving the 3 stages outlined above, took an average of around 50 minutes.

Data Analysis

Descriptive and inferential statistical analyses were carried out to characterise the sample in relation to mood, global cognition and IADL profile, and descriptive analyses were implemented, using mean and standard deviation.

An independent samples t-test was conducted to examine the demographic variables of age and education between YA and OA, as well as to examine potential EF performance differences (VF tests and Stroop test) and ERQ responses, across the two age groups. Partial $\eta 2$ was used as an index of effect size with 0.01, 0.06, and 0.14 being considered small, moderate, and large effect sizes, respectively (Cohen, 1988). Additionally, Pearson's correlation coefficients were calculated to assess the relationship between the ERQ and the EF tests for each group of participants. Analyses were performed using the IBM SPSS Statistics for Windows v.25 software package. The level of statistical significance was set at 5% ($p < .05$).

Results

In the YA, participants had a mean age of 26.77 (standard deviation 6.82) years and a mean education of 15.42 (standard deviation 2.42) years, and were 50% females. In the OA, participants had a mean age of 68.00 (standard deviation 7.02) years and a mean education of 14.68 (standard deviation 4.16) years, and were 55% females. As expected, the groups differed in terms of age (p = 0.001). However, there was no statistically significant demographic difference for the education variable (p = 0.333), indicating sample homogeneity for level of formal academic education. With regard to the clinical characteristics of the sample, mean scores attained by the YA on the HADS was suggestive of anxiety and probable depression. By contrast, mean scores of the OA were within the expected range (Table 1).

Comparison of performance on the ERQ for age revealed a statistically significant group difference for the CR variable (p = 0.001). Although no statistically significant difference between groups was found for the ES variable, a tendency towards significance was observed for this skill (p = 0.066). As expected, group differences

were found in performance on the VF tests for almost all variables (except the FAS-S variable), with higher scores for the YA compared to the OA, i.e., the YA had a greater mean number of correctly accessed words. Lastly, on the Stroop Test, statistically significant differences were evident for the variables in execution time of the three tasks (colours, words and Stroop Effect), whereby the YA had better performance (shorter execution time) compared to the OA (p = 0.001) (Table 2).

Pearson's correlation coefficients were also performed between the tests applied in order to describe the intragroup characteristics and explore the relationship between ER and EF within the groups. In the YA (Table 3), the results showed a significant correlation among the VF tasks Fruits (p < 0.005), Switching (p < 0.05), and Pairs (p < 0.005). In the same group, there was no statistically significant correlation between the score on the ERQ for the ES skill and performance on executive tests.

Regarding the OA (Table 4), the results showed a significant correlation between the ERQ score for the CR skill and the FAS (p < 0.050), FAS-A (p < 0.050), FAS-S (p < 0,050); and Stroop 2 – Time (p < 0.050), Stroop 3 - Time (p < 0.050) and Stroop 3 - Errors (p < 0.050). Parallel to the YA, in the OA, there was no statistically significant correlation between the variables from the ER questionnaire for the ES skill and the tasks eliciting executive processes.

Discussion

ER predominantly involves changes in the dynamic of emotions, whereby processing develops over a time window, impacting latency, timing of behaviour, magnitude, duration and fluctuation of these responses in domains that encompass behavioural, experiential and physiological processes (McRae & Gross, 2020). ER strategies (CR and ES) can be defined as being more or less appropriate for a given context, without one outweighing the other, given they hinge on emotional experience and acting developmental variables, such as mechanisms of selection, optimisation and compensation, culminating in a more appropriate response for the emotional resources available (CR), that does not exclude ES (Batistoni et al., 2013). CR and ES are two independent regulation strategies that differ across individuals and contexts at different levels (John & Gross, 2004; McRae & Gross, 2020).

Thus, since ER skills are context-dependent, i.e., although antecedent strategies (CR) are considered more appropriate in most situations, there are emotional circumstances in which modulation of the response (ES) is required, particularly in early development, where greater use of suppression has been associated with school readiness in preschoolers (Harrington et al., 2020). With YA, due to the structure of emotional experience in context, there may be more situations requiring the use of ES in everyday life than for OA (John & Gross, 2004). Thus, the pattern of development of ER is maintained, with progressively better use of adaptive strategies throughout the lifespan, as evidenced in the present study. Moreover, the division between use of antecedent strategies (CR) or modulation of the emotional response (ES) becomes more apparent in healthy adults. Overall, the OA group studied made greater use of both ER strategies and had more successful outcomes for CR (higher mean scores on the ERQ) than the YA. These results corroborate the findings of John and Gross (2004), Gross et al. (2006) and Yeung et al. (2011), showing that OA tend to employ antecedent ER strategies involving CR prior to exercising the emotional response, a pattern associated with psychological health and emotional well-being (Aldao et al., 2015; McRae & Gross, 2020).

However, the majority of ER measures reported in the literature are self-reported, such as the ERQ (Boian et al., 2009; Gross & John, 2003). These instruments rely on the individual´s perception and, hence, on a well-established self-concept and self-knowledge. Based on the current results, it can be inferred that the OA had a better perception of their own emotions than the YA, with the former attaining higher mean scores for both ER strategies, even though ES is considered a maladaptive ER strategy under most circumstances (John & Gross, 2004; McRae & Gross, 2020). It is believed that the deeper self-knowledge held by the older participants conferred them with the ability to adapt the way they expressed their emotions to a greater number of situations, attaining higher scores for both CR and ES, despite a predominance of CR use.

Moreover, evidence suggests that ER (especially CR) can be refined using therapeutic coping strategies. In a dialectic association between the constructs, the study by Segal et al. (2023) involving a sample of 18-35 years of age, showed that the practice of emotional acceptance, i.e., living one's emotions, sensations and thoughts to the fullest without trying to change them (Wolgast et al., 2011), improves the implementation of CR, highlighting the importance of understanding and comparing interactions between different ER strategies. While these concepts appear on the surface to be counterproductive, emotional acceptance can be construed as a response-focused emotional strategy (like ES) which, when modulated, promotes the improvement of antecedent emotional strategies, such as CR (Segal et al., 2023).

Nevertheless, with regard to coping strategies, CR is positively related to coping via reinterpretation, whereas ES is negatively associated with coping by venting (John & Gross, 2004). Evidence suggests that, while therapeutic training for young adults yields results in terms of a better use of CR through the use of emotional acceptance (Segal et al., 2023), practices of attention and acceptance of emotional contexts in older individuals lead to enhanced adaptive ER skills (CR) which can offset age-related cognitive declines in EF, supported by the higher levels of self-knowledge held by this population group.

The findings for ER contrast with the pattern of development and maturation of EF, characterised by cognitive abilities peaking at between the second and third decades of life, with cognitive decline in later life (Diamond, 2013). The YA had a better performance on the EF tasks, even in a homogeneous sample for education, ruling out the influence of formal academic education on this group (young undergraduates). Concomitantly,

both recent ES and CR appear to have a deleterious impact on EF performance, explained by their use of similar resources. Therefore, both strategies should be considered when assessing ER and its impact on EF (Brothers et al., 2022).

EF have core characteristics for other adaptive processes which, in a network approach, the unity of EF represents an emerging property of the dynamic between multiple abilities (inhibitory control, cognitive flexibility and working memory). These abilities, in conjunction, lead to higher integrative processes (problem resolution, fluid intelligence) that contribute to executive behaviour and the attainment of goals during the lifespan (Fiamoncini & Satler, 2021; Karr et al., 2022), suggesting that ER is an integral part of this process (Diamond, 2013).

It is also suggested that hot EF - that is, related to internal, emotional and motivational components of the individual - play a central role in ER, modulating it, with ER being one of the main domains related to hot EF (Salehinejad et al., 2021). In this sense, it is worth reflecting on the use of ER tasks to measure EF, and whether these domains would be directly related in neuropsychological tests. Such conclusions would be able to justify the adequate performance of the YA group in the ER and EF tasks. However, it does not clarify the highly satisfactory performance of OA in the ER task, in contrast to the decline in purely cognitive (cold) EF tasks, suggesting that hot EF would be better consolidated with age.

Additionally, with regard to the pattern of development of EF during the lifespan and age-related decline, the study by Ménétré and Laganaro (2023) sought to document the temporal dynamic observed on the Stroop test from childhood through to young and older adulthood. With aging, there is a tendency for greater use of crystallised intelligence (common sense) as a way of offsetting executive decline in later life and a lesser ability to exercise fluid intelligence. Thus, executive ability decreases with age, yet conflict resolution processes appear to be spared (Ménétré & Laganaro, 2023). In short, there is an overlapping of neural mechanisms related to simplified processes, which require less cognitive effort in the context of a decline in EF.

In the present study, there was a statistically significant correlation of the VF semantic and switching tests with the CR strategy in the YA. Furthermore, amid conflicting reports in the literature on the use of VF tests to access EF, in as far as these tests evaluate other cognitive and linguistic domains; the study by Paula et al. (2015) suggests that switching versions of VF tests are the most suitable for accessing EF, without disregarding other assessment approaches. Corroborating the studies of Mohammed et al. (2022) and King Johnson et al. (2023), the present results suggest a direct association between EF and the use of adaptive ER strategies (CR in this case), particularly in the YA, where executive proficiency predicts emotional skills.

With the OA, however, a significant correlation between performance on the phonemic VF test and CR was found, in contrast to the YA, where a correlation between CR and the semantic VF test results was identified. These findings suggest the executive level needed to carry out ER strategies is maintained in the older group, albeit on a different scale. The Phonemic VF test requires greater cognitive effort because habitual responses tend to use semantic association networks (Pagliarin et al., 2022), explaining the statistically significant correlation between CR and phonemic VF tests in the older group. This phenomenon highlights the executive mechanisms needed for antecedent ER strategies, not only in this group, given executive decline over the lifespan.

Hence, ER plays an emotion protection and socio-affective role via the positive relationships between CR, satisfaction with life and positive affects, and negative relationships with depression, where greater use of CR is indicative of better emotional health in older individuals (Batistoni et al., 2013). In addition, the use of CR is moderated by social relationships, in the same way that it is associated with the emotion strategy dominant in those OA with better performance in EF, particularly with regard to cognitive flexibility (King Johnson et al., 2023). Therefore, the results confirm the notion that the higher level of EF seen in the YA is associated with the effective application of ER strategies, an outcome maintained throughout life, and one that may be associated with other skills in OA.

Regarding the limitations of the study, first, the sample size was relatively small. Secondly, the study encompassed highly educated YA and OA. Third, individual variabilities in factors such as personality traits, physical activity, occupation and socioeconomic status were not accounted for in the analysis or interpretation of the results. Additionally, only verbal instruments were utilised for assessing EF. Therefore, future research should involve a larger, more diverse sample, integrating both verbal and non-verbal assessment tools to enhance the understanding of the relationship between ER and EF skills in terms of developmental trajectories and maturation.

Finally, this article underscores several contributions to both research and clinical practice: (1) Mental health interventions: by comprehending ER in OA, tailored interventions can be devised to bolster mental well-being, potentially reducing the prevalence of mood disorders such as depression and anxiety, and augmenting the overall quality of life; (2) Enhanced cognitive functioning: Understanding the correlation between ER and EF can guide strategies aimed at sustaining or improving cognitive abilities in OA, potentially offsetting age-related cognitive decline; (3) Early detection and intervention for neurodegenerative diseases: Changes in ER and EF may act as early warning signs for neurodegenerative disorders, facilitating prompt diagnosis and intervention; (4) Crafting psychotherapeutic approaches specifically designed for OA, addressing their emotional needs and challenges.

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