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Memory Age-based Stereotype Threat: Role of Locus of Control and Anxiety

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ABSTRACT

Background: Age-related stereotype threat impacts episodic memory performance. This study compared the predictors of memory performance in older adults with and without exposure to age-related stereotype threat, hypothesizing that activating the stereotype threat modulates the relative weight of metamemory predictors of memory performance.

Methods: Participants were 80 older adults (aged 60–84 years) divided into two groups, one with stereotype threat activation and one without; both groups performed an episodic memory task. To activate the stereotype threat, the memory component of the task was emphasized in the instruction given to the threatened group. Both groups also completed two scales of the MIA questionnaire (locus of control and anxiety) to identify potential predictors of memory performance.

Results: Results indicated that the non-threatened group performed better than the threatened group on the episodic memory task. They also indicated that factors predicting episodic memory performance varied according to the group. In the non-threatened group, both control and anxiety were involved in memory performance and interacted whereas in the threatened group only anxiety was involved.

Conclusion: This study confirms that aging stereotype threat impairs episodic memory performance; it also suggests that stereotype threat disrupts mechanisms underlying memory performance abolishing the role of control over memory regardless of the level of anxiety.

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Introduction

Since the seminal research of Steele and Aronson (1995), stereotype threat effects have been studied in a variety of research fields, including race, gender, socioeconomic category, and age. For age-related stereotype threat, the main domain that has been investigated is memory because there is a strong culturally shared stereotype that older people have a poor memory (Lineweaver & Hertzog, 1998; Stein, Blanchard-Fields, & Hertzog, 2002). Experimental studies in this field have used either a priming technique in which older adults are subliminally primed with aging stereotype cues (Levy, 1996; Stein et al., 2002) or an instruction manipulation in which the memory component of the task is emphasized (Desrichard & Kopetz, 2005; Rahhal, Hasher, & Colcombe, 2001). Their results converge, showing that stereotype threat is detrimental to the performance of older participants (for a meta-analysis see Armstrong, Gallant, Li,

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Patel, & Wong, 2017). Conversely, when the salience of the memory component of a task is reduced, the magnitude of the age effect is also reduced (Desrichard & Kopetz, 2005; Hess, Auman, Colcombe, & Rahhal, 2003; Rahhal et al., 2001).

Numerous studies have sought to gain a better understanding of the mechanism underlying stereotype threat effects. They show that the factors involved might vary according to the domain, manipulation of the stereotype threat, and the type of measure used, suggesting that the underlying mechanism is complex to grasp (Barber, 2017). Several putative key factors have been investigated, including control. In the model proposed by Schmader, Johns, and Forbes (2008), executive control measured through a working memory task was affected by intrusive thoughts related to threat, showing how stereotype threat can disrupt memory performance in young adults. Examining this hypothesis in relation to aging, and to the memory performance of the elderly in particular, Mazerolle, Régner, Morisset, Rigalleau, and Huguet (2012) confirmed that stereotype threat consumes working memory, reducing controlled processes and increasing automatic processes. Moreover, in the aging-related literature, Hess et al. (2003) found that the threat effect was mediated by the use of strategies which are known to be related to executive control (Bouazzaoui et al., 2010; Bryan, Luszcz, & Pointer, 1999; Taconnat et al., 2006; Taconnat, Clarys, Vanneste, Bouazzaoui, & Isingrini, 2007; and see; Lemaire, 2010 for a review). Another way to test the hypothesis that control is a key variable involved in the stereotype threat phenomenon is to test the link between self-reported control and memory performance in the context of age-based stereotype threat. The relationship between self-reported control and memory performance has previously been highlighted; for example, using a general index of control not specifically related to memory beliefs (Duttweiler's Internal Control Index, 1984), Amrhein, Bond & Hamilton (1999) found that older adults with a low internal locus of control exhibited poorer episodic memory performance than those with a high internal locus of control. In the same vein, other studies that compared the impact of the internal and external locus of control on memory performance showed that internal locus was associated with better memory performance than external locus (Grover & Hertzog, 1991; Lachman, 1986). These results thus suggest that people who believe that their performance depends mostly on themselves perform better than those who believe that the outcome is primarily determined by external factors. Control beliefs are associated with engagement, which is beneficial for memory performance (Hertzog, McGuire, & Lineweaver, 1998; Valentijn et al., 2006). This suggests that locus of control plays a significant role in optimizing the memory performance of older adults. Given that belief about the locus of control is related to memory performance, it would be interesting to test this relationship in the context of stereotype threat and to demonstrate that control, whether measured objectively or subjectively, plays a role in the stereotype threat effect.

Another variable thought to play a key role in the stereotype threat effect is anxiety. Some studies on cognitive aging have focused on the link between anxiety and memory. Using a self-report measure of trait anxiety, Davidson, Dixon, and Hultsch (1991) found that anxiety was associated with memory performance. Likewise, Andreoletti, Veratti, and Lachman (2006) found that state anxiety was related to poor recall. Anxiety can thus be considered to be a factor that negatively affects the memory performance of the elderly. The role of anxiety in the age-related stereotype effect has been extensively investigated, but inconsistent results have led to disagreements about its potential mediating role. Reviewing this topic in a meta-analysis, Barber (2017) confirmed that the data yielded mixed results. In their integrated model, Schmader et al. (2008) proposed that stereotype threat increases physiological stress, which leads to reduced executive control, resulting in turn to poorer performance. The

mediating role of anxiety has been found in numerous studies in young adults (Spencer, Steele, & Quinn, 1999) and in the context of age-based stereotype threat (Abrams et al., 2008; Abrams, Eller, & Bryant, 2006; Swift, Abrams, & Marques, 2013). However, other studies failed to find any relationship, either in trait anxiety measured prior to testing (Hess et al., 2003) or in state anxiety experienced during the test (Chasteen, Bhattacharyya, Horhota, Tam, & Hasher, 2005; Hess & Hinson, 2006; Hess, Hinson, & Hodges, 2009). These contradictory findings indicate that the role of anxiety needs further investigation.

Following up on previous research, the aims of the present study were first to confirm the effect of age-related stereotype threat on the memory performance of older adults, and secondly to demonstrate that stereotype threat affects the mechanisms underlying memory performance. Given that memory performance is known to be enhanced by control processes, including locus of control (Amrhein, Bond, & Hamilton, 1999; Hertzog et al., 1998; Valentijn et al., 2006), and that control processes have been shown to be impacted by stereotype threat (Hess et al., 2003; Mazerolle et al., 2012), we expected that self-reported locus of control would moderate the stereotype threat, and would play a greater role in the memory performance of the non-threatened than the threatened group. On the other hand, concerning the role of anxiety, two plausible results could be expected. Considering the greater vulnerability arising from the threat condition, and in line with studies showing the role of anxiety in the threat effect (Abrams et al., 2008, 2006; Swift et al., 2013), we expected that self-reported anxiety would be more involved in the memory performance of the threatened than the non-threatened group. However, consistent with other studies that found that anxiety was not a determinant factor of the threat effect (Chasteen et al., 2005; Hess & Hinson, 2006; Hess et al., 2009), and given that older adults are particularly prone to report anxiety (Andreoletti et al., 2006 ; Davidson et al., 1991; Dixon & Hultsch, 1983; Loewen, Shaw, & Craik, 1990; McDonald-Miszcak, Hertzog, & Hultsch, 1995), it is also possible that the effect of anxiety on memory performance would be similar in the two groups.

To test the hypotheses, two groups of 40 older adults, one threatened and one non-threatened with age stereotype, were compared on episodic memory performance (Logical memory task, Wechsler, 1981). To activate the stereotype threat effect, we manipulated the instructions of the memory task, emphasizing the memory component for the threatened group and de-emphasizing it for the non-threatened group. To pinpoint the predictors of memory performance, we used the Metamemory in Adulthood questionnaire (MIA, Dixon, Hultsch, & Hertzog, 1988). This questionnaire is an ecological multidimensional measure of memory beliefs that provides a better account of daily memory functioning than laboratory measurements. In this study, we selected two subscales that are domain-specific measures of memory, the memory locus of control scale and the memory anxiety scale. Before inducing stereotype threat, participants were asked about their perceptions of their own memory, making it possible to investigate the extent to which their memory performance was related to their prior memory control and to memory anxiety.

Method

Participants

The size of the target sample was determined using a power analysis (G*Power; Faul, Erdfelder, Lang, & Buchner, 2007). In line with Lamont, Swift, and Abrams (2015), who

Table 1. Participants' characteristics by group.

	Non-threatened group *n* = 40 M (*SD*)	Threatened group *n* = 40 M (*SD*)	*t*(78)
% Females	57	65	-
Age (years)	70.90 *(5.9)*	69.20 *(7.86)*	-1.09^{ns}
Education level (years)	12.7 *(2.66)*	13.3 *(2.55)*	1.02^{ns}
Vocabulary (Mill Hill)	25.87 *(5.46)*	26.55 *(5.36)*	0.55^{ns}
MMSE	28.8 *(1.15)*	28.9 *(1.25)*	0.64^{ns}
Anxiety (HADS A)	*5.5 (2.83)*	*5.22 (3.56)*	-0.38^{ns}
Depression (HADS D)	*7.02 (3.08)*	*6.32 (3.62)*	-0.93^{ns}

Note: ns = not significant.

investigated the age-based stereotype-threat effect, we used a *d* of 0.52. Our mixed design could achieve 80% power with 64 participants (with r = .60 anticipated correlation between our repeated measures (i.e. type of recall)). To reach this criterion, our sample size was set at 80 participants.

Eighty older adults were recruited via leisure clubs and through word of mouth. All participants were volunteers and signed consent forms. They were randomly assigned to either the non-threatened or the threatened condition. The mean age and the proportion of males to females (see Table 1) were equivalent in the two groups [$\chi 2$ (1) = 0.47, NS]. No effect of group was found on educational level and vocabulary (Mill Hill Vocabulary Scale, Deltour, 1993), indicating a similar level of general cultural knowledge in the two groups (Raven, 1994). They were screened for cognitive impairment with the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975) and all achieved a score of over 27 ensuring that none suffered from dementia. They were also screened for anxiety-depression with the Hospital Anxiety and Depression Scale (HADS, Zigmond & Snaith, 1983); all of them scored below the cutoff of 11 for each dimension, with no significant difference in scores on the two subscales between groups.

Materials and Design

First, the participants completed the MMSE, the Mill Hill Vocabulary Scale, and the HADS (as indicated above). They also completed two subscales (locus of control and anxiety) of the French version of the abridged Metamemory in Adulthood questionnaire (MIA, Boucheron, 1995; Dixon et al., 1988). They were told that these measures provided general information prior to performing a test. For the MIA, participants had to rate 15 statements on a 5-point scale from 1 (= completely agree) to 5 (= completely disagree). The locus of control subscale, measuring perceived sense of control over memory, comprised 7 items (e.g. "I know that if I use my memory I will never lose it", Cronbach's Alpha = .72). High scores indicate a high internal locus of control, whereby individuals consider that the preservation of their memory is dependent on their own efforts, implying a sense of control over memory functioning. Conversely, participants with low scores think that their efforts would be insufficient to protect their memory, which will decline anyway. The anxiety subscale measures perceived anxiety related to memory performance through eight items (e.g. "I become anxious when I have to remember something", Cronbach's Alpha = .85). Participants with high scores are anxious

in memory-demanding situations; low scores indicate less anxiety. A total score per subscale was calculated for each participant.

Subsequently, both groups performed the French version of the Logical Memory test (Wechsler, 1981), an episodic memory task in which participants have to recall in self-paced time two short stories (A and B) using as many of the words of the original text as possible in immediate recall and thirty minutes later in delayed recall. The number of free-recall units and thematic units were recorded. Three scores were calculated: immediate recall, delayed recall, and a total mean score of immediate and delayed recall scores. Stereotype threat was activated by manipulating the instructions. For the threatened group, to emphasize the memory component of the task, participants were told that the objective of the task was to evaluate their memory, a cognitive function that declines with age ("*In this test, I am interested in how your memory works. You know that memory declines with age, the older we are the less we remember things (we forget birthdays, shopping lists, etc.), so we would like to test your memory. I am going to read you two short stories and I will ask you at the end of each one to recall all the elements you can remember, even if you are not sure. Are you ready?*"). For the non-threatened group, to de-emphasize the memory component of the task, participants were told that the objective of the task was to judge their understanding of the two stories *("I have written two short stories that are like news items. I want to be sure these stories can be easily understood, and I would like your help. So I will read you these stories and ask you at the end of each one to tell me about it, to see if you have understood it. Are you ready?").*

Results

First, mixed ANOVA with Group as between-subjects factor and Type of recall as within-subjects factor was conducted to examine the effect of stereotype threat on immediate recall and delayed recall. Next, to ensure that both groups of participants reported the same self-perceived memory functioning, we performed a *t* test to calculate the effect of group on MIA scores (anxiety and locus of control subscales). Finally, to test our main hypothesis that anxiety and locus of control would lead to different predictions of episodic memory in the threatened and non-threatened groups, regression analyses were performed with MIA scores as potential predictors of memory performance.

As shown in Figure 1, the results revealed a main effect of stereotype threat on recall (F (1, 78) = 7.994, $p < .01$, $\eta^2_p = .09$), the threatened group scoring significantly lower than the non-threatened group; a main effect of type of recall (F (1, 78) = 56.709, $p < .001$, $\eta^2_p = .42$) indicated that memory performance was better on immediate recall than on delayed recall. A significant interaction between group and type of recall (F (1, 78) = 14.646, $p < .001$, $\eta^2_p = .16$) showed that the stereotype threat effect was greater on delayed than immediate recall (F (1, 78) = 12.502, $p < .001$,$\eta^2_p = .13$, and F (1, 78) = 4.050, $p < .05$, $\eta^2_p = .04$, respectively), and also that the effect of type of recall was greater in the threatened group than in the non-threatened group (F (1, 78) = 64.497, $p < .001$, $\eta^2_p = .45$, and F (1, 78) = 6.858, $p < .01$, $\eta^2_p = .0.008$, respectively).

Mean rating scales did not differ between the non-threatened group and the threatened group on MIA anxiety (M = 25.12, SD = 6.27 vs. M = 24.17, SD = 5.47, respectively; $t(78) = -0.721$, ns,$\eta^2_p = .006$) and on MIA locus of control (M = 25, SD = 3.45 vs.

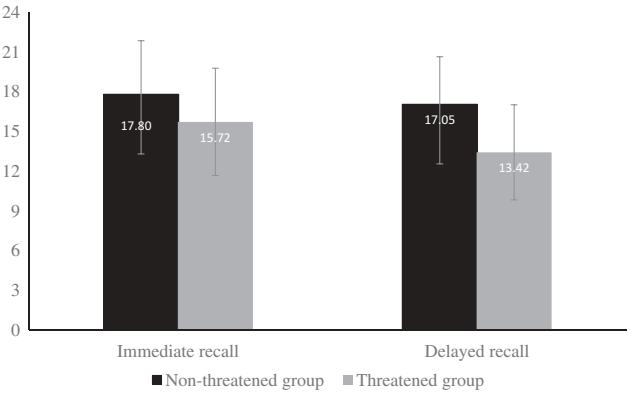

Figure 1. Memory performance for the two groups

$M = 24.62$, $SD = 4.40$, respectively; $t(78) = -0.423$, ns, $\eta^2_p = .002$) indicating that the two groups reported the same level of memory anxiety and locus of control.

Using Z scores, regression analyses were conducted to examine the predictors of memory performance. In the first step, main effects of Group, Control and Anxiety were entered in the model with Age and Education as they could also contribute to memory performance. In the second step, relevant interactions (Group x Control; Group x Anxiety; Group x Control x Anxiety) were tested under control of main effects, Age and Education to examine whether they had predictive value in addition to the main effects. Total mean recall scores were reported in the section below as the pattern of results was similar between immediate and delayed recall.

There was a significant relationship between Group and memory performance, $\beta = .33$, $t(74) = 3.608$, $p < .001$, and a significant negative linear association between Anxiety and memory performance $\beta = -.42$, $t(74) = -4.195$, $p < .001$. The positive association between control and memory performance approached significance $\beta = .17$, $t(74) = 1.753$, $p = .08$. None of the two background variables significantly predicted memory performance (Age $\beta = -.09$, $t(74) = -0.947$, $p = .34$; Education $\beta = .02$, $t(74) = 0.222$, $p = .82$). The overall effect of this first model accounted for 37% of the variance of memory performance, $R^2 = .37$, $F(5, 74) = 8.856$, $p < .001$. These results indicate that a low level of anxiety and marginally high level of control were associated with good memory performance.

In the second step, interactions were added in the model. The main effects of Group, $\beta = .23$, $t(71) = 2.660$, $p < .01$ and Anxiety $\beta = -.58$, $t(71) = -2.029$, $p < .05$ remained significant. The effect of control approached significance, $\beta = .50$, $t(71) = 1.877$, $p = .06$. Age ($\beta = -.11$, $t(71) = -1.181$, $p = .24$) and Education ($\beta = .002$, $t(71) = 0.022$, $p = .98$) were non-significant. In this model, the Group x Control interaction predicted performance significantly, $\beta = 0.78$, $t(71) = 2.815$, $p < .01$. The Group x Anxiety interaction was non-significant, $\beta = 0.15$, $t(71) = 0.529$, $p = .59$. The Group x Control x Anxiety interaction was significant, $\beta = -0.35$, $t(71) = -3.885$, $p < .001$. The overall effect of this model accounted for 51% of the variance of memory performance, $R^2 = .51$, $F(8, 71) = 9.469$, $p < .001$.

To gain a better understanding of the interactions and to test our main hypothesis that predictors of memory performance differ according to the group, regression analyses were

conducted for the threatened and non-threatened groups separately. Results revealed a different pattern in each group. In the non-threatened group, Control was a significant predictor of memory performance, ($\beta = 0.45$, $t(36) = 3.378$, $p < .01$); memory variance was also partly explained by Anxiety ($\beta = -0.41$, $t(36) = -3.005$, $p < .01$) and by the Control x Anxiety interaction ($\beta = -0.40$, $t(36) = -3.210$, $p < .01$). The model accounted for 49% of the variance of memory performance in this group, $R^2 = .49$, $F(3, 36) = 11.827$, $p < .001$. To interpret the Control x Anxiety interaction, subgroups were formed to compare high and low levels of control and anxiety based on a median split (participants with a score equal to the median were eliminated from the analysis). Results showed that Anxiety predicted memory performance in the high control group ($\beta = -.68$, $t(14) = -3.493$, $p < .01$), but not in the low control group, and ($\beta = -.08$, $t(12) = -0.285$, $p = .77$). We also explored the relationship between control and memory performance according to the level of anxiety and found that control predicted memory performance in the low anxiety group ($\beta = .69$, $t(18) = 4.119$, $p < .001$) and that this relationship was not significant in the high anxiety group ($\beta = .10$, $t(18) = 0.440$, $p = .66$). By contrast, in the threatened group, anxiety was the only significant predictor of memory performance variance ($\beta = -.64$, $t(36) = -4.685$, $p < .001$); neither control ($\beta = .09$, $t(36) = 0.717$, $p = .47$) nor the interaction between Control and Anxiety ($\beta = -.23$, $t(36) = -1.753$, $p = .09$) contributed significantly to memory performance. The model accounted for 38% of the variance of memory performance, $R^2 = .38$, $F(3, 36) = 7.427$, $p < .001$.

Discussion

The aim of our study was to investigate whether stereotype threat changes the mechanisms underlying memory performance in older adults. We expected that self-reported control would be more involved in the memory performance of the non-threatened than the threatened group, indicating that control, measured subjectively or objectively, may moderate the stereotype threat. Given the divergent results in the literature regarding the role of anxiety, we examined whether it played a moderating role or was involved in either group.

In line with our expectations, the results showed that performance on an episodic memory task deteriorated when the memory component of the task was emphasized. This is in line with previous studies investigating the memory stereotype threat effect (see Armstrong et al., 2017; Barber,2017; Lamont et al., 2015 for reviews). The impact of stereotype threat was significant in both immediate and delayed recall performance but was greater on delayed recall. This suggests that the stereotype threat actually increased with delay. One possible explanation is that the threat situation did not provide the optimal conditions to initiate deep encoding, leading to worse performance in delayed than in immediate recall. In their meta-analysis, Lamont et al. (2015) examined the effect of stereotype threat when multiple dependent variables were used within the same study. They hypothesized that the significance of the age-based stereotype threat depends on the timing of the dependent variable in the sequence of tasks; the threat would be significant when it is proximal to the manipulation and should decrease when performance is measured later. Overall, the meta-analysis revealed that when two tasks are carried out, the stereotype threat effect is significant at task 1 and is lower at task 2, but the difference between tasks is not significant. However, the decrease becomes significant with subsequent tasks. Among the studies cited in this meta-analysis, Desrichard and Kopetz (2005) used three successive memory tasks, (1) recall of verbal information, (2) recall of visuo-visual information, and (3) a visuo-visual span task. The results showed that the memory performance of older

adults on the three tasks was instruction-sensitive, with a robust effect size. By contrast, in Kang and Chasteen (2009), the age-related stereotype threat was significant only for the first task (free recall) and not for the second or third task (cued-recall and recognition), with a moderate effect size. It is important to note that in some of these studies there was an interference task between encoding and retrieval, whereas in others retrieval followed encoding. Other researchers have suggested that this increase in age-based stereotype threat can be explained by the stereotype rebound effect, whereby attempts to suppress the unwanted thoughts can, in fact, re-emphasize the threat (Follenfant & Ric, 2010; Macrae, Bodenhausen, Milne, & Jolanda Jetten, 1994).

Further research is therefore needed to focus on this issue in order to explain these divergent findings regarding changes in the stereotype threat effect between successive tasks and related to the time that elapses between successive tasks and the nature of the task. Moreover, although the statistical power of our study appeared to be adequate, the effect sizes of the Anova results were small to moderate. The significant interaction showing that the threat effect is greater in delayed than in immediate recall is supported by a small effect size ($\eta^2_{\ p} = .16$), as was the finding that the stereotype threat effect was greater on delayed than immediate recall ($\eta^2_{\ p} = .13$ vs. $\eta^2_{\ p} = .04$). These small effect sizes suggest that there was considerable intra-group variability, individuals within a group support the direction of the means but others do not. These effect sizes should be taken into account when interpreting the pattern of results observed concerning the increase of stereotype threat with delay.

Regression analyses provided a number of interesting results. Examination of the predictors of memory performance supports our hypotheses. While, in average at a basal level, the two groups reported the same perceived locus of control and anxiety, regression analyses revealed that memory predictors differed between groups and that background measures (age and education) did not alter our pattern of results. Overall, the group predicted memory performance, which is consistent with the ANOVA results. Locus of control marginally predicted memory performance and interacted with the group, indicating that its role differed between groups. In the non-threatened group, locus of control was a determinant of performance, whereas in the threatened group it did not predict subsequent memory performance. Control thus appears to be an operative factor of the stereotype threat effect. In the non-threatened group, individuals who believed and reported that their engagement can help maintain good memory functioning showed a high level of memory performance. This relationship between control belief and memory performance is in line with several studies on aging that have shown the predominant role of control on memory performance, whether measured objectively (Bouazzaoui et al., 2010; Bryan et al., 1999; Taconnat et al., 2006, 2007) or subjectively (Hertzog et al., 1998; Hertzog et al., 1990; Valentijn et al., 2006). To maximize performance, it thus seems important to believe in one's own abilities. The main explanation for this link reported in the literature concerns engagement in effort and motivation. Those who believe they can act to maintain optimal performance are also those who put more effort into tasks (Riggs, Lachman, & Wingfield, 1997). Engagement in effort is a determinant variable explaining the role of internal control (Lachman, 2000). Strategy use is also an intermediary variable between perceived control and performance (Lachman, 2006). However, in our study, belief about the locus of control predicted memory performance under the non-threatening condition, but not under the threat condition, confirming the hypothesis that stereotype threat modulates the impact of processes underlying memory performance by reducing the involvement of control. Although control was measured prior to inducing the stereotype threat and consequently was

not related to the threat situation, our results are in line with studies using objective control measures, which found that stereotype threat artificially abolishes the role of control over memory (Mazerolle et al., 2012; Schmader et al., 2008), and with the findings of Hess et al. (2003) who found that the threat effect impaired strategy use, which is known to be related to control.

Regression analyses also showed that anxiety was also a significant predictor of memory performance; low anxiety was associated with better memory performance and did not interact with the group. This result suggests that anxiety does not moderate stereotype threat, which is consistent with findings that anxiety is not a key factor in the mechanism underlying the stereotype threat effect (Chasteen et al., 2005; Hess et al., 2003; Hess & Hinson, 2006; Hess et al., 2009), but it contrasts with other studies highlighting the role of anxiety in age-based stereotype threat (Abrams et al., 2008, 2006; Swift et al., 2013). In our study, the absence of a moderation effect indicates that the memory performance of both groups was affected by anxiety. This suggests that trait anxiety, in other words, anxiety not specifically related to the test, seems to play a determining role in predicting memory performance with advancing age, and more importantly that this effect is not sensitive to instruction manipulation. Indeed, even though the non-threatened group was not exposed to the stereotype threat, there was a relationship between anxiety and memory performance. Our results are in line with numerous previous studies demonstrating that anxiety disrupts the memory performance of older adults (Davidson et al., 1991; Andreoletti et al., 2005; Chasteen et al., 2005; Li et al., 2004), particularly when the measure is domain-specific as in our study, since the MIA is a measure of memory anxiety. However, our results are not consistent with those of Hess et al. (2003), who used the same measure of anxiety (MIA anxiety scale) and found neither a moderating role of anxiety nor a significant relationship between anxiety and recall performance. The mechanism thought to link anxiety and memory is based on the assumption that anxious individuals are particularly prone to intrusive thoughts, which are detrimental to attention, which in turn impairs cognitive performance (Deraksan & Eysenck, 2009). This assumption refers to a difficulty inhibiting distracting thoughts, preventing optimal task performance, and was tested through trait and state anxiety.

Finally, the significant two-way Group x Control x Anxiety interaction provides interesting clarifications concerning the effect of control and anxiety on memory performance in relation to age-based stereotype threat. The predictive role of control on memory performance described and discussed above appeared actually to depend not only on the group but also on the level of anxiety. Indeed, when individuals were not exposed to the threat effect, control was a significant predictor of memory performance only in the low anxiety group in which participants with a high level of control performed better than those with a low level of control. It is plausible to consider that when anxiety is low, individuals are less disturbed by negative thoughts and are therefore more likely to put efforts into a task and to implement strategies to optimize their performance. Conversely, when the level of anxiety is high, control is no longer a significant determinant of memory performance and one can suppose that when anxiety is high, negative thoughts are more prevalent which could have the effect of preventing the implementation of controlled processes. Looking at what the threat changes in this situation, we observe that the effect of control was not significant in either low or high anxiety groups leading to an absence of significant interaction between control and anxiety in the threatened group. This result indicates that stereotype threat seems to abolish the beneficial role of control in low anxiety individuals those who no longer differed from high levels of anxiety concerning the involvement of locus of

control in memory performance. Thus, individuals with high control and low anxiety appear to be those who are most sensitive to the stereotype threat effect. A plausible explanation for this result is that individuals with a high level of control and low level of anxiety are those who place the greatest value on their abilities, making them more sensitive to the stereotype threat. This is in line with the suggestion of Hess et al. (2009) that the greater effect of the age-based stereotype threat observed in people with higher levels of education is due to the fact that they value their cognitive skills more than the people with lower education levels.

Furthermore, this two-way interaction provides important details about the role of anxiety suggesting that this depends on the level of control. Indeed, when participants were not exposed to the threat effect, anxiety significantly reduced the memory performance of those with high control but not those with low control. People with a strong internal locus of control individuals believe that they can act to maintain their memory; they thereforehave a high expectation of their performance, which could be associated with anxiety. Conversely, people with a low sense of control think that they cannot do much to maintain their memory, and then are therefore likely to make less effort which may explain why their performance was not dependent on the level of anxiety. With the threat effect, anxiety predicted memory performance in both high and low control groups. This suggests that the stereotype threat effect artificially increases the role of anxiety particularly in low control individuals who no longer differed from those with high control. In our study, the stereotype threat made salient anxiety only when the level of control was considered. However, it is important to note that in order to examine this two-way interaction, participants were divided into small groups and these interpretations should be therefore be treated with caution as moderation analyses require larger samples. Another important thing to note about our study is that although a link was established between control and anxiety measures and memory performance, it remains difficult to explain the underlying mechanism since these measures (control and anxiety) were administered prior to the experimental manipulation, then our interpretations are based on inferences.

In sum, our study revealed that age-based stereotype threat impacts memory performance and modulates the role of control and anxiety in memory. Under stereotype effect, memory performance was only predicted by anxiety. By contrast, when the stereotype threat was removed, both control and anxiety were involved in memory performance and interacted. This dissociative pattern of results suggests that stereotype threat might artificially prevent the establishment of controlled processes regardless of the level of anxiety and that control and anxiety are operative factors of the age-based stereotype threat effect.

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