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Complete List of Authors:	Kalenzaga, Sandrine; University of Poitiers, CeRCA CNRS Clarys, David; University of Poitiers, CeRCA CNRS Piolino, Pascale; Laboratoire de Psychologie et de Neuropsychologie Cognitives - Université Paris Descartes - CNRS FRE 3292 - , Psychologie
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Effortful memory processes under stereotype threat and self-concept in aging

Sandrine Kalenzaga[1] , David Clarys[1] and Pascale Piolino[2,3,4]

1- UMR-CNRS 7295 Centre de Recherches sur la Cognition et l'Apprentissage, Université de Poitiers, Poitiers, France

2- Université Paris Descartes, Sorbonne Paris Cité, Institut de Psychologie, Laboratoire Mémoire et Cognition, Boulogne Billancourt, France

3- INSERM UMR S894, Centre de Psychiatrie et Neurosciences, Université Paris Descartes, Paris, France

4- Institut Universitaire de France (IUF), France

Corresponding author:
Sandrine Kalenzaga
UMR-CNRS 7295 Centre de Recherches sur la Cognition et l'Apprentissage
Université de Poitiers
5, rue Théodore Lefebvre
86000 Poitiers, France
E-mail: sandrine.kalenzaga@univ-poitiers

Co-corresponding author :
Pascale Piolino
INSERM UMR S894, Laboratoire Mémoire et Cognition
Centre de Psychiatrie et Neurosciences
Université Paris Descartes
2 ter rue d'Alesia
75014 Paris, France.
E-mail: pascale.piolino@parisdescartes.fr

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Abstract

Objectives: The present study aimed at exploring the effect of stereotype threat on the controlled part of memory in older adults using a deep level of processing, namely self-reference encoding.

Method: To meet this objective, 25 younger adults and 25 older adults performed a Remember/Know recognition task following self-reference versus other-reference encoding of adjective traits, under stereotype threat or not.

Results: The results indicated that under stereotype threat, older adults' production of Remember responses was specifically impaired following self-reference encoding. Moreover, whereas executive functioning and group identification did not moderate stereotype threat effect, measure of self-worth did.

Conclusion: These findings suggest that stereotype threat in older adults may be a self-concept threat and that moderators of stereotype threat found in other groups (i.e., group identification and executive functioning) may not be generalized to this group. Rather, as stereotype threat in aging may represent a threat to the self, self-worth might have a central role, whereby individuals with high self-worth remain self-confident even under stereotype threat and are thus able to down-regulate their negative affects to face such a threat.

Keywords: Aging, Stereotype threat, Self-concept, Self-worth, Age group identification

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Introduction

Stereotype threat refers to the fact that introducing a negative stereotype about a social group in a particular domain can reduce the performance of members of that group (Steele, 1997). For example, previous studies demonstrated that African Americans performed poorly on cognitive tasks assumed to assess intelligence (Steele & Aronson, 1995), women performed worse on math problems when the test was described as producing gender differences rather than when such differences were not highlighted (Spencer, Steele, & Quinn, 1999), and White people performed poorly on athletic tasks that are supposedly diagnostic of athletic ability (Beilock, Jellison, Rydell, Mc-Connell, & Carr, 2006; Stone, Lynch, Sjomeling, & Darley, 1999).

In the field of aging, several studies have shown that stereotype threat impairs older adults' memory performance when the memory component of the test is emphasized (Desrichard & Köpetz, 2005; Kang & Chasteen, 2009), when performance differences between younger and older adults are highlighted by test instructions (Hess, Auman, Colcombe, & Rahhal, 2003; Hess, Hinson, Hodges, 2009b), and when the age-related stereotype regarding memory is implicitly activated using priming techniques (Levy, 1996).

The mechanisms underlying stereotype threat in aging remain poorly understood. Using the Process Dissociation Procedure developed by Jacoby (1991), Mazerolle, Régner, Morisset, Rigalleau, and Huguet (2012), found that stereotype threat specifically undermined the controlled use of memory in aging, sparing the more automatic memory processes. This pattern of results was also found by Eich, Murayama, Castel and Knowlton (2014) who demonstrated in older adults that age-related stereotype threat impairs explicit memory performance requiring controlled retrieval but has no effect on implicit memory performance

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that relies on automatic processes. Mazerolle, Regner, Rigalleau and Huguet (2015) confirmed this finding using another procedure that enabled controlled memory processes to be dissociated from more automatic ones, namely the Remember/Know (R/K) procedure (Gardiner, 1988; Tulving, 1985). The R/K procedure differentiates between remembering and knowing, by asking the participants during the recognition phase whether they remembered the item (i.e., they could recollect the context in which it had been studied; R response) or whether they just knew it (i.e., the item seemed familiar but they could not recollect contextual details; K response). Remembering is seen as an effortful, consciously controlled process whereas knowing is considered as a more automatic process. Mazerolle et al. (2015) concluded that stereotype threat causes a transitory reduction in executive-control resources. This is in line with Schmader and colleagues' suggestion of executive control interference, postulating that when individuals are faced with negative stereotypes regarding their abilities, they devote resources to processes such as self-monitoring or emotion regulation, thereby limiting the resources needed to perform difficult tasks that tap controlled processes (Johns, Inzlicht, & Schmader, 2008; Schmader & Johns, 2003; Schmader, Johns, & Forbes, 2008). It is worth highlighting that, earlier, Hess, Emery, and Queen (2009a) found an age-related stereotype threat effect on R responses, but only when response time was limited. When participants had all the time to make a recognition decision, stereotype threat had no effect on recollection in older adults.

Researchers have also turned their attention to internally-based factors such as high value for memory ability (Hess et al., 2003), or high levels of stigma consciousness or perceived stereotype threat (Hess et al., 2009a, 2009b; Kang & Chasteen, 2009). In their study, Hess and Hinson (2006) found that stereotypes about aging had greater threat effects in the younger-old than in the older-old. This result was also observed by Eich et al. (2014). Those authors postulated that people who are just entering old age might be more aware of

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their age-related status and that the negative effects of the stereotype would be most evident in those whose group membership is most salient (see also Hess et al., 2009b). In the same vein, O'Brien and Hummert (2006) demonstrated that only adults in late middle-age who had begun making the identity transition into older adulthood were affected by age-related stereotype threat.

Indeed, in certain groups, group identification may be a factor that moderates stereotype threat, previous studies having shown that only women who identified strongly with their gender were susceptible to gender-related stereotype threat (Schmader, 2002; Wout, Danso, Jackson, & Spencer, 2008). This is in line with Steele, Spencer, and Aronson (2002)'s claim that *"the more one is identified with the group about whom the negative stereotype exists, or the more one expects to be perceived as a member of that group, the more stereotype threat one should feel in situations where the stereotype applies"* (p. 391). However, this would not be the case for older adults.

As previously mentioned, in the field of aging, some studies have assessed the effect of age-related stereotype threat across the age-range of older adults, reporting stereotype threat effects in the younger-old adults, but not in the older-old adults (Eich et al., 2014; Hess & Hinson, 2006; Hess et al., 2009b; see Barber, 2017 for a review). This differential effect of stereotype threat in early and later aging is interpreted as illustrating the fact that earlier in aging, individuals may not fully identify with the older age group. Thus, the stereotype of memory loss in old age is very salient and threatening for them while later in aging, individuals have habituated to this fact and no longer find it threatening. According to Barber (2017), these finding may illustrate the fact that this is the older-old adults, who as a whole are more likely to self-identify as being a member of the older adult age group (Montepare & Lachman, 1989), who are actually less susceptible than younger-old adults to experiencing age-based stereotype threat about cognitive decline. Barber (2017) proposes that older adults

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are threatened by the possibility that age-related stereotypes about cognitive declines are personally true of themselves, and thus they experience stereotype as a self-concept threat rather than as a group threat.Indeed, the only one study that has explored the relationship between age group identification per se and stereotype threat effect (Kang & Chasteen, 2009) suggest that although the more people self-identify as older adults, the lower their memory performance, age group identification did not moderate the observed stereotype threat. Thus, studies exploring the relationship between age group identification and stereotype threat effect in aging are lacking.

One variable strongly related to age group identification and stereotype threat is self-concept. Self-concept is a collection of beliefs and views about the self, including elements such as academic performance, physical appearance, as well as gender and age roles, and racial identity. The process whereby stereotypes become integrated in the self-concept is termed stereotype internalization. Rothermund and Brandtstädter (2003) demonstrated that the more older adults identify with their age group, the closer their self-views are to the stereotyped expectations about older people. In other words, aging stereotypes become internalized into older people's self-views as they begin making the identity transition into older adulthood. The working self is a cognitive situational structure that includes a subset of the total information held about the self but that also varies depending on the context (Conway & Pleydell-Pearce, 2000). This context-dependent self is sensitive to the social circumstances, and much research has demonstrated the effects of stereotype threat on the currently activated self (Schmader Croft, & Whitehead, 2014). It has been proposed that the working self is involved in the Self-Reference Effect in memory (SRE, i.e., better memory for information processed in relation to the self than for information related to someone else or processed for general meaning, Rogers, Kuiper, & Kirker, 1977), as it determines which details will be encoded and which memories will be recalled in accordance with the principle

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of self-coherence (Conway, Meares, & Standart, 2004). Therefore, the self-reference effect provides good means of accessing the working self and we operationalized it in this way in the present study.

The first objective of the present study was to confirm and extend the findings of Mazerolle et al. (2012, 2015) showing an effect of stereotype threat specifically on the controlled part of memory. We predicted that stereotype threat would impair older adults' rate of R responses but would have no influence on K responses. Stereotype threat manipulation should have no effect on the performance of young adults. It is noteworthy that Mazerolle et al. (2015) found stereotype threat effects on R responses using a structural encoding task (counting letters in the word). The authors wonder whether these effects would be replicated using a deeper encoding strategy such as self-reference encoding (Rogers, Kuiper, & Kirker, 1977; Symons & Johnson, 1997). Self-reference encoding tasks have been shown to improve R responses (Conway & Dewhurst, 1995) and could thus prevent the effect of stereotype threat on this kind of response in older adults. Indeed, numerous studies have indicated that the SRE is well-preserved in aging (Bugaiska, Ferreri, Bouquet, Kalenzaga, & Clarys, 2015; Dulas, Newsome, & Duarte, 2011; Glisky & Marquine, 2009; Gutchess, Kensinger, & Schacter 2007, 2010; Hamami, Serbun, & Gutchess, 2011; Kalenzaga, Bugaiska, & Clarys, 2013; Kalenzaga & Clarys, 2013; Kalenzaga, Sperduti, Anssens, Martinelli, Devauchelle, Gallarda, et al., 2015; Lalanne, Rozenberg, Grolleau, & Piolino, 2013). However, a self-reference encoding task may also promote self-focused attention, which, ironically, may in turn exacerbate the stereotype threat effect through the activation of a stereotype-relevant working self (Schmader et al., 2008). Thus, in the present study we manipulated the levels of processing (Craik & Lockhart, 1972), comparing self-reference encoding to other-reference encoding to structural encoding during the memory tasks.

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Our second objective was to assess the relationship between memory performance under stereotype threat and executive functioning, together with several independent variables linked to self-concept such as self-image in various domains and global valence of self-image assessed by the Tennessee Self-Concept Scale (Fitts & Warren, 1996), self-esteem assessed by the Rosenberg Self-Esteem Scale (Rosenberg, 1965) and age group identification assessed by the age group identification scale (Garstka, Branscombe, & Hummert, 1997).

Method

Participants

Twenty-five healthy younger adults aged 21-30 years and 25 healthy older adults aged 66-80 years, all native French speakers, participated in the study. All participants had normal or corrected-to-normal vision, and they were free from medication that could affect the central nervous system. The older adults scored above the 27-point cut-off on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975). The demographic characteristics of the two groups are shown in Table 1. The young adults were more highly educated than the older adults, but the older adults demonstrated better verbal ability on the French version of the Mill-Hill test (Deltour, 1993) than the younger adults.

Insert Table 1 about here

Materials

Encoding and recognition

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Six lists of 10 personality-trait adjectives were selected from a normalized pool (Anderson, 1968) and were matched for word length. On the basis of the method used by Gutchess, Kensinger, Yoon, and Schacter (2007), each list contained equal numbers of positive and negative trait adjectives (i.e., 5 positive and 5 negative). The six lists were counter-balanced across the threat versus nonthreat conditions so that within each group, half the participants encoded the first three lists in the threat condition and the last three lists in the nonthreat condition while it was the reverse for half the other participants. The lists were also counter-balanced across the encoding conditions so that each list was used in each encoding condition as many times as the other five lists.

The recognition lists consisted of a random mixture of 18 old words (i.e. 6 words from the 3 lists seen during the encoding phase) and 18 new words matched for word length and valence.

Executive tasks

Running-span test

The running-span test (Pollack, Johnson, & Knaff, 1959) is assumed to tap the updating executive component. Participants were presented with lists varying in length from six to twelve consonants, but they were not told in advance how many items there would be in the list: in other words, the number of items was unpredictable. They were instructed to try to remember the last six consonants in the list in their order of presentation. Thus, in each step after position 6, participants had to delete the first element in the current six-item list, and add the last-presented item to the end of the list.

Trail Making Test

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The Trail Making Test (Reitan & Davison, 1974) was used to assess the shifting executive component. This task is divided into two parts. In Part A, participants have to draw lines to sequentially connect circles numbered 1 to 25, as quickly as possible, without lifting the pencil from the page. In Part B, participants have to draw lines to numerically and alphabetically connect alternating circles containing a number or letter respectively. Time to completion was recorded in the two parts, and the difference in time to complete Part A and Part B was used in analyses.

Tennessee Self-Concept Scale

In order to assess the multidimensionality of the self-concept, the short-form of the French version of the TSCS-II, (Fitts & Warren, 1996) was administered to the participants. We obtained seven scores. First, the total self-concept score gave an indication of whether people tend to hold a generally positive self-description (i.e., positive sense of self). Secondly, five scores explored self-concept in specific areas of experience (personal, familial, social, moral, physical), high scores indicating a positive self-description. Thirdly, an identity score was calculated to reflect how people describe themselves when they are referring to who they are.

Age Group Identification Scale

Age group identification was measured using the five-item questionnaire developed by Garstka, et al. (1997), to which participants responded using a 7-point Likert scale (1: *strongly disagree*, 7: *strongly agree*): “I like being a member of my age group,” “I am proud to be a member of my age group,” “My age group membership is central to who I am,” “I

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believe that being a member of my age group is a positive experience," and "I have a clear sense of my age group identity and what it means to me." A mean age group identification score was calculated for each participant, with higher values representing greater age group identification.

Procedure

The study was run in a single session and took place in the participants' home. Participants were told that the experiment was concerned with memory. All participants were assigned to both the stereotype threat and the nonthreat conditions. The conditions were counter-balanced across participants, so that in each group, half the participants were presented with stereotype threat instructions first and then with nonthreat instructions, and vice versa for the other half the other.

First, all the participants completed the self-esteem scale and the age group identification questionnaire. This was followed by the two memory tests corresponding to the threat versus non threat conditions. More precisely, a threat or nonthreat instruction was given to the participants. Then, they performed the first memory task implying encoding three lists of words. After that, the other instruction was given (i.e., threat or nonthreat as a function of the previously given instruction), and then the participants performed the second memory tasks requiring encoding the other three lists. The memory tasks were presented using the SuperLabPro software (Experimental Laboratory Software Version 2.01). Participants were told that they would be presented with words that they would have to remember for a subsequent memory test. In the threat condition, the participants were also informed that the test was diagnostic of memory capacity and that members of their age group were rarely successful. In the nonthreat condition, participants were told that the test was easy for people

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in their age group. To justify the difference between the two memory tasks, in the threat condition participants were told that the words were difficult to remember whereas in the nonthreat condition, they were told that the words were easy to remember. For each memory test, the learning phase was divided into three sessions corresponding to the three encoding conditions. Encoding conditions were counter-balanced across participants in each group. Participants were instructed to read the words aloud and make a judgment about these words using the keyboard. Adjective traits were randomly presented in the middle of the screen for 5 seconds. In the self-reference condition, participants had to answer the question "*To what extent does this adjective describe you?*" using the "1, 2, 3, 4" buttons corresponding to a four-point rating scale ranging from "Not at all" to "Completely". For the other-reference condition, two show-business personalities (one for each memory task, counter-balanced across the threat and nonthreat conditions), different for young and older adults, were selected on the basis of their popularity for each age group. Yannick Noah/Jean Dujardin and Alain Delon/Charles Aznavour were chosen for young and older adults, respectively. The participants had to decide to what extent the adjectives described the person using the same "1, 2, 3, 4" buttons. Finally, for the structural condition, the participants had to indicate if the words were composed of less or more than four vowels or four consonants (counter-balanced across the threat and nonthreat conditions) using the "s" and "l" buttons, respectively.

In each memory task, the encoding phase was followed by a 15-minute retention interval during which participants completed the Mill-Hill test in the first condition and the Trail Making Test and the Running-span test in the second condition. After that, they completed the recognition task. This was associated with the R/K paradigm (Gardiner, 1988; Tulving, 1985). The 36 words (18 old words and 18 new words) were randomly presented on the screen. The participants had to indicate whether or not they recognised the words from the study list by pressing the corresponding key. If they did, then they had to indicate whether or

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not they had a conscious recollection of the learning sequence. They were instructed to give an R response when they recognized a word, if their recognition was accompanied by the ability to mentally travel back in time and re-experience their thoughts during encoding. By contrast, they were instructed to give a K response if they recognized a word and felt confident that it was in the study list but could not give any detail about its encoding. Finally, participants were told that if they were not sure whether the word belonged to the study list or not, they should give a G response (Mäntylä, 1993). This alternative was provided to ensure that K responses did not reflect a degree of uncertainty. Participants had unlimited time to make a recognition decision.

Statistical analyses

The dependent variables were based on the proportions of correct R and K responses with respect to the recognition hits (#R hits/# recognition hits) for each experimental condition. G responses were included to compute these scores, but they were not analysed independently because this category was only included to enhance the quality of K responses. They were also judged to be too low. Furthermore, in accordance with the Independence Remember-Know (IRK) procedure, K responses were not analysed on their own but they were used to compute an IRK score by dividing the proportion of K responses by the proportion of trials that were not assigned R ((Know/(1 – Remember), Jacoby, Yonelinas, & Jennings, 1997; see Yonelinas, 2002 for details). This was done in order to assess the proportion of K responses independently of the proportion of R responses. We also collected the number of R and K false alarms made in each instruction condition.

As Test instruction was a within-subjects factor, the results of the memory tasks were controlled for order effects by including task order as a covariate using Analyses of covariance (ANCOVAs). ANCOVAs did not reveal order effect nor interaction effects. R

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responses and IRK scores were analysed separately using a 2 (Group: Young versus Older adults) X 2 (Test instruction: threat versus nonthreat) X 3 (Encoding condition: self-reference versus other-reference versus structural) ANCOVA. R and K false alarms were analysed separately using a 2 (Group: Young versus Older adults) X 2 (Test instruction: threat versus nonthreat) ANCOVA. Group was considered as a between-subjects factor and Test instruction and Encoding condition were considered as within-subjects factors.

Results

Remember responses

Figure 1 shows the proportions of R responses by group, test instruction, and encoding condition.

Insert Figure 1 about here

The ANCOVA revealed a main effect of group on R responses, $F(1,47) = 4.02$, $p < .05$, $\eta p^2 = .08$, showing that older adults produced fewer R responses than young adults. There was a significant interaction between group and test instruction, $F(1,47) = 9.05$, $p < .01$, $\eta p^2 = .16$, indicating that older participants produced fewer R responses in the threat condition than in the nonthreat condition, $F(1,47) = 25.50$, $p < .001$, $\eta p^2 = .35$, whereas test instruction had no effect in the young group, $F(1,47) = .63$, $p > .05$. There was a main effect of encoding condition, $F(2,94) = 22.71$, $p < .001$, $\eta p^2 = .32$, indicating that the participants produced more R responses following self-encoding compared to structural encoding, $F(1,47) = 33.16$, $p <$

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.001, $\eta p^2 = .41$, more R responses following other-encoding compared to structural encoding, F(1,47) = 20.56, p< .001, $\eta p^2 = .30$, and more R responses following self-encoding compared to other-encoding, F(1,47) = 3.78, p< .05, $\eta p^2 = .07$. There was a significant interaction between test instruction, encoding condition and group, F(2,94) = 2.87, p<.05, $\eta p^2 = .06$, indicating that older adults produced fewer R responses than young adults following self-encoding in the threat condition, F(1,47) = 30.01, p<.001, $\eta p^2 = .39$, whereas there was no difference between the two groups in the nonthreat condition, F(1,47) = .14, p>.05. Following other-encoding, older adults produced the same rate of R responses as young adults in both the threat condition and the nonthreat condition, F(1,47) = 1.40, p>.05, and F(1,47) = .24, p>.05, respectively. Following structural encoding, older adults produced the same rate of R responses as young adults in both the threat condition and the nonthreat condition, F(1,47) = .66, p>.05, and F(1,47) = .01, p>.05, respectively. The other effects and interactions were not significant.

IRK scores

Figure 2 shows the proportions of IRK scores by group, test instruction, and encoding condition.

Insert Figure 2 about here

The ANCOVA revealed a significant effect of encoding condition, F(2,94) = 3.56, p<.05, $\eta p^2 = .07$, indicating that the participants produced more K responses following self-encoding compared to structural encoding, F(1,47) = 4.08, p<.05, $\eta p^2 = .08$, more K

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responses following other-encoding compared to structural encoding, $F(1,47) = 7.97$, $p<.01$, $\eta p^2 = .14$, and the same rate of K responses following self-encoding and other-encoding, $F(1,48) = .64$, $p>.05$. The other effects and interactions were not significant.

False alarms

Figure 3 shows the number of R and K false alarms by group and test instruction.

Insert Figure 3 about here

Regarding R false alarms, the ANCOVA revealed no significant effects or interactions (all ps>.05).

Regarding K false alarms, the ANCOVA indicated that the effect of group was not significant, $F(1,46) = 2.48$, $p>.05$, indicating that older adults made as many K false alarms as younger adults. There was a significant interaction between group and test instruction, $F(1,46) = 5.56$, $p<.05$, $\eta p^2 = .11$, indicating that older adults made more K false alarms under stereotype threat than in the nonthreat condition, $F(1,46) = 10.21$, $p<.01$, $\eta p^2 = .18$, whereas there was no difference between the number of K false alarms made by the younger adults in the two conditions, $F(1,46) = .03$, $p>.05$.

Executive functions, self-concept and age group identification scores

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Insert Table 2 about here

T-tests revealed that the two groups differed significantly on executive scores, TSCS Identity score and age group identification score. The two groups did not differ on any of the measures assessing the valence of self-image (Total score and scores in the various domains assessed by TSCS scores).

Relationship between stereotype threat and independent variables in older adults

In order to examine the moderating effect of executive measures, self-concept variables, and age group identification score on the effect of stereotype threat in the older group, we computed the difference between the rate of R responses produced in the nonthreat condition and the rate of R responses produced under stereotype threat in each encoding condition and for each older participant. As recommended by Spiller, Fitzsimons, Lynch, and McClelland. (2013), we then conducted regression analyses entering this score as the dependent variable and the variables of interest as independent variables. We found that only TSCS Total score interacted with stereotype threat effect in the self-reference condition, ß = -0,29, $p<.05$, such that the effect of stereotype threat decreased as the positive image of self increased.

Discussion

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Following the work of Mazerolle et al. (2012, 2015), the present study aimed at exploring the effect of stereotype threat on the controlled part of memory using a deep level of processing, namely self-reference encoding. We used the R/K/G procedure to dissociate the controlled from the automatic memory processes.

In line with a myriad of studies (Clarys, Bugaiska, Tapia, & Baudoin, 2009; Clarys, Isingrini, & Gana, 2002; Piolino, Desgranges, Clarys, Guillery-Girard, Taconnat, et al., 2006) we found a decrement in R responses in older adults compared to young ones, whereas there was no difference between the two groups regarding K responses. This result confirms that recollection, which is an effortful process, is specifically impaired in aging. As we predicted, in the older group the stereotype threat condition impaired even more remembering following self-reference encoding, whereas knowing was unaffected by test instruction. Moreover stereotype threat had no effect on young adults' performance. In overall, this is consistent with the results of Mazerolle et al. (2012, 2015) showing that stereotype threat undermines the controlled memory processes of older adults while sparing the automatic processes. However, it must be highlighted that Mazerolle et al. (2015) found a stereotype threat effect on R responses using a structural encoding while in our study, older adults' memory performance following the structural encoding condition was not impacted by stereotype threat. This may be explained by the fact that Mazerolle et al. asked their participants to hear the words and to count the total number of letters in each word while in the present study, participants had to read the words on the screen and to indicate if the words were composed of less or more than four vowels or four consonants (counter-balanced across the threat and nonthreat conditions). One can assume that Mazerolle et al.' s structural encoding instruction was harder and cognitively costly, especially as their experimental design imposed a rapid pace. This may be the reason why these authors observed a stereotype effect following structural encoding while we did not. Note that in the present study, the rate of R responses was affected by stereotype

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threat following self-reference encoding only, probably not because this encoding was cognitively costly, but because it promoted self-focused attention. Moreover, contrary to Hess et al. (2009a), we found a stereotype effect whilst time was unlimited at recognition. This finding was also observed by Mazerolle et al. (2015). It is important to highlight that in Hess et al.'s study, participants had no specific processing to make at encoding, while in Mazerolle et al.'s study and in ours, participants processed the to-be-encoded words in a way that either was cognitively costly or that promoted self-focused attention. Altogether, these findings suggest that stereotype threat may affect older adults' memory performance through mechanisms occurring rather at encoding as in Mazerolle et al.'s study and in ours, or rather at retrieval as in Hess et al.'s study, depending whether the demand is placed on the encoding or on the retrieval phase.

The results of a recent study conducted by Wong and Gallo (2018) indicate that explicit activation of stereotype impacts more encoding than retrieval memory processes. As proposed by those authors, activation of stereotype at encoding may interfere with the processing of words, diminishing incidental thoughts about the studied words and focusing participants on stereotype-relevant thoughts. This distraction from the instruction might have reduce the encoding of contextual details that would promote recollection processes. However, Krendl, Ambady, and Kensinger (2015) demonstrated that activating a subliminal stereotype impacts retrieval more than encoding. Although this interpretation is speculative, it is possible that limited time during the recollection task in Hess et al.'s (2009a) study, was difficult for older adults and that this reminded them of their stereotyped status, subliminally activating age-related stereotype. Hess et al. themselves highlighted that the absence of group differences they observed in subjective reports of threat may suggest alternative mechanisms consisting in the activation of automatic and unconscious stereotype-consistent behaviors.

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Regarding Know responses, contrary to Mazerolle et al. (2015), but in line with Hess et al. (2009a), we found no effect of stereotype threat on familiarity processes. It is important to note that this discrepancy could be explained by methodological differences. Indeed, in the same way as Hess et al. (2009a), but unlike Mazerolle et al. (2015), we included a long retention delay (i.e., 15 minutes) that is necessary for the SRE to emerge (Conway, Dewhurst, Pearson, & Sapute, 2001). We also used "Guess" responses that ensure that K responses do not reflect a degree of uncertainty and thus that R and K responses do not differ in accuracy or confidence (Mäntylä, 1993). Thus, using the same methodology as Hess et al. (2009a), we replicated the results of those authors regarding the lack of stereotype effect on familiarity processes.

The results of the present study indicate that older adults' production of R responses is specifically impaired under stereotype threat following self-reference encoding. It is noteworthy that this lack of SRE in the older group under stereotype threat cannot be explained by an impairment in self-referential processing as the analyses revealed a main effect of encoding condition, indicating that, overall, the SRE occurred in the older group. This confirms that self-reference encoding has a specific effect on R responses (Conway & Dewhurst, 1995) and that older adults may improve their recollection following self-referential processing (Bugaiska et al., 2015; Kalenzaga et al., 2012; Kalenzaga & Clarys, 2013; Kalenzaga et al., 2015; Lalanne et al., 2013). Therefore, as proposed by Mazerolle et al. (2015), it may be the case that under stereotype threat, self-reference encoding promotes self-focused attention, leading older adults to be more consciously aware of the threat that the stereotype represents for the self and thus activating a stereotype-relevant working self. Two recent studies explored the relationship between self-concept and stereotype threat in aging. Liu, Zhao, Zhang, and Dang, (2017) used a modified Stroop task consisting in the presentation of different qualities of the elderly (positive, negative, and neutral) in order to

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operationalize the working self, and they demonstrated that age-related stereotype threat selectively activated negative self-representations (ie, longer reaction times for naming the color of negative qualities) in older adults. Moreover, negative self-representations mediated the effect of stereotype threat on memory performance in the elderly. In the present study, stereotype threat specifically decreased memory performance in the self-condition in the older group, but it did not activate negative self-representations given that statistical analyses indicated no effect of the emotional valence. However, it must be highlighted that using the same modified Stroop task as used by Liu et al. (2017), Zhang et al. (2017) found that an age-related stereotype threat condition activates self-representations (ie, longer reaction times for naming the color of related self-concept words) whatever their valence. Thus, whatever the method used to operationalize self-concept in those studies and in the present one, overall the findings indicate that stereotype threat induces self-processing biases that result in poorer performance for items related to the self.

The fact that stereotype threat effects were especially evident in the condition in which older adults had to process information in relation to the self is in accordance with Barber's (2017) assumption that older adults are particularly prone to experience stereotype threat as a self-concept threat. Indeed, according to that author, threatened older adults are most worried by the possibility that age-related stereotypes about cognitive losses are true of them personally rather than of their age group. Moreover, we found that although older adults had higher age group identification scores than younger adults, this score did not moderate the effect of stereotype threat on memory performance. To the best of our knowledge, to date Kang and Chasteen (2009) were the only ones who have tested the impact of identification to the stereotyped group on stereotype threat effect. Our results confirm the finding of these authors who also found no relationship between stereotype threat and age group identification in their older group. Moreover, this corroborates Barber's (2017) hypothesis that the

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moderators of threat observed in other groups, including group identification, are not generalized to age-related stereotype threat. Instead, the findings of the present study indicate that the effect of stereotype threat on the rate of R responses produced in the self-condition was moderated by the TSCS Total score, suggesting that the better the self-image, the lower the stereotype threat effect. Considering that advancing age is associated with better emotion regulation (Phillips, Henry, Hosie, & Milne, 2008; Scheibe & Blanchard-Fields, 2009) and that emotion regulation is associated with higher self-esteem (Gross & John, 2003), it is possible that individuals with a positive self-image are better able to resist the threat that stereotype constitutes for the self-concept. According to Barber (2017), due to these age-related improvements in emotion regulation abilities, stereotype threat does not seem to reduce older adults' executive control resources (see also Barber & Mather, 2014, for a review). Indeed, by demonstrating that stereotype threat impairs younger adults' performance on tasks of executive and working memory (which relies on executive functions, Miyake, Friedman, Emerson, Witzki, & Howerter, 2000), numerous studies have suggested that executive control interference is the key mediator of stereotype threat effects in this group (Beilock, Rydell, & McConnell, 2007 ; Johns, Inzlicht, & Schmader, 2008; Schmader & Johns, 2003). In the same vein, other researchers have reported that younger adults with high working memory capacities are better equipped to face stereotype threat than those with low capacities (Regner, Smeding, Gimmig, Thinus-Blanc, Monteil & Huguet, 2010). In the field of aging, based on the hypothesis of executive control interference (Schmader et al., 2008), the stereotype threat-related impairment of controlled memory processes (Mazerolle et al., 2012) and recollection-based judgments (Hess et al., 2009a) have been interpreted as illustrating the fact that stereotype threat temporally reduces the amount of older adults' executive resources. However, although stereotype threat causes negative affective responses in older adults, they could be able to down-regulate these negative emotions, which may not

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be cognitively costly for them (Scheibe & Blanchard-Fields, 2009), as found by Popham and Hess (2015) in the field of stereotype threat. Consistent with these findings, we found no role for executive functioning in the effect of stereotype threat on memory performance. However, it is worth noting that Running span score (i.e., updating function) correlated with R responses produced following self-reference encoding, but this correlation was not specific to the stereotype threat condition, as it was also found in the nonthreat condition ($r=.47$; $p<.001$, and $r=.34$; $p<.05$, respectively). This confirms that recollection is a controlled, effortful process requiring executive control. Moreover, this result is consistent with the finding of Clarys et al. (2009) demonstrating a central role for updating function in remembering.

More than executive decrements, it is maybe the fear of making mistakes, especially in a condition in which the self was salient and thus the threat for the self was also salient, that led older adults to produce fewer R responses. We found that TSCS Total score moderated the effect of stereotype threat on memory performance; we can therefore assume that the greater the self-worth, the better the self-confidence, and the less the sensitivity to stereotype threat. Indeed, it has been shown that older adults adopt more conservative and risk-averse response criteria under stereotype threat (Barber & Mather, 2013), as illustrated by a decrement in their memory errors (Barber & Mather, 2013; Popham & Hess, 2015; Wong & Gallo, 2015). R false alarms are typically more numerous in older participants than in their younger counterparts, whereas age-related effects are smaller for K false alarms (McCabe, Roediger, McDaniel, & Balota, 2009). Those authors assumed that R false alarms are particularly reliant on decision processes engaged at retrieval in order to determine whether recollection arose from the study episode or not. In the present study, older adults made as many R false alarms as younger adults and although the difference was not significant, they made fewer R false alarms in the threat condition. Thus, it is possible that stereotype threat led older adults to be more conservative in their decision to make a “Remember” response. It is noteworthy that in

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the present study we did not instruct our participants to minimize the risk for errors as it has been done in previous studies reporting exacerbated prevention focus under stereotype threat in older adults (Barber & Mather, 2013; Popham & Hess, 2015; Wong & Gallo, 2015). This may explain why the rate of R false alarms was not significantly reduced under stereotype threat in the present study. The prevention strategy seems to be restricted to very controlled memory processes, as it has been previously shown with a complex working memory task (Barber & Mather, 2013; Popham & Hess, 2015) and with the Deese-Roediger-McDermott paradigm when emphasis was put on item-specific recollections (Wong & Gallo, 2015). Indeed, Wong and Gallo (2015) assumed that, on the contrary, stereotype threat enhances older adults' false memory when the achievement of the task may rely on general feelings of familiarity as it is the case in a yes/no recognition task (Thomas & Dubois, 2011). Consistent with this idea, in the present study, K false alarms which rely on very automatic processes, were enhanced under stereotype threat, which is also in line with studies reporting that memory processes that rely on automatic responses are enhanced under stereotype threat in older adults (Mazerolle et al., 2012, 2015).

The fact that a positive self-image moderates the stereotype effect seems to be in line with Desrichard and Köpetz's (2005) findings showing in older adults that lower levels of memory self-efficacy correlate with lower performance when the memory component of the task is emphasized (see also Beaudoin & Desrichard, 2017). The common denominator between self-worth and self-efficacy might be self-confidence that would prevent older adults from stereotype threat. This corroborates Stangor, Kiang, and Carr's (1998) suggestion that confidence in one's task ability might exacerbate or reduce the negative impact of task instructions pertaining to a stereotypical task. However, the present study lacks a measure of self-confidence in one's ability to perform the task that would sustain the interpretation of our findings. Our findings are in line with Barber's (2017) assumption that age-based stereotype

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threat, as a threat to self-concept, threatens the sense of self-worth and may be reduced by value affirmation interventions. According to the author, value affirmation interventions aim at reminding older adults that their self-identity does not rely only on the threatened domain, but is also linked to other domains of personal importance. It is worth highlighting that in the present study, we found that the total self-concept score (i.e., positive sense of self) correlated with memory performance under stereotype threat, whereas scores exploring the self-concept in specific domains (personal, familial, social, moral, physical) did not. This might suggest that a positive overall self-image, rather than a positive self-image in specific areas provides protection against stereotype threat.

Finally, it is worth noting that contrary to Popham and Hess (2015), we did not observe a stereotype threat effect in the young group. However, the instruction used by those authors did not focus on a specific cognitive ability, while in our study, the threatened cognitive domain was memory. On the one hand, the importance placed upon memory abilities has been shown to increase with age (Hess & Hinson, 2006). On the other hand, memory is a cognitive domain associated with age-related declines. Thus, as the task was depicted as measuring an age-related stereotyped trait, older adults probably personally identified with the threatened domain, while memory is a cognitive domain that is maybe not central enough to young adults' self-identity. Moreover, even when the threatened domain is relevant to their identity, younger adults often cope with stereotype threat by choosing to consider that this domain is unimportant to their self-worth (Major, Spencer, Schmader, Wolfe, & Crocker, 1998; von Hippel, von Hippel, Conway, Preacher, Schooler, & Radvansky., 2005). These reasons may explain why we did not observe a stereotype threat effect in the young group.

To summarize, the findings of the present study indicate that stereotype threat in older adults may be a self-concept threat and that moderators of stereotype threat found in other groups (i.e., group identification and executive functioning) may not be generalized to this

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group. By contrast, as stereotype threat in aging represents a threat for the self, individuals with high self-worth may be able to remain self-confident and to down-regulate negative affects to cope with this type of threat.

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Figure Captions

Figure 1

Mean proportions (and standard deviations) of Remember responses by group, test instruction, and encoding condition

Figure 2

Mean proportions (and standard deviations) of IRK scores by group, test instruction, and encoding condition

Figure 3

Number (and standard deviation) of Remember and Know false alarms by group and test instruction

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Table 1

Means and standard deviations of participants' characteristics for the two groups

	Young adults (n= 25)		Older adults (n= 25)		t(1,48)
	M	SD	M	SD	
Age (years)	24.12	2.63	71.28	4.86	-42.64**
Education (years)	15.8	1.7	13.64	2.61	3.46***
MMSE	-	-	29.2	1.08	
Mill Hill	23.28	4.03	27.64	2.06	-4.81*
BDI	2.76	2.36	2.04	1.34	1.32 NS

Note. *** p<.001; *p<.05; NS: Not significant; MMSE: Mini Mental State Examination; BDI: Beck Depression Inventory

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Table 2

Means and standard deviations of participants' scores on executive tasks, self-concept and self-esteem assessment, and age group identification assessment

	Young adults (n= 25)		Older adults (n= 25)		t(1,28)
	M	SD	M	SD	
Trail Making Test	21.7	10.85	33.48	17.41	-2.86*
Running Span Test	2.76	1.79	1.61	1.01	2.77**
TSCS scores					
Total	83.44	9.19	80.28	7.87	N.S
Personal	33.04	12.76	30.92	14.78	N.S
Familial	33.44	16.74	27.96	14.29	N.S
Social	28.56	17.44	25	17.07	N.S
Moral	31.28	15.43	28	14.09	N.S
Physical	33.56	14.65	30.48	16.45	N.S
Identity	88.96	5.32	83.08	9.67	2.66**
RSES	31.96	3.43	30.08	3.52	N.S
Age group identification scale	24.44	5.42	28.88	5.93	-2.38*

Note. **p<.01; NS: Not significant; TSCS: Tennessee Self-Concept Scale; RSES: Rosenberg Self-Esteem Scale

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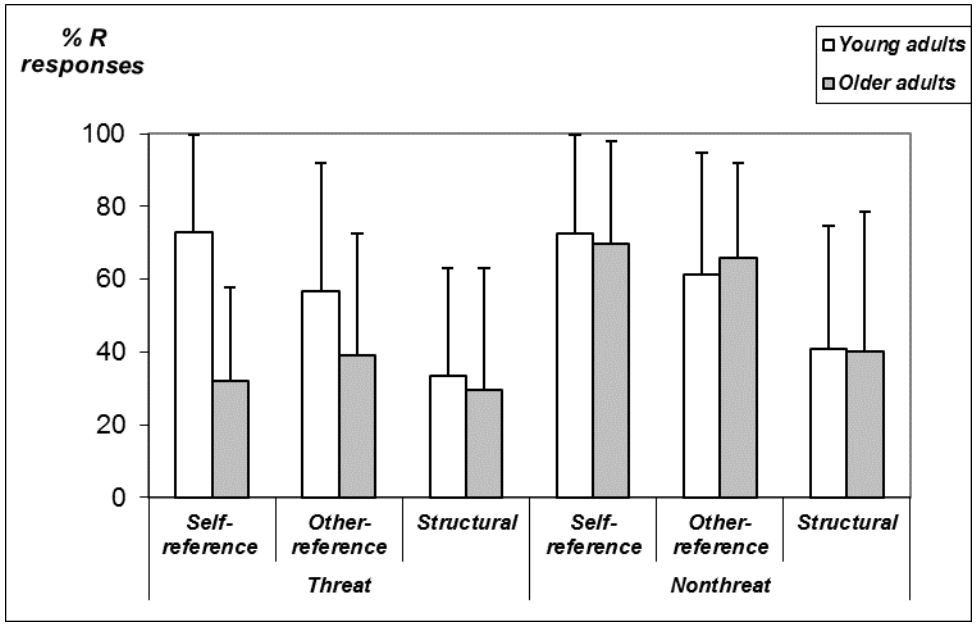

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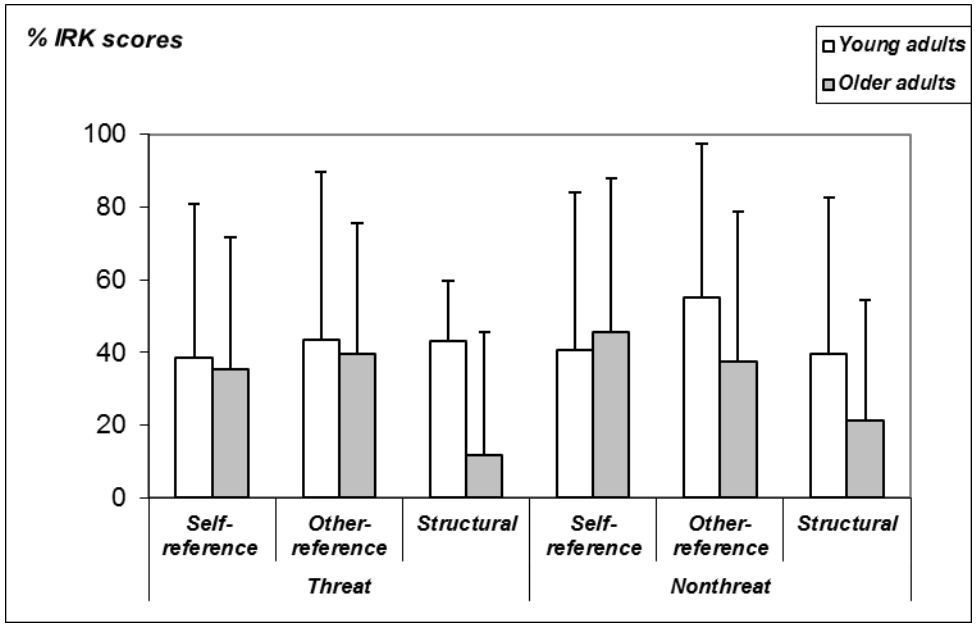

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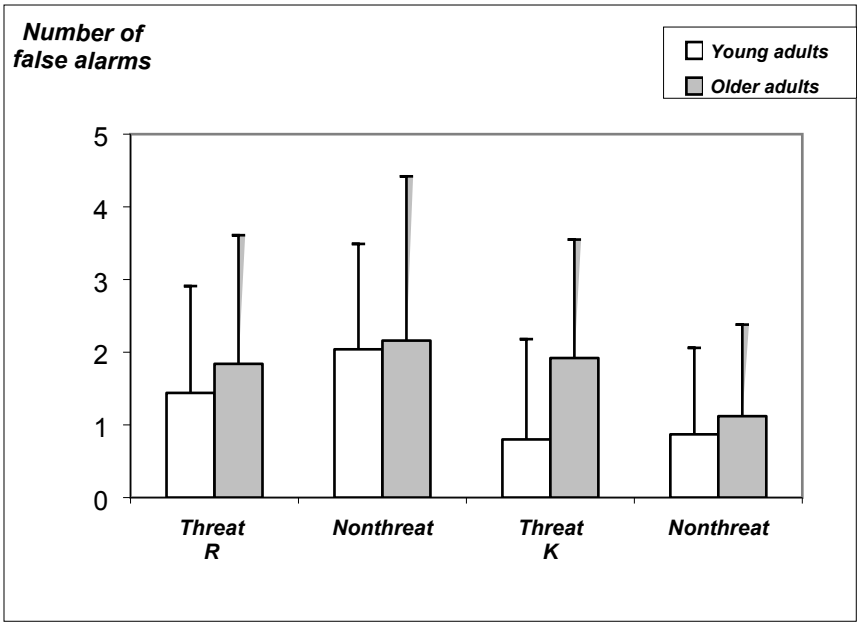

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