



# The relationship between cognitive reserve and the spontaneous use of emotion regulation strategies in older adults: a cross-sectional study

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## Abstract

**Background** Several studies reported cognitive reserve (CR) as an important factor in promoting healthy aging within a non-clinical aging population.

**Aims** The main goal of the present study is to investigate the link between higher levels of CR and more effective emotion regulation. In more detail, we examine the association between a number of CR proxies and the habitual use of two emotion regulation strategies, cognitive reappraisal and emotional suppression.

**Methods** Three hundred and ten older adults aged between 60 and 75 (mean = 64.45, SD = 4.37; 69.4% female) joined this cross-sectional study by filling out self-report measures of CR and emotion regulation.<sup>2</sup>

**Results** Reappraisal and suppression use were correlated. Practicing different leisure activities constantly over many years, being more original and having a higher education promoted more frequent use of cognitive reappraisal. These CR proxies were also significantly related to suppression use, even though the percentage of variance explained was lower.

**Discussion and conclusions** Exploring the role played by the cognitive reserve on different emotion regulation techniques can be useful in understanding which variables predict the use of antecedent-focused (reappraisal) or response-focused (suppression) emotion regulation strategies in aging individuals.

**Keywords** Cognitive reserve · Emotion regulation · Aging · Reappraisal · Suppression

## Introduction

The concept of cognitive reserve (CR) has been introduced by Stern [1, 2] to explain why some individual responds better to different forms of brain damage or perform better than other given the same level of neuropathology. The CR model assumes that the brain can use compensative cognitive strategies and recruit alternative neural networks to overcome limitations caused by different form of brain damage [3]. The CR levels can predict the efficacy of this alternative

mechanisms. The CR is not fixed or genetically determined, but it develops during life, based on different activities and experiences, which are generally used as proxies to assess the CR levels [4]. These proxies include level of education [5], type and frequencies of leisure activities [6], and extent of social network [7]. More recently creativity and, more specifically, flexibility of thought (which include aspects linked to number and originality of new ideas), has been suggest being linked to CR level [8–10].

CR has been mainly studied as a protective factor that could lead to better cognitive and functional outcomes in aging population with different pathologies like dementia, Alzheimer's and cognitive decline [11–13], and also Parkinson's [14]. More recently, however, several studies reported the CR levels as a protective factor for non-clinical aging population [4, 15]. To be more specific, the CR has been found to help improving cognitive skills [16, 17], protect the aging population from the effects of stress [18, 19], and increase wellbeing [20].

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Notably, although aging is normatively associated with many forms of decline (e.g., physical, cognitive, social), there is evidence that older adults tend to experience high levels of affective wellbeing through most of their adult years [21–23]. To explain the so-called wellbeing paradox of aging, research has started to investigate the cognitive-emotional mechanisms that may underlie such beneficial wellbeing outcomes [24]. Among these mechanisms, it has been suggested that aging may be associated with a more effective use of emotion regulation (ER) [22]. For instance, the socioemotional selectivity theory (SST) postulates that—since future time starts to be perceived as limited—older adults become more focused on goals related to emotional meaning and more motivated to effectively regulate their emotions to enhance their well-being [25]. Along this line of reasoning, the model of Selection, Optimization and Compensation with Emotion Regulation (SOC-ER) [21, 22] has suggested that the resources that are required for the implementation of ER strategies and that are crucial determinants of ER use and success vary with age. These resources comprise both individual variables (e.g., cognitive control abilities) and environmental affordances (e.g., positive social relationships).

Starting from these premises, the present study adds to prior literature concerning cognition-emotion interactions in later adulthood by hypothesizing a link between higher levels of CR and a more effective emotion regulation. Both CR [20] and ER [26] have been shown to contribute to older adults' affective wellbeing, and CR may be part of the resources that underlie the effective implementation of ER strategies. Yet, this link hasn't been studied extensively by recent literature. For instance, Bruno et al. [27] discuss how higher level of cognitive reserve could predict the so-called "positivity effect" [28] that has been reported being linked to aging. This effect describes the preference of older people to focus and remember mainly positive emotional stimuli, devoting less resources to negative ones [29]. Although this study supports a link between CR and a form of cognitive bias (i.e., prioritizing positive information), CR has been measured using only one proxy (i.e., years of education) while, as discussed above, most recent studies agree on the fact that the CR is a much more complex variable. It is also unclear if the effect of the CR goes beyond the positivity effect, extending to the use of emotion regulation strategies.

Several studies have examined whether aging individuals regulate their emotions more effectively than younger adults [22, 23]. This research has mainly focused on one form of ER, namely cognitive reappraisal [22, 26], which refers to the ability of modulating one's emotional response by changing perspective and re-evaluating the meaning of emotion-eliciting situation [30, 31]. Cognitive reappraisal is generally conceived as a functional, adaptive strategy since its habitual use has been related to higher levels of

well-being [32, 33]. On one side, correlational studies have examined whether older adults tend to use cognitive reappraisal more frequently than younger ones. This research, however, has led to mixed results, with some studies finding higher use of reappraisal with increasing age [25] and other studies finding no associations [34–36]. On the other side, experimental research has examined whether older adults are more successful when using cognitive reappraisal to down-regulate negative emotions. Overall, the results suggest that this might be the case for some forms of cognitive reappraisal, such as positive reappraisal [37, 38], but not for other forms such as detached reappraisal [37, 39] possibly because these latter forms rely more on fluid cognitive abilities and cognitive control, which are known to decline with age [40]. Finally, some research has examined the neural underpinnings involved in the use of cognitive reappraisal in younger and older adults, showing differences in functional connectivity and PFC recruitment during cognitive emotion regulation tasks [39, 41]. The fact that connectivity levels seem to be implied in this process might suggest a possible mediating role of the CR in promoting this different pattern in the aging population.

Another possible explanation of the positive association between CR and the use of cognitive reappraisal is linked to one of the most recent proxies that has been associated with the cognitive reserve: creativity [8]. Creativity has been defined in many different ways—but all definitions seem to assume that any creative activity share three mechanisms [42]: widening (the tendency to keep an open mind and be able to deal with a high number of elements), connecting (the capacity to establish relationships among different elements and to combine them in unusual ways), and reorganizing (being able to change perspective and inverse relationships among elements). All these mechanisms might promote mechanisms linked to cognitive reappraisal, as also supported by the fact that flexibility of thought (often used as a synonym of creativity) has been reported [43] to be positively associated with successful emotion regulation, both in younger and older individuals. Going more into details about this relationship, creativity and creative insight has been reported to be a significant predictor of the regulating effects of reappraisal [44].

Within the theoretical framework provided by the Process Model of emotion regulation [45, 46], studies on emotion regulation typically contrast cognitive reappraisal (an antecedent-focused strategy) to expressive suppression (a response-focused strategy), which has been defined as the attempt to actively inhibit one's emotional responses [47], thus requiring a constant self-monitoring to inhibit the expressive component of a given emotional response [48]. Although cognitive reappraisal and expressive suppression have been shown to share common neural bases [49], they lead to different health outcomes. While cognitive

reappraisal is positively associated with higher affective wellbeing [47, 50], suppression tends to be linked to worse health-related outcomes and it is thus generally considered a maladaptive strategy [26, 51]. To date, little research has focused on expressive suppression in aging [25, 34, 46]. Research comparing younger and older adults' habitual use of suppression has shown mixed results, with some studies reporting less frequent use of suppression in older adults [26], other studies reporting more frequent use [46], and others reporting no differences [49]. Notably, one cross-sectional study [52] found that suppression use was associated with higher reporting of psychological distress in the sample of younger, but not of older adults, suggesting a possible decoupling of the use of suppression and distress with age. In contrast, experimental research has shown more consistent results, finding that both younger and older adults effectively use suppression during instructed emotion regulation tasks [37, 53]. To our knowledge, no one has investigated the possible role of the CR in affecting expressive suppression in older adults.

The present cross-sectional study aims at adding to the existing literature about cognitive-emotional processes in the aging population by examining the relationship between CR and older adults' habitual use of cognitive reappraisal, adopting a comprehensive model of the CR that takes different proxies into consideration. A specific focus of our study is the relationship between different components of the creative process and the use of cognitive reappraisal. The hypothesis is that specific components of the CR will have different weights in predicting the use of cognitive reappraisal within a regression model, with higher influence linked to proxies that are germane to cognitive changes (e.g., being able to have different original ideas and change perspective, constantly do diversified activities, etc.). The study also aims at exploring the neglected link between aging and suppression. Since this aspect has not been investigated in depth by existing literature, we do not have a hypothesis, but we consider this more an explorative part of the study, aiming at investigating the possible role of the CR in influencing differently antecedent-focused (cognitive reappraisal) and response-focused (suppression) emotion regulation strategies.

## Methods

This study was approved by Champlain College IRB (COA: IRB000128).

## Participants

310 participants, age between 60 and 75 (mean = 64.45, SD = 4.37) joined the study. The sample was not balanced by gender ( $F = 69.4\%$ ).

Participants were recruited by word of mouth, by posting descriptions of the study on social media platform (Facebook, Instagram, LinkedIn). No incentive was used to promote participation.

Participants had to confirm to be 60 years old or older and not to have any diagnosis of psychological disorder to be able to join the study.

Data collection were done online, using the platform Qualtrics.

## Measures

Participants filled out the ERQ and the CoRe-T.

The ERQ (Emotion Regulation Questionnaire) [32]: this ten-item (on a seven-point Likert scale) questionnaire measures individuals' tendency to regulate their emotions using either cognitive Reappraisal or expressive suppression. The items were rationally derived from the operational definition of each emotion regulation strategy. In addition to some general-emotion items, both the Reappraisal and the Suppression scale includes at least one item that focuses on negative emotion (sadness and anger) and one on positive emotion (joy and amusement). Moreover, items are formulated so to avoid any potential confounding, and they do not mention any positive or negative consequences or affect, social functioning, or well-being. Cronbach's  $\alpha$  for the cognitive reappraisal scale in our sample was 0.81 and for the suppression scale 0.70.

The Cognitive Reserve Test—CoRe-T [8] was used to assess the cognitive reserve utilizing an integrated approach. This self-report part of this questionnaire combines all the proxies traditionally used to assess the CR (see Introduction section). The second section of the CoRe-T measures the flexibility of thought, which has been reported to be positively correlated with the CR both in healthy [9, 10] and clinical populations [14, 54]. Self-report data include information about education level (years of completed education, including vocational training), type and frequency of leisure activities (both frequencies of performing teach-specific selected activity and numbers of years they have been practicing it), and occupation history. Two tasks are used to assess fluidity of thought: the "Acronyms" task, where participants are given 5 min list all the terms that can fit into the three given acronyms (the terms had to make sense together), and the "Alternative uses task" where participants, in 5 min, are asked to list as many different, interesting or unusual usages for an empty plastic bottle as they can. Scoring, that leads to a cumulative score, as well as

separate fluidity and originality scores, is described in detail in Colombo et al. (2016).

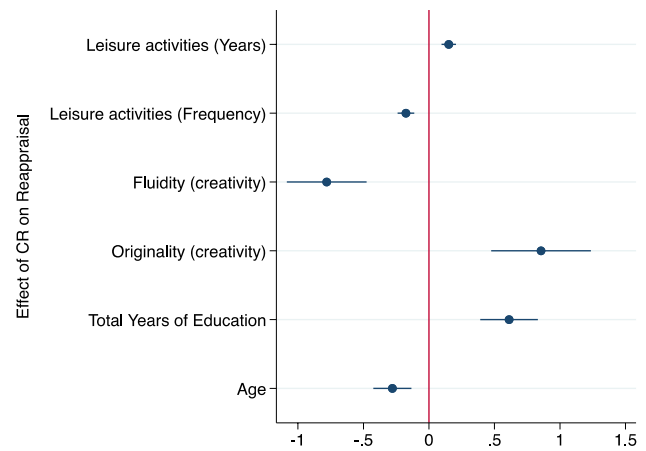
## Results

Analyses were performed using STATA 17.

As a first step, considering that emotion regulation might be used differently by older adults, we explored how cognitive reappraisal and expressive suppression were used in our sample. Both strategies were used at a similar rate ( $\text{Mean}_{\text{Reappraisal}} = 3.01$ ,  $\text{SD}_{\text{Reappraisal}} = 1.04$ ;  $\text{Mean}_{\text{Suppression}} = 4.02$ ,  $\text{SD}_{\text{Suppression}} = 1.13$ ), and the two scales were significantly positively correlated ( $r = 0.29$ ,  $p < 0.0001$ ;  $95\% \text{ CI} = 0.18\text{--}0.39$ ).

Our second question was linked to the possible role of the cognitive reserve and, more specifically, of some of its component, to influence the use of the two different emotion regulations strategies.

To explore this relationship, we run two linear regression models, using the emotion regulations subscales as outcomes, and the CR proxies as predictors, controlling for the effect of age. Results are reported in Table 1, Figs. 1 and 2. From the results reported below, we can see how practicing different leisure activities constantly over many years, being more original and having a higher education promote higher level of cognitive reappraisal. Similar factors lead to the use of suppression strategies but practicing leisure activities more often also played a significant role as a predictor, even more than the years of constant practice.



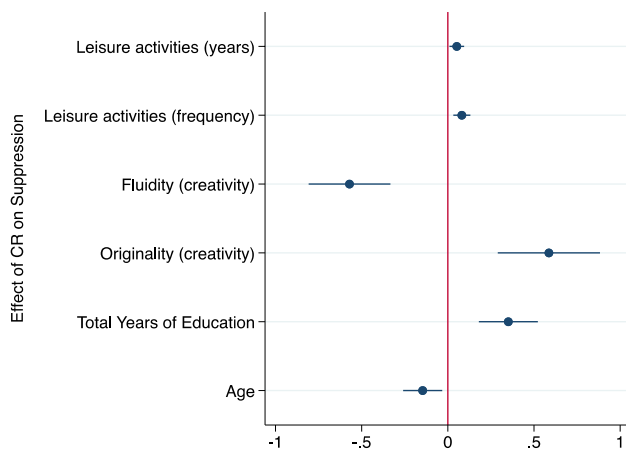
**Fig. 1** Effect of CR proxies on the use of reappraisal strategies (horizontal lines shows 95% CI)

## Discussion and conclusions

This cross-sectional study represents a first attempt at exploring the role of the CR in influencing the habitual use of antecedent-focused (cognitive reappraisal) or response-focused (expressive suppression) ER strategies. Among the theoretical models concerning the cognition-emotion link in later adulthood [24], the SOC-ER framework [21, 22] suggests that there are individual differences in the resources that are necessary for the successful implementation and use of ER strategies. In the present study, we examine this

**Table 1** Regression models: effects of CR proxies on emotion regulation strategies

	<i>B</i>	<i>SE</i>	$\beta$	<i>t</i>	<i>p</i>
<i>Reappraisal</i>					
(Constant)	5.13	.79		6.49	<.001
Leisure activities (years of practice)	.02	.01	.29	5.42	<.001
Leisure activities (frequency of practice)	-.03	.01	-.30	-5.44	<.001
Creativity—fluidity	-.13	.03	-.77	-5.05	<.001
Creativity—originality	.14	.03	.65	4.42	<.001
Education (total number of years)	.10	.02	.28	5.47	<.001
Age	-.05	.01	-.19	-3.78	<.001
$R^2 = .25$ ; $p < .001$					
<i>Suppression</i>					
(Constant)	4.15	.92		4.49	<.001
Leisure activities (years of practice)	.01	.01	.14	2.38	.02
Leisure activities (frequency of practice)	.02	.01	.19	3.21	.001
Creativity—fluidity	-.14	.03	-.77	-4.74	<.001
Creativity—originality	.15	.04	.62	3.89	<.001
Education (total number of years)	.08	.02	.22	4.02	<.001
Age	-.04	.01	-.14	-2.54	.01
$R^2 = .13$ ; $p < .001$					



**Fig. 2** Effect of CR proxies on the use of suppression strategies (horizontal lines shows 95% CI)

hypothesis with respect to the individual differences in a set of resources that are considered as proxies of CR.

Our first research question explored whether increasing age was associated with more habitual use of cognitive reappraisal (generally conceived as an adaptive strategy) and less frequent use of expressive suppression (mostly associated with detrimental health outcomes). This research question was linked to prior literature suggesting that older adults may show a more effective use of ER strategies [22, 23]. Our results showed that older adults reported a similar average use of the two strategies; compared to previous studies assessing habitual use of ER strategies in the elderly population [26, 55], however, our participants reported an overall low mean score for cognitive reappraisal. Moreover, the two strategies were positively intercorrelated, while previous studies employing the ERQ have generally found that the two strategies are independent [26, 55]—for exceptions see Balzarotti [33] and Wiltink et al. [56]. Notably, age showed negative (if small) correlations with the habitual use of both strategies. This result is consistent with previous research finding a negative association between age and suppression use, but not with the idea that older adults tend to increase their habitual use of adaptive forms of ER such as cognitive reappraisal [26]. On one side, our results add to an existing literature that has provided mixed results concerning the relationship between age and self-reported use of ER strategies [34, 35]. Thus, it seems that this relationship is more complex than expected and may be mediated or moderated by other factors. For instance, it has been reported [57] that life events are a significant mediator of the relationship between age and the experience of negative affect—and this might be an interesting variable to be explored more in depth in future studies. Alternatively, differences within the aging population in

the use of ER strategies [58] might vary depending on the age range considered in the studies: some studies but not others have included the oldest-old (i.e., aging individuals above the age of 80) in their samples. Although levels of well-being appear to remain relatively stable throughout adulthood and old age, research has shown that late in life well-being declines considerably [59]. Finally, our sample was not balanced for gender, and prior studies have shown that women report to use suppression more frequently than men. These variables should be included as possible mediators in future studies.

Our results exploring the association of CR with the habitual use of ER strategies show that overall, both strategies seem to be influenced by the same proxies—which is consistent with the finding that the two measures are correlated. Although we expected that CR proxies would show differential links with cognitive reappraisal and expressive suppression (based on the hypothesis that CR would be associated with more frequent use of an adaptive form of ER such as cognitive reappraisal), the substantial similarity that emerged in the pattern of associations seems to point in a different direction. Previous research has shown that there is considerable overlap in the neural bases of the two strategies and that both cognitive reappraisal and suppression rely on executive functions (EF) such as cognitive flexibility, working memory, and inhibitory control [49]. Notably, the link between CR and EF has been well documented [60]. Our results seem thus consistent with prior studies showing that individuals with better performances in tasks measuring EF are able to use both reappraisal and suppression more effectively [61, 62].

Despite the overall similarity, some differences in the associations between CR and ER strategies also emerged. First, the values of  $R^2$  in our regression models were higher for cognitive reappraisal, suggesting that CR may be more linked to the use of this strategy. Second, practicing several leisure activities very often was associated with a lower use of cognitive reappraisal, but with a higher use of emotional suppression. Notably, practicing leisure activities constantly over time was positively related to higher use of both strategies. Social context and social situational norms might influence the choice of different emotion regulation strategies [63], which then would depend not a set individual preference, but rather on the specific context in which strategies need to be used [30, 64]. Possibly, constantly practicing the same type of leisure activities (for example, gardening, or being involved in a book club, or playing music) over years fosters cognitive reappraisal for individuals inclined to use it, because the emotions that the activity might trigger, and their antecedents, become familiar over time (for example, dealing with unsuccessful gardening season, having disagreements with members of the club, or dealing with anxiety performance or other musicians not being available for

rehearsals). This explanation has some limitation, since in our data, the same variable in a similar regression model predicted (even if to a lesser extent) the use of suppression as well—this result can be linked to the fact that being constantly involved in many different activities might lead to more socially diverse unexpected situations (for example, if a person frequently changes venues for music practice and performance, or alternates between a gardening club and a book club). This might lead to the use of emotional suppression, since focusing on the emotional response as it develops requires more cognitive efforts but less planning [45].

Consistently with our hypothesis, we found a link between the creativity-related proxy of the cognitive reserve and emotion regulation. The mechanisms linked to creative thinking, and especially originality (being able to change perspective, reorganize elements of a situation) are similar to the mechanisms required to successfully use cognitive reappraisal (which requires reinterpreting an emotion-eliciting situation in a way that alters its meaning and changes its emotional impact). Studies on children and teenagers [65, 66] as well as college students [67] reported a positive correlation between creativity and the ability of regulating emotions, supporting this association at a theoretical level. Interestingly, fluidity (having many different ideas) was a negative predictor for the use of both emotion regulation strategies. This result could be linked to how higher level of creativity might lead adults to social alienation [68], which, in turn, has been reported to lead to lower levels or more inconsistent use of emotion regulation strategies [69, 70].

Despite being the first one to explore a possible link between cognitive reserve and self-reported use of emotion regulation strategies in the aging population, the study presents some limitations. First, the sample is not balanced by gender. Second, our results could have been clarified by a more in-depth analysis of participants' individual life experiences, which could have helped explaining the results linked to individual differences in emotion regulation. Finally, our study focused on the frequency of use of two ER strategies—thus employing self-report measures only—while we did not consider whether older adults are more or less successful when using them using experimental ER tasks and behavioral measures. Finally, our data can be generalized only to some extent, since even if we had a large sample, we used a cross-sectional study, while longitudinal data would have been more adequate to explore the long term effects of CR. Nonetheless, so far, prior research has mostly used experimental methods to examine whether younger and older adults can successfully employ cognitive reappraisal and emotional suppression to down-regulate negative emotions, while fewer studies have investigated individual differences in the habitual use of these strategies in older adults. Since current available evidence is mixed, the investigation

of the relationship between age and self-reported use of ER strategies in later adulthood deserves future studies.

Despite these limitations, this study provides interesting insights into the habitual use of two emotion regulation strategies in the aging population, showing that the use of both cognitive reappraisal and expressive suppression is related to some of the cognitive reserve proxies, namely education, originality, and the constant practice of leisure activities over time. Thus, CR proxies seem to be associated with more frequent, self-reported use of forms of ER that rely on executive functions, rather than being selectively related to adaptive strategies such as cognitive reappraisal.

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**Data availability** The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Conflict of interest** The authors declare no conflict of interest.

**Ethical statement** Protocols and procedures were conducted according to the Declaration of Helsinki. Protocols and procedures for this research were approved by Champlain College's IRB (COA IRB000128).

**Informed consent** Each participant filled out an informed consent form.

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