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Effects of Age-Related Stereotype Threat on Memory and Executive Function

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Psychology

by

Natasha Yvette Fourquet

2017
ABSTRACT OF THE DISSERTATION

Effects of Age-Related Stereotype Threat on Memory and Executive Function

by

Natasha Yvette Fourquet

Doctor of Philosophy in Psychology

University of California, Los Angeles, 2017

Professor Barbara Knowlton, Chair

Recall performance is greatly affected when older adults are presented with stereotype threat regarding memory (See Lamont et al., 2015 for a review). Stereotype threat is a concern that one’s performance will confirm negative stereotypes about one’s group. In Study 1 (Chapter 2), we examined the effect of threat on metamemory processes and memory selectivity for high value information. Our findings showed that threat affected calibration (i.e., bets-recall, p=.045) and total score (p=.03), both which require metacognitive control. Our threat manipulation did not affect value. That is, both groups placed bets and recalled more high-value words than low and medium value words (p>.05). Metacognition goes hand in hand with executive control, thus it is possible that threat burdened both cognitive processes. Moreover, the effect of value was stronger than that of threat.
In Study 2 (Chapter 3), we were interested in testing the effect of threat when the manipulation was done after encoding (i.e., prior to retrieval). We found no differences across groups in free recall or cued recall with this manipulation. However, we cannot refute the plausible effect of threat on retrieval given differences in experimental conditions (i.e., encoding time) between the current study and previous research. Taken together, our results provide partial support for executive function (See Chapter 2) as a possible mechanism of stereotype threat’s effect on memory performance.

We were interested in contributing to the growing body of literature on the cognitive mechanisms that underlie this disruption in performance. Study 3 (Chapter 4) aimed to assess the effect of different types of threat on executive function. Older adults were assigned to one of three conditions: a neutral, memory threat, or processing speed threat condition. Participants completed a task-switching paradigm, in which global, local, and alternating switch costs were examined. Reaction time and accuracy were used as dependent measures. Overall, participants displayed a pattern of performance that is consistent with the task switching literature. That is, older adults showed global and local switch costs (e.g., Mayr, 2001). Participants in the memory threat condition did not differ greatly from those in the neutral condition, while participants in the processing speed threat condition were significantly faster than the other two groups, (p=.03). We did not observe an interaction between trial type and group for local switch costs (p>.05). Group differences only emerged for global switch trials. It is possible that our processing speed threat manipulation may have prompted a reminder about the objective of the task. Taken together, incorporating value-based tasks into neuropsychological assessments would provide an improved objective measure of memory performance. Also, as suggested by Study 3, deemphasizing memory prior to a task of executive function may improve performance.
The dissertation of Natasha Yvette Fourquet is approved.

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CHAPTER 1. General Introduction

Older adults have poorer cognitive skills (e.g., explicit memory and executive function) than younger adults (see Luo & Craik, 2008, for a review). There are both biological and contextual causes that may lead to cognitive decline in older adults. Stereotype threat is one of the contextual variables that has been shown to affect cognitive performance among older adults.

Stereotype threat arises when a person is concerned that their performance will confirm a negative stereotype about their group (Steele & Aronson, 1995). The seminal study by Steele and Aronson (1995) had a sample comprised of African American and Caucasian participants, who were asked to answer questions taken from the Graduate Record Examination’s (GRE) verbal section. Half of the participants were told that the questions assessed verbal ability (i.e., diagnostic condition). For the remaining half, the instructions did not make any reference to verbal ability, rather the experimenters explained that they were interested in examining psychological factors affecting verbal problem-solving (i.e., non-diagnostic condition). Steele and Aronson (1995) were interested in whether the interaction of participant’s race (i.e., Caucasian or African-American) and test instructions (i.e., diagnostic or non-diagnostic) had an effect on performance. The data showed that when the test was presented as diagnostic of verbal reasoning ability, African American participants performed worse than Caucasian peers and African-Americans in the non-diagnostic condition (See Study 2). These findings suggested that stereotype threat affects performance regardless of intellectual ability.

A similar pattern of results emerged in other studies that included minority groups under different stereotypes. Gonzales, Blanton, and Williams (2002) conducted a stereotype threat study with Latino and Caucasian undergraduate participants using the same test-instruction
manipulation introduced by Steele and Aronson (1995). In the diagnostic condition, the instructions stated that the objective was to assess personal factors involved in performance (i.e., math and spatial ability); however, the non-diagnostic condition did not make reference to testing of ability. Latino participants performed worse in the diagnostic condition than Latino peers in the non-diagnostic condition and their Caucasian counterparts in the diagnostic condition.

Stereotype threat has also been proven to be present in non-minority groups (e.g., Caucasian men). Aronson et al. (1999) conducted a study in which they recruited Caucasian men who obtained high scores (610 or higher) in the math section of the Scholastic Assessment Test (SAT). Participants in the stereotype threat condition were told that the objective of the experiment was to understand why Asians outperformed other ethnic groups in math. This stereotype was not made salient for the control group. Caucasian men in the stereotype threat condition made significantly fewer correct answers than those in the control condition (Aronson et al., 1999). In a different study by Stone et al. (1999), Caucasian men performed worse than African-American men in a golf task when informed that the objective of the study was to assess natural athletic ability. Taken together, these findings suggest that anyone, regardless of ethnicity or skillset, could experience the negative effects of stereotype threat.

Older adults are also a target of negative stereotypes, and thus not exempt from the effects of stereotype threat. It has been shown that stereotype threat arises for older adults when they are concerned that their performance will confirm the notion that individuals in their age group have difficulties with memory (e.g., Desrichard & Köpetz, 2005; Chasteen et al., 2005). Hess et al. (2003) studied stereotype threat among older adults using performance in a story-recall exercise as a dependent measure. The results showed that when older adults were presented with fictitious news articles depicting a negative stereotype about aging (e.g.,
forgetfulness) prior to reading the target story, their recall score suffered compared to older adults who read stories that did not convey negative stereotypes about individuals in their age group. Similarly, Chasteen et al. (2005) provided older adults with either memorization or impression formation (i.e., forming a first impression based on behavioral descriptions) instructions before they took part in a sentence formation test using previously presented stimuli. Results indicated that older adults who were given memorization instructions performed worse in both the recall and recognition conditions than those who received impression-formation instructions. Furthermore, participants who reported high levels of perceived threat demonstrated poorer memory performance. In a different study, Desrichard and Köpetz (2005) found that stereotype threat only affects older adults when the task is labeled as one that assesses memory, compared to visual-spatial, story comprehension or shape processing labels. More to this, Hess, Hinson and Hodges (2009) found that older adults on the younger end of the spectrum (i.e., 60-70 years old) exhibited a significant decrease in memory performance when under threat, while older adults (i.e., 71 years of age and older) did not. These findings suggest that entering the “old age category” may increase group identification, which might in turn make negative stereotypes more salient to individuals entering such group.

Although the effects of stereotype threat have been widely documented, much less is known about the cognitive mechanisms through which stereotype threat affects older adults. Research studies with young adults have found relationships between stereotype threat and high levels of anxiety (e.g., Steele, 1997; Steele, Spencer, & Aronson, 2002; Osborne, 2001), decline in executive control resources (e.g., Schmader & John, 2003), and an imbalance in regulatory fit (Seibt & Förster, 2004; Grimm et al., 2009). However, these associations are not always found for older adults. For example, previous research has not found support for the association
between stereotype threat and anxiety in older adults (e.g., Hess et al., 2003; Chasteen et al., 2005).

The finding that stereotype threat taxes executive control resources is strongly supported in young adults. Schmader, Jones, and Forbes (2008) developed an integrated model based on research conducted with young adults, which theorizes that stereotype threat affects performance through three distinct, yet interconnected cognitive processes. First, stereotype threat affects monitoring (e.g., Beilock, Rydell, & McConnell, 2007). Stereotype threat induces a state of divided attention, which makes it harder for participants to manage the task at hand. Second, stereotype threat induces stress. Stress affects neural activity in prefrontal areas (e.g., Arnsten, 2009; Schoofs, Wolf, & Smeets, 2009), which play a major role in executive function. Lastly, stereotype threat induces negative mood, thus affecting emotion regulation and an individuals’ ability to complete a task successfully (e.g., Steele, 1997; Steele et al., 2002). The effects of negative mood are important because the process of mood regulation competes with executive control demands. Divided attention, stress, and negative mood converge to tax executive resources, which are essential for any cognitive task.

The research on the effects of stereotype threat on executive function in older adults is mixed. Hess et al. (2009) employed a computation-span task, a commonly used paradigm, to assess working memory—an important component of executive function. In this task, participants completed arithmetic problems in sets of one to nine problems each. Participants had to solve these problems mentally and select one out of three answer choices presented in a multiple-choice format. Participants were asked to say their answer aloud, without looking at the answer sheet, after each set. Older adults were randomly assigned into threat and non-threat conditions. Participants in the threat condition were informed that the objective of the task was to
address age-related differences. Older adults in the non-threat conditions were told that the task had been found to yield comparable performance across age groups. Results showed that there were no significant differences in working memory performance between groups. Given this finding, Hess et al. argued that working memory may not be susceptible to threat. However, this lack of statistical significance may be due to the way the computation-span task was presented to the participants. Rather than being presented as a memory task, it was framed as a measure of quantitative skills, which may not be an effective label to induce threat in older adults (Desrichard & Köpetz, 2005). Hence, the findings and implications of this study should be evaluated with caution.

However, other studies have found differences in executive function performance between older adults under stereotype threat and in non-threat conditions. Mazerolle et al. (2012) used a reading-span task to assess working memory under stereotype threat. Participants read sets of two to five sentences aloud, and they then had to say the last word of each sentence after each set. In the threat condition, participants were told that the experimenters were interested in the performance of young and older adults. Participants in the non-threat condition were also told that the experimenters were interested in the performance of young and older adults, but that performance in reading-span tasks is essentially the same across age groups. Results showed that older adults under threat had poorer performance than both young and older adults in the control condition. Mazerolle et al. (2012) also examined controlled versus automatic responses using a cued recall task. First, participants were asked to read aloud a list of 40 words that appeared on a computer screen. Next, they were presented with 80 exercises of word stem completions using the first three letters of a word. For half of the exercises, participants were asked to complete the stems using words that had appeared on the previous list (i.e., inclusion condition). The
remaining items asked participants to complete the stems using the first new word that came to mind (i.e., exclusion condition). An automatic response would consist of completing a word using one that had been previously presented on the list. In contrast, a controlled response consisted of completing a word stem with a previously unseen word—indicating goal-directed strategies. Controlled rather than automatic memory processes require filtering out the previous list, and therefore a larger amount of executive control. Results from this study showed that older adults under threat displayed more automatic responses (than controlled responses), compared to older adults in the non-threat condition. Taken together, these findings provide support for the idea that, under specific experimental conditions, working memory may in fact be affected when older adults face stereotype threat.

Additional studies have found counterevidence for the executive function hypothesis, and support an alternative one, the regulatory fit hypothesis. This hypothesis stems from the idea that individuals differ in their approach to accomplishing goals (Higgins, 1997). On one hand, some people have a promotion focus, which prioritizes gains. On the other hand, some people have a prevention focus, which underscores an absence of losses. Research has found that performance can be maximized when there is a regulatory fit, that is, when the reward structure is in tune with the regulatory focus of the individual (Higgins, 2000). Regulatory focus can be manipulated experimentally for a short period of time. One such example is stereotype threat, where a prevention focus state is induced. Individuals under stereotype threat try to prevent losses rather than to maximize their gains (i.e., prevention focus; e.g., Seibt & Förster, 2004).

Barber and Mather (2013a) tested this idea with an older adult sample using a sentence span task and a reward structure (i.e., gains or loss based) manipulation. In the gains-based condition, participants received two poker chips whenever they recalled a word. Three poker
chips were subtracted from a total of 100 chips for every word that participants failed to recall in
the loss prevention condition. In the gains-based structure, stereotype threat negatively affected
the number of words recalled. However, the number of words recalled increased significantly in
the loss-based structure (Barber & Mather, 2013a).

In another study by Barber and Mather (2013b), older adults were instructed to study a
list of 30 words for 2 min. Participants were allotted 3 min for free recall in Experiment 1.
Experiment 2 followed the same free recall time protocol, but also added a second task
component where participants saw a set of 60 words that included 30 words from the original list
and 30 new words. Participants had to indicate whether the word was old or new. Older adults in
the stereotype threat condition made fewer errors (e.g., intrusions and false alarms) in both
Experiments 1 and 2, compared to older adults in the control condition. Along these lines,
Popham and Hess (2013) manipulated threat while older adults performed a letter-cancelling
task. The results showed that participants in the threat condition were slower, but more accurate,
that those in the no-threat condition. Together, these findings show that executive control
resources may not fully explain the decrement in cognitive performance found in older adults
who are under threat, given that in some cases (e.g., loss-based structure) stereotype threat
actually enhances performance. Furthermore, stereotype threat positively affected the quality of
the information that was recalled by older adults, as reflected by high accuracy scores.

As highlighted by the research presented above, there may be several plausible cognitive
mechanisms through which stereotype threat affects cognitive performance in older adults. Study
1 (Chapter 2) used a gambling task to assess memory selectivity and metamemory—abilities that
have been shown to be generally spared in normal aging. The goal of this study was to assess
whether stereotype threat (a) affects performance in tasks where older adults have been proven to
excel in and (b) how stereotype threat impacts the way older adults think about their own memory. Study 2 (Chapter 3) utilized a recall task to assess whether or not stereotype threat affects retrieval independently from encoding. The goal of my third study was to further examine the impact of stereotype threat on executive function in aging. More specifically, Study 3 (Chapter 4) assessed task-switching, an important component of executive function. The task-switching paradigm measures working memory, inhibition, and backward inhibition. The task-switching paradigm allows us to examine the effect that stereotype threat may have on these mechanisms independently from one another, and also, the specificity of its impact.

CHAPTER 2: Age-Related Stereotype Threat on Metacognition

2.1. Introduction

People are bombarded daily with information they have to remember. Although it is often impossible to recall everything we ought to, it is imperative for individuals to choose on which information to focus their attention. In recent years, researchers have created memory tasks to examine the process of selecting/prioritizing information needed for later recall.

The value-directed remembering task (Castel et al., 2002), for example, presents words that are paired with arbitrary point values that indicate the value of each word. The objective of this task is to maximize the amount of points. Words and point values are presented in a list format on a computer screen. After each list is presented, participants are prompted to say all the words (not the point values) that they are able recall. Not surprisingly, results have shown that older adults recall less number of words than younger controls. However, older adults have a comparable recall for words with high point values (e.g., Castel et al., 2002; Castel, Balota, & McCabe, 2009). These findings highlight that while older adults are impaired in terms of the
quantity of information they can retain, they can still recall information and be selective with regards to the information they attend to.

Research by Barber and Mather (2013b) used a modified value-directed paradigm to assess the effects of stereotype threat in older adults’ recall. The authors were also interested in testing the regulatory fit hypothesis with this group. In their experiment, participants were presented with four cycles of words and point value pairings. Half of the words led to point gains and the other half led to point losses. Their results showed that older adults under stereotype threat remembered more words that led to point losses. However, these findings were only true for the first cycle of words and not for the last three cycles. The authors argued that the lack of significant findings for the last cycles was due to dissipating effects of stereotype threat. Their data suggest that older adults under threat are sensitive to value effects, as they generally selected words that led to point losses. Barber and Mather’s (2013b) findings provide partial support for the regulatory fit hypothesis. However, given that their study is the only one that has looked at memory selectivity in older adults under stereotype threat with inconclusive results, more research is needed to understand the impact that stereotype threat may have on memory selectivity processes.

The current study used a value directed paradigm as modified by McGillivray and Castel (2011), because it allowed us to assess how older adults make metacognitive judgments in the context of stereotype threat. Similar to the original task (Castel et al., 2002), older adults were presented with words and point values pairings. Also, words were presented across six lists. The current study used a gambling paradigm that required participants to “bet” on a word on a trial-by-trial basis. Specifically, older adults had to choose if they wanted to “bet” on each word presented. If they successfully recalled “bet on” words, participants were awarded the amount of
points that the word was worth, but lost the amount of points if they did not. Participants were informed that the task’s goal was to maximize their gains (i.e., obtain a high score) before they began the experiment.

McGillivray and Castel (2011) tested this task with a sample of young and older adults. Results showed a similar pattern to the original value directed paradigms—although older adults were not able to recall the same number of words as young adults, they were able to remember a similar amount of high-value words with increasing task experience. McGillivray and Castel (2011) found that older adults (and young adults) were initially overly confident—betting on more words than they could recall. But, as the task progressed, older adults were able to implement more effective strategies. For example, older adults showed greatly improved calibration score (i.e., “bet on” words versus remembered words). Given that older adults improved their calibration score with task experience, these findings suggested that—to some extent—adults preserve metacognition as they age. Young adults recalled more low and medium value words than older adults. However, older adults remembered as many high-value words as young adults. These findings provide further support to the notion that older adults have good memory selectivity, and that even though older adults are not able to recall the same amount of information as young adults, they are able to prioritize high-value information.

To our knowledge, the current study is the first to look at how older adults selectively remember important information and how they judge their memory abilities when faced with stereotype threat. We predicted that older adults under threat will not show an initial period of overconfidence as that shown in the original paper (McGillivray & Castel, 2011). In fact, given that stereotype threat has been thought to induce a prevention focus (e.g., Seibt & Förster, 2004; Popham & Hess, 2015), we hypothesized that older adults in this condition might choose to bet,
in general, on fewer words, than those in the control condition. Furthermore, we hypothesized that older adults in the stereotype threat condition might be extremely conservative and choose not to bet on high-value words at all, given the high-risk factor. In turn, this strategy might lead to lower total scores for older adults in the stereotype threat condition.

2.2. Method

(a) Participants

Older adults (N=44) were recruited for the current study. Participants were recruited through newspaper advertisement. Half of the sample were randomly assigned to a neutral condition (n=22, women=11, \( M_{\text{Age}} = 68.0, \ M_{\text{MMSE}} = 28.95, \ M_{\text{Education}} = 16.05 \)) and the other half to a stereotype threat condition (n=22, women=11, \( M_{\text{Age}} = 64.0, \ M_{\text{MMSE}} = 28.95, \ M_{\text{Education}} = 15.45 \)). Participants were tested in the Cognitive Neuroscience Lab at the University of California Los Angeles. Participants’ parking expenses were covered and received $20 as compensation.

(b) Design

We used a 3 X 2 mixed-subjects design. The first independent variable was List. Participants saw 6 lists; however, lists were collapsed into beginning, middle, and end to maintain power. That is, List 1 and 2 were averaged into a single measure (i.e., “beginning”). The same was done with List 3 and 4 (i.e., “middle”) and List 5 and 6 (i.e., “end”). The second independent variable was Group. Participants were randomly assigned to either a Neutral or Stereotype threat condition.

(c) Materials
Gambling task. Seventy-two common nouns were used as stimuli. The nouns were presented for 5s across six lists with 12 words each. All words contained four to five letters. Each stimulus was randomly assigned a point value. Point values range from 1-10, 15, and 20. Each point value was only used once within a list, and the order of the point values within and across lists varied (e.g., the 7-point may appear first on List 1 but fifth on List 2). Participants had 90s to type all the words that they could recall immediately after the screen showed the stimuli.

Blurb manipulation. Blurbs differed in content, which was either neutral or threat related. The neutral blurb served as our control manipulation and depicted a non-biased view of aging, which did not mention possibly stereotyped words such as memory or memory deterioration. In contrast, it highlighted words such as cognition and cognitive changes. This blurb stated that they would take part in a cognitive task. The threat manipulation emphasized a negative view of aging. The threat blurb highlighted words like memory and the fact that it deteriorates with age. This blurb stated that participants would take part in a memory task. Moreover, the text in the neutral blurb was followed by a prompt to provide their subject ID. The threat blurb prompted participants for their age, which was meant to be a reminder of their age category.

Mini Mental Status Exam. The Mini Mental Status Exam (MMSE; Folstein et al., 1975) is a widely used measure of global mental status in older populations. The MMSE consists of 30 items assessing time and place orientation, simple arithmetic problems, visuoconstruction, and language abilities. The MMSE has been validated with different age groups, and is commonly used for dementia screenings. The maximum total score is 30.

Perceived stereotype threat scale. The current study used the adapted version of the perceived stereotype threat questionnaire (Chasteen et al., 2005), which contains five-questions. This
measure assesses people’s beliefs about memory and age. Participants responded using a 5-point Likert scale ranging from (1) *strongly disagree* to (5) *strongly agree*. The perceived stereotype threat questionnaire has good internal consistency (Cronbach’s α = .79).

(d) Procedure.

Participants were first given a consent form. Next, they received instructions to complete the gambling task. The instructions explained that they would see words paired with point values to indicate each word’s worth. Participants were also informed that they would be making bets on a trial by trial basis. The scoring schema was also delineated: (a) they would earn points whenever they bet on a word and later recalled it, (b) and lose the points if they failed to recall a word that they had placed a bet on. The instructions explicitly mentioned that their goal was to maximize their score. Participants were then given the chance to ask any questions before beginning the task, and then they were instructed to read their corresponding blurbs. The words were displayed on the computer screen for 5s, and participants had to indicate if they wanted to bet on each word by clicking “yes,” or “no” if they did not want to bet. If no choice was made it was calculated as a “no.” After a list of 12 words was shown, participants were prompted with blanks or lines where they would type in the words they remembered. Participants had a 90s-recall period and were given their total score after each list. Participants completed the self-report questionnaires after they finished all six cycles. They were compensated for their participation and those in the stereotype threat condition were debriefed at the end of the session.

2.3. Results
A two-way ANOVA was used to analyze the data for this study. List and Group were used as independent variables. List was a within-subjects variable and Group was a between-subjects variable.

**Bets.** We examined the raw number of bets that participants made for each list. We observed no interaction between list and group, $F(2,84)=.76, p=.47$. Bets did not increase with task experience, $F(2,84)=1.84, \text{MSE}= 2.56, p=.17$. Additionally, stereotype threat did not appear to have an effect on number of bets, $F(1,42)=.32, \text{MSE}= 10.56, p=.58$.

**Recall.** We examined the raw number (independent of point value) of words recalled per list. We did not find an interaction between List and Group, $F(2,84)=.70, p=.50$. List positively impacted recall (i.e., their recall increased as they saw more lists), $F(2,84)=5.39, \text{MSE}=1.13, p=.006$. No main effect of group was found, $F(1,42)=1.43, \text{MSE}=4.76, p=.24$.

**Average score.** Total score was calculated by adding the point values of the words they bet on and later recalled, but also subtracting point values of words they bet on but forgot. Words that they recalled but were not bet on were not taken into account in this analysis. A significant interaction of List and Group was revealed for total score, $F(2,84)=6.59, p=.002$. Overall, participants benefitted from task experience, $F(2,84)=33.94, \text{MSE}=290.30, p<.001$. Participants obtained higher scores in the beginning ($M=27.48, \text{SE}=3.60$), than in the middle ($M=24.76, \text{SE}=3.69$) or the end ($M=31, \text{SE}=4.03$). Stereotype threat did not have a significant effect on total score, $F(1,42)=1.58, \text{MSE}=1302.37, p=.216$.

**Calibration.** This measure was calculated by subtracting the number of bets from the number of words recalled. An ideal score would be zero, where number of bets and number of words recalled are equal. The interaction between List and Group was not significant, $F(2,84)=2.35,$
p=.10. Task experience aided calibration, F(2,84)= 11.86, MSE=1.88, p<.001. No main effect of group was revealed, F(1,42)= 2.14, MSE=8.15, p=.15. Planned comparisons, combining list 3 through 6, revealed a significant difference between the neutral (M=1.02, SD=.99) and stereotype threat group (M=2.11, SD= 2.27), t(42)=2.07, p=.045.

**Recall value.** We examined the effect of value on recall. In order to maintain power, values were grouped into three categories: low (values 1-4), medium (values 5-8), and high (values 9-20). We found no interaction between recall value and group, F(2,84)=1.00, p=.372. Overall, participants recalled more high-value words, F (2,84) 26.03, MSE=16.28, p<.001. No group differences were found, F(1,42)=.58, MSE=18.96, p=.453.

**Bet value.** We assessed how value affected betting. In order to maintain power, values were grouped into three categories: low (values 1-4), medium (values 5-8), and high (values 9-20). We found no significant interaction between group and bet value, F(2,84)= 1.23, p=.297. A significant main effect of value was revealed, F(2, 84)= 48.53, MSE=25.51, p<.001. No main effect of group was found, F(1,42)= .83, MSE=53.90, p=.367.

**Points lost.** We examined group differences across list for points lost. We found no significant interaction between list and group, F(2,84)= 2.35, MSE= 118.99, p=.10. A significant main effect of list was found, F (2,84)= 29.20, MSE= 118.99, p<.001. In beginning lists, participants lost more points (31.77, SE=2.49), than in the middle (M=16.59, SE=1.92) and end (M=16.18, SE=2.16). We did not find a main effect for group, F (1,42)= 1.05, MSE= 403.58, p=.31. An independent samples t test revealed a marginally significant difference in points lost for neutral (M=13.14, SD= 9.02) and stereotype threat groups (M=19.64, SD= 14.92), t(42)=1.75, p=.088.

2.4. Discussion
The objective of the current study was to examine the effect of stereotype threat on metacognition. We used a gambling version of the value-directed remember (VDR) tasks, which allowed us to study how older adults prioritize information and how they assess their own memory abilities while under stereotype threat. Previous research has documented that older adults remember fewer words than younger controls (Castel & McGillivray, 2011), but that older adults still recall a comparable amount of high-value words. Castel and McGillivray (2011) found that older adults were initially overconfident—exemplified by their excessive betting on earlier lists, but managed to calibrate bets and recall in later lists.

In the current study, both the neutral and stereotype threat groups showed consistent betting across lists. Furthermore, task experience aided recall for both the neutral and stereotype threat groups. There were no differences across groups for bets and recall; however, the stereotype threat group was numerically worse in both. We also examined a combined measure of bets and recall (i.e., calibration; bets-recall), and our findings showed that stereotype threat negatively affected calibration. McGillivray and Castel found that task experience helped older adults’ initial “metacognitive failure,” and our results partially support that as well. In our study, participants in the neutral condition benefitted from task experience, which supports the idea that older adults have the ability to incorporate metacognitive knowledge when navigating memory tasks. This finding is consistent with previous research saying that older adults’ metamemory is comparable to that of young adults’ (e.g., Souchay & Isingrini, 2004; Hetzog & Hultsch 2000; McGillivray & Castel, 2011). Nonetheless, when older adults face negative stereotypes regarding their memory, their decreased performance reflects “metacognitive failure.”

Our results demonstrated that stereotype threat affected overall score. Both groups show comparable scores in earlier lists, but some noteworthy differences arose in the rest of the lists.
Similar to the McGillivray and Castel paper, the neutral condition group benefitted from task experience, while older adults in the stereotype threat condition did not. It is plausible that stereotype threat overrides the benefit of task experience in this metacognitive task. Older adults may be preoccupied with confirming the stereotype; consequently, cognitive resources devoted to adapting an effective strategy may become compromised. Previous research has shown that strategy is affected when older adults navigate a memory task under threat. For example, Hess and Hinson (2006) showed that older adults under threat underutilized clustering (i.e., grouping words of a similar semantic category). Strategy is crucial to maximize the overall score; therefore, metacognition became highly important in the current study.

Metacognition and executive function both require control and monitoring information in order to execute a desired voluntary action. Previous research has found that older adults who show greater executive control also display better metacognition (Souchay & Isingrini, 2004). The frontal cortex also plays a role in metacognitive monitoring (Fernandez-Duque et al., 2000). For instance, patients with frontal damage display deficits in metacognition (e.g., Shimamura & Squire, 1986; Janowsky, Shimamura, & Squire 1989). The evidence of the role of frontal areas in executive control is widely supported. Taken together, these findings suggest a strong overlap in cognitive processes and a convergence of brain regions that subserve metacognition and executive control. Our findings support an executive function hypothesis, which predicts that executive control may be affected in older adults while under threat. Specifically, we found that the threat group obtained both lower total and calibration scores than the neutral group. Both of these measures require metacognitive control, which in turn requires executive function.

Our understanding of the mechanism(s) by which stereotype threat affects cognition is less clear. One camp argues that stereotype threat affects executive control (e.g., Mazerolle et al.,
2012), while others believe that the mechanism at play is related to the regulatory fit hypothesis. Mazerolle et al. found differences across groups in a sentence span task, which is a common task used to examine working memory. These findings bolster the hypothesis that executive function may indeed be affected under threat and a possible mechanism by which it exerts its detrimental effect in normal aging. Supporters of the regulatory fit hypothesis have found that stereotype threat induces a prevention focus (i.e., instead of a promotion focus; Seibt & Förster, 2004), which makes individuals under threat become more concerned with not doing their worst and less worried about doing their best. Consistent with this perspective, research has found that participants under threat recall less words, but make fewer errors (e.g., Barber & Mather, 2013b).

One way we measured errors in the current study was by quantifying points lost when words that were bet on were later forgotten during the free recall portion of the task. Our findings show that older adults in the stereotype threat condition lost more points (p=.08), which is not what would be predicted by the regulatory fit hypothesis.

We examined other factors that may underlie total score performance. For example, we explored the effect of value on betting and recall. We hypothesized that the difference in total score across groups was driven by the difference in the point values of the words that participants bet on versus the ones they remembered during free recall. Additionally, a regulatory fit hypothesis would predict that older adults under threat (using a prevention focus approach) would be less sensitive to gains, thus betting on information of lower value. Our results show that both groups were sensitive to value—that is, both the neutral and stereotype threat groups placed more bets on—and recalled more high-value—words. A regulatory fit hypothesis cannot account for these findings.
Taken together, our results suggest that threat does impair older adults’ ability to prioritize high-value information. Our findings do suggest that metacognition, a cognitive process that is generally found to be intact in normal aging, is susceptible to the negative impact of threat. Given the overlap between metacognitive abilities and executive control, we argue that both are burdened when stereotype threat is introduced to older adults while performing a memory task.
2.5. Figures

![Graph showing recall and bets as a function of list]

*Figure 2.1.* Recall and bets as a function of list is presented. No List by Group interaction was found for bets (p=.47) or recall (p=.50).
Figure 2.2. Average score across lists is presented above. Both groups show an increase in score across lists. However, the stereotype threat condition does not appear to benefit from task experience when compared to the neutral condition (p=.002).
Figure 2.3. Calibration score is calculated by subtracting number of words recall from number of bets (bets - recall). Zero is the ideal score. Overall, older adults in the threat condition are poorly calibrated when compared to those in the neutral condition (p=.045).
Figure 2.4. Older adults in the threat condition lose more points in middle and end lists than those in the neutral condition. The difference across groups is not significant (p=.08).
CHAPTER 3: Age-Related Stereotype Threat on Retrieval

3.1. Introduction

Research on stereotype threat and aging has focused extensively on memory. However, less is known about specific memory stages disrupted during the recollection process, and much less about the role, if any, of stereotype threat. Thus, the question remains which memory processes are affected when older adults are under stereotype threat. Is encoding affected? Is retrieval affected? Are both processes affected? If so, does inducing stereotype threat affect both processes to a different extent?

Some research studies have assessed the effects of incidental versus intentional encoding. Under these paradigms, participants are presented with words lists. Tests of intentional encoding inform the test-taker that they will be asked to repeat from memory (i.e., free recall) the list of words that they learn. Tests of incidental encoding surprise test-takers with a free recall test. Previous research using these paradigms have underscored that age-related differences are decreased with incidental encoding and increased with intentional encoding (e.g., Yonelinas, 2002). One plausible explanation may be that older adults are able to better encode when they are not threatened by the possibility of being tested in a domain in which their performance is stereotypically perceived to be poor (i.e., stereotype threat). More to this, while these findings speak about encoding, it may also be possible that the retrieval stage is differentially affected by the presence of threat.

The majority of the studies in the stereotype threat literature look at the effect of threat on memory, specifically when the stereotype threat manipulations occur prior to encoding (e.g., Hess, Hinson, & Hodges, 2004; Chasteen et al. 2005; Eich et al., 2014). The findings across
these studies are consistent in that an effect of stereotype threat on memory is found. Interpretations from these studies are limited to the general effect of threat on memory but are not specific to any of the memory stages. A recent study has examined the effect of stereotype threat on recognition before and after encoding. Krendl, Ambady, and Kensinger (2015) found that older adults under threat exhibited increased false alarms. Moreover, this effect was greater when threat was introduced prior to retrieval. The authors delineated a strong argument for the cognitive mechanisms that may be involved based on the research documenting that increases in false alarm rates are related to lower monitoring ability during retrieval (e.g., Curran et al., 1997; Kelley & Sahakyan, 2003). Given the negative relationship between false alarm rates and executive control, Krendl et al. argue that executive control (i.e., monitoring) may be a possible mechanism by which threat affects memory performance in aging.

Krendl et al. addressed the effect of stereotype threat before and after encoding on recognition. Also, as previously mentioned, there are multiple studies that support the deleterious impact of stereotype threat on older adults’ memory performance. Yet, the majority of these studies introduce the stereotype threat manipulation prior to encoding. Given their format, we are unable to determine the effect of threat on the individual stages of memory. The present study aimed to address this gap by examining the effect of stereotype threat prior to retrieval. In light of previous findings, we hypothesized that presenting older adults with negative information related to aging prior to retrieval will yield differences across groups in free recall and cued recall. The current study would be the first to address the effect of threat on retrieval during a recall task.

3.2. Method
(a) **Participants**

Older adults (N=38) were recruited to be part of this study. Participants were randomly assigned to a stereotype threat (n=19, 10 women) or neutral condition (n=19, 10 women). Both groups were similar in age (Mean= 69.34 ; p>.05) and scored comparably in the Mini Mental Status Exam (Mean=28.94, p>.05). Participants were recruited through newspaper ads and were tested in the Cognitive Neuroscience Lab at the University of California, Los Angeles. Participants’ parking expenses were covered and they received $20 as compensation.

(b) **Design**

The independent variable in the study was stereotype threat group. Older adults were assigned to Neutral or Stereotype threat condition.

(c) **Materials**

**Study list.** Thirty words were presented on a computer screen for 3 min. All 30 words were displayed at the same time. The words were listed across six rows of five words each. The order of words was randomized across participants.

**Free recall test.** Participants wrote down as many words as they could remember.

**Cued recall test.** Participants were provided a sheet with the first two letters of all 30 words they previously learned. This list was presented across two columns with fifteen items each.

**Blurbs.** The same blurbs from *Study 1* (Chapter 2) were used during this task.

(d) **Procedure**
Participants read brief instructions, which stated that they would be given 3 min to study a list of words displayed on a computer screen. No information regarding the upcoming recall test was provided. If a participant asked whether they were expected to remember any of the words, the experimenters emphasized that they should “study” the words (i.e., no mention of memory task). Once participants finished the study phase, they were provided with their corresponding blurb. Participants were provided with a sheet of paper immediately after the learning phase, and explained that they had 2 min to write down as many words as they were able to remember. After the 2 min, they were given another sheet of paper that included the cued recall task. Participants had 3 min for this portion of the experiment. Once the 3 min were over, the experimenter came back into the room to administer the MMSE, collect demographic information, and ask participants to complete the Perceived Stereotype Threat Scale. Compensation was given at the end.

3.4. Results

Our independent variable was manipulated between subjects. We conducted independent samples \( t \) tests to examine recall in two types of tests: free and cued recall.

(a) Free recall. We found no significant differences between neutral and stereotype threat conditions in overall recall, \( t(36)= .118, p=.91 \) (See Figure 3.1). We examined both intrusions and perseverative errors. No differences across groups for intrusions were revealed, \( t(36)= .181, p=.857 \) (See Figure 3.2). Similarly, we saw no differences in perseverative errors, \( t(36)=1.44, p=.158 \) (See Figure 3.3).

(b) Cued recall. We observed no significant difference across groups for recall, \( t(36)= -.282, p=.78 \).
3.5. Discussion

The present study examined the effect of stereotype threat on recall. More specifically, we wanted to determine whether recall differences across groups are found when negative information related to memory was presented after encoding (i.e., prior to retrieval). Previous research has highlighted that the effect of threat for recognition is stronger for those who received the manipulation prior to retrieval (e.g., Krendl, Ambady, & Kensinger, 2015) as opposed to those who received it prior to encoding. Given stereotype threat’s effects on aging have disproportionately focused on recall, it is imperative to know which stages are more affected throughout learning and memory.

Our results revealed no differences across groups (i.e., neutral or stereotype threat) on free recall. Further analyses showed that there were no differences in perseverative errors or intrusions. Participants completed a cued recall task in addition to a free recall task. We also found no effect of stereotype threat on cued recall. Given that previous research has documented that recognition is affected to a greater extent when threat is presented prior to retrieval, we expected to see the same pattern emerge in findings for recall. It is plausible that the effects of threat on recall, which have been replicated robustly, are due to its impact on encoding alone and not on retrieval. These findings may differ from those of Krendl et al. and Hess et al. given the nature of the task. Anything that competes with the encoding processes may greatly affect performance given their importance for recall. In contrast, strong encoding processes may not be as necessary to achieve average recognition; therefore, introducing the manipulation prior to retrieval yields larger group differences.

This study had several limitations. First, the proportion of words recalled across groups in the current study was lower than that found in previous studies. For example, Hess, Hinson, and
Hodges (2009) found that, on average, older adults remembered nearly half of the words from a 30-word list. Barber and Mather (2013a) found that participants in the threat condition, which was had the lower score of the two groups, remembered more than 35% of the words. In the current study participants in both conditions recalled around 25% of the words on a similar 30-word list. Second, the length of time allotted for learning and memory tasks varied across this study and previous research. Both, Hess et al. and Barber and Mather presented the study list for 2 min, whereas, we allotted 3 min for encoding. Given that even our control group, which was expected to have a higher recall, showed a low proportion of words recalled, it is possible that our 3 min study period was too long. This excessive time period may have caused participants to become disengaged. The lack of significant differences may not be due to the absence of effect of threat on retrieval, instead, it is possible that the words were not strongly encoded. This brings up an interesting issue that should be addressed in future studies. Is the effect of stereotype threat on recall sensitive to time spent encoding? Additionally, to make a proper comparison of the effect of threat on individual memory stages, an encoding group should be added. That is, a condition where older adults are presented with both neutral and stereotype threat information before encoding. Adding the two groups would allow for direct comparisons. In light of these limitations, we cannot rule out the possible effect of stereotype threat on retrieval.
3.5. Figures

*Figure 3.1.* No differences in free recall across groups ($p=.91$).
Figure 3.2. No effect of stereotype threat was found on intrusions ($p=.857$).
Figure 3.3. Groups did not differ in perseverative errors (p=.518).
Figure 3.4. No effect of stereotype threat was found when participants were presented with a cued recall task (p=.78).
CHAPTER 4. Age-Related Stereotype Threat on Task-Switching

4.1. Introduction

Task-switching, an important component of executive function, has been proven to decline with age. Task-switching refers to the ability to effectively change from one cognitive task set to another. Task-switching is measured by examining switch costs (i.e., time cost associated with changing from one task to another) in experimental settings. There are different types of switch costs, such as global, local, and alternating switch costs.

Trials are generally performed in blocks, single or mixed task blocks in task-switching paradigms. Single blocks require participants to perform the same task in every trial. Mixed blocks display tasks in a mixed order and can include switches from one task to another (e.g., in the sequence ABC each letter represents a different task) and non-switch trials (e.g., in the AAB sequence AA are non-switch trials). Global switch cost refers to the response time (RT) difference between trials in a single-task block and non-switch trials within mixed blocks. In essence, global switch costs measure the cost associated with maintaining a task set when competing ones are present. Local switch costs are calculated as the RT difference between non-switch trials and switch trials within mixed task blocks. Local switch costs are defined as the ability to deactivate a previous task in order to successfully perform the next one. Thus, inhibition is an important underlying mechanism when assessing local switch costs. Alternating switch cost is a type of local switch cost, which is measured by further dividing switch trials into non-alternating (e.g., ABC) and alternating (e.g., in an ABA sequence one must return to A when it was presented two trials before). Alternating switch costs are calculated using the RT difference between non-alternating and alternating within mixed blocks. In this case, participants
must overcome an already imposed inhibition (i.e., backward inhibition) to perform the alternating task.

Evidence of age-related decline in task-switching is mixed. Research has consistently shown an age-related increase in global switch costs (Kray & Lindenberger, 2000; Mayr, 2001). In contrast, evidence for local-switch costs in older adults is equivocal (e.g., Kramer et al. 1999, Cepeda et al., 2001). In sum, these results suggest that while older adults may not always struggle in making switches within trials, they are consistently impaired at selecting or maintaining the correct task set when interfering irrelevant task sets are present.

As highlighted in Chapter 1, the literature on the mechanisms by which stereotype threat impacts older adults’ cognitive performance is mixed. One idea is that, similar to young adults, stereotype threat taxes executive control resources and that this, in turn, affects performance of the task at hand. As previously mentioned, Mazerolle et al. (2012) showed that working memory was impaired when older adults were under stereotype threat. However, Barber and Mather’s (2013a) found that older adults’ who were under threat showed enhanced working memory when the task at hand included a loss-based reward structure. Nonetheless, older adults with larger working memory capacity did not show any benefits in the task. Together, these mixed findings highlight the need to better understand the mechanisms through which stereotype threat affects cognitive functioning in older adults.

The current study used a task-switching paradigm that required participants to make judgments about stimuli presented on a computer screen. Participants made judgements based on color, fill-pattern, or shape. Preliminary studies from our lab have examined the effects of stimulus ambiguity on task-switching. Ambiguous stimuli display all three possible judgments
with a single stimulus, hence the interference is deemed to be “high” (See Figure 4.2). In contrast, unambiguous stimuli display a single judgment (e.g., color). Our preliminary findings indicated that when the stimuli are ambiguous (i.e., high conflict), older adults have increased global (p<.001) and local (p<.001) switch costs than older adults who are presented with unambiguous (i.e., low conflict) stimuli. Older adults presented with ambiguous stimuli were faster during alternating trials than on switch trials (p=.016), suggesting that the previously active task set remained active after the switch. Moreover, as seen in previous research, stereotype threat had a stronger effect on cognitive performance when the task demands were high (e.g., Hess, Emery, & Queen, 2009). Hence, we decided to incorporate the use of high-conflict stimuli only for the current study (See figure 4.2).

Participants were divided into three groups. The first group (n=21) participated in a neutral condition in which older adults were presented with blurbs that highlighted changes in cognition (not specific to memory decline or slowing). They were asked to report their study ID number after reading the blurb. We also incorporated two stereotype threat groups, a memory and a processing speed threat group. The memory threat condition depicted a negative view of aging and its language emphasized memory decline. The processing speed threat condition also depicted a negative view of aging, but the language emphasized deterioration of processing speed. Both groups were asked to report their age after reading their blurbs.

As previously explained, global switches require participants to maintain a mental task set, thus working memory resources are vital for this trial type. Overall, we predicted that older adults in the neutral or non-threat condition would show global, local, and alternating switch costs similar to those seen in the aging literature. However, we also predicted that older adults under memory threat would have greater costs (i.e., increased RT) when making a global switch,
compared to those in the neutral and processing speed threat conditions. Local switches require a
greater load of inhibition, another important component of executive control. We expected threat
to also consume inhibitory processes. Thus, we predicted that older adults under memory threat
would show greater costs when making a local switch, compared to those in the neutral and
processing speed threat conditions. Alternating switches require participants to overcome an
already imposed inhibition. Similarly, we predicted that costs would be greater for older adults
under stereotype threat than for those in the neutral and processing speed threat conditions in this
case. Of note, we expected participants in the processing speed threat condition to show costs
similar to those in the neutral condition. Research has shown that older adults’ performance is
only affected when the threat relates to memory and not executive function (e.g., Desrichard &
Köpetz, 2005).

The aforementioned hypotheses are related to reaction time. If the predicted findings fail to
reject our hypotheses, our results would support executive control as a possible cognitive
mechanism by which threat affects cognitive performance in older adults. We do not expect to
see differences in errors, which would lead us to argue that a prevention focus during threat is
not always accompanied by a speed-accuracy tradeoff.

4.2. Method

(a) Participants

Sixty older adults (N=60) were recruited for this study. Twenty-one participants were
assigned to the neutral group (13 women, M_{Age}=66.10, M_{Education}= 15.48, M_{MMSE}= 28.71),
twenty-two to the memory threat group (14 women, M_{Age}=69.09, M_{Education}= 15.73, M_{MMSE}=
28.91), and seventeen to the processing speed threat group (10 females, M_{Age}=62.00, M_{Education}=
15.76, M_{MMSE}= 29.24). Participants were recruited through newspaper ads and were tested in the Cognitive Neuroscience Lab at the University of California Los Angeles. Participants’ parking expenses were covered and received $20 as compensation. Two participants were excluded from this study based on low MMSE scores (<24 out of 30).

(b) Design

This study used a 2 x 3 mixed-subjects design. Our first independent variable, Trial type, was a within-subjects variable and Group was a between-subject variable. For global switch costs, Trial type was either blocked or non-switch trials (embedded in a mixed-task block). For local switch costs, Trial type was either non-switch or switch trials, and either alternating or switch trials for alternating switch costs. Our second independent variable, Group, was a between-subject variables. Participants were divided into three groups, neutral (n=21), memory threat (n=22), or processing speed (n=17) threat conditions. We used response time (RT) and accuracy as dependent measures. RT analyses only included correct trials.

(c) Materials

Task-switching paradigm. The task-switching test used three different 2-choice classification tasks. This paradigm required participants to perform three types of judgments. However, participants only had to perform one of those judgments for a given stimulus presented on a computer screen. They were asked to judge the color of the stimulus (i.e., red or blue), the shape (i.e., square or triangle) or the fill pattern (i.e., stripes or checks) for each stimulus presented. These three characteristics were all embodied in a single stimulus, so that interference from irrelevant task attributes would be high (see Figure 4.2 for stimuli examples). For example, a red-checkered-triangle could be presented when making a judgment of color, fill-pattern, or
shape. Participants pressed one of two keyboard keys to select their answers, with responses for all three tasks mapped onto the same two keys (i.e., \(j\) and \(k\)).

This task had 6 blocks (i.e., single-task or mixed-task blocks) with 32 trials each. Three single-task blocks were presented. In single-task blocks the same judgment was performed for all 32 trials. For example, block 1 prompted for color judgments, block 2 for fill-pattern judgments, and block 3 for shape judgments. The other three blocks were mixed-task blocks, where all three judgments were performed simultaneously (e.g., ABCCABC; letters represent judgments). The three single-task blocks were always performed consecutively, but the order between single and mixed task blocks was counterbalanced across subjects. This experiment was implemented using E-Prime 2.0 software and ran in a Sony Vaio laptop. The diagonal screen length was 15.5in. The screen refresh rate was 85ms.

**Blurs.** Blurs differed in content, which was either neutral, memory threat, or processing speed threat related. The neutral blur and memory threat blurs were identical to Study 1. The current study added a processing threat blurb, which highlighted words such as *processing speed* and stated that older adults get *slower* as they get older. This blurb specified that participants would take part in a *processing speed* task. Similar to the memory threat blurb, the processing speed threat blurb prompted participants for their age, which was meant to be a reminder of their age category.

**Self-report measures.** The questionnaires used in Study 3 were identical to those from Study 1. See Chapter 2 for more information.

**(d) Procedure**

First, participants were given the consent form. Once participants consented to take part in
In the study, they were asked to look up at the screen in front of them for instructions and a practice session. The experimenter remained in the room for this portion of the task. The instructions explained that they would be performing judgments about stimuli presented on the screen and emphasized that they should answer as quickly and accurately as possible. The practice session was introduced immediately after the instructions. The practice session consisted of three single-task blocks of eight trials each and one mixed-task block of 16 trials. After the practice session was over, the experimenter clarified any questions about the task and presented participant with their corresponding blurs. The experimenter then exited the room. Participants completed self-report questionnaires once they completed the computer tasks. Participants first completed a demographic questionnaire and were then administered the Mini Mental Status Exam. Next, participants filled out the Perceived Stereotype Threat Scale. Participants in the threat condition were debriefed after completing the self-report questionnaires. All participants received compensation for their participation at the end of their visit.

### 4.3 Results

We conducted a two-way ANOVA with Trial type as a within-subjects variable and Group as a between-subjects variable. Response time (RT) and accuracy were used as dependent measures.

(a) **Global switch costs: Response time.** For Trial type we examined trials in single-task blocks versus non-switch embedded in a mixed-task block (See Figure 4.1). We found a significant interaction between Trial type and Group, \(F(2,57)=3.65, p=.03\). Those in the neutral condition showed greater switch costs (i.e., higher RT for non-switch trials versus blocked) than the memory and processing speed threat groups. There was a significant main effect of group, \(F(2,57)=3.28, p=.045\). Overall, the processing speed threat group was faster than both the
memory threat and neutral conditions. We also found a main effect of trial type, $F(1, 57)=109.02$, $p<.001$. That is, participants were faster when making judgments for blocked trials than non-switch trials. The patterns for RT are displayed in Figure 4.3.

**(b) Global switch costs: Accuracy.** When looking at accuracy, no interaction was revealed for Trial type and Group, $F(2,57)=.012$, $p=.99$. We found no main effect of group, $F(2, 57)=1.15$, $p=.323$. A significant main effect of Trial type, $F(1,57)=6.48$, $p=.014$ was revealed. Participants were more accurate in blocked trials than in non-switch trials. Data is represented in Figure 4.4.

**(c) Local switch costs: Response time.** We examined RT for trials non-switch and switch trials embedded in a mixed-task block. No interaction between Trial type x Group was found, $F(2,57)=.831$, $p=.441$. There was no main effect of group, $F(2,57)=2.52$, $p=.089$, but there was a significant main effect for trial type, $F(1, 57)=109.02$, $p<.001$. Participants were faster in non-switch trials than in switch trials. The patterns for RT are displayed in Figure 4.5.

**(d) Local switch costs: Accuracy.** There was no interaction between Trial type and Group, $F(2,57)=.313$, $p=.733$. We found no main effect of group, $F(2,57)=.677$, $p=.512$, and no main effect of trial type, $F(1,57)=1.73$, $p=.194$. Data is represented in Figure 4.6.

**(e) Alternating switch costs: Response time.** We examined RT for switch and alternating trials embedded in a mixed-task block. An interaction between Trial type and Group was found, $F(2,57)=3.71$, $p=.031$. The neutral group was faster in alternating trials, the memory threat showed similar RTs for switch and alternating, while the processing speed threat group was slower in alternating trials. We found no main effect of group, $F(2,57)=1.03$, $p=.363$ or Trial type, $F(1,57)=.681$, $p=.413$. The patterns for RT are displayed in Figure 4.7.

**(f) Alternating switch costs: Accuracy.** There was no interaction between Trial type and
Group, F(2,57)=.801, p=.454 when looking at accuracy. We found no main effect of group, F(2,57)=.253, p=.777 or Trial type, F(1,57)=.167, p=.684. Data is represented in Figure 4.8.

(g) Analyses excluding older participants. Analyses revealed that the processing threat group was significantly younger (M=62.00) than the memory threat (M=66.09) and neutral groups (M=69.10). In an effort to match our groups by age we excluded participants over the age of 77 (n=7 excluded), but no age differences were found across groups F(2,47)= 1.57, p=.219. We ran analyses for global, local, and alternating switch costs. The trial type and Group interaction for global switch costs maintained its significance, F(2,47)= 3.22, p=.049. Moreover, the main effect of Group was strengthened, F(2,47)= 3.75, p=.031. Trial type and Group did not interact when examining local switch costs (p=.619), which was also true before the exclusion criteria. Consistent with initial analyses, Trial type and Group interacted when looking at alternating switch costs, F(2,47)= 4.06, p=.024.

4.4. Discussion

The present study aimed to shed light on the mixed research regarding the impact of stereotype threat on executive function among older adults. The use of a task-switching paradigm allowed us to not only assess executive function, but also to study the impact of stereotype threat on working memory, inhibition, and backward inhibition. Previous research from Hess et al. (2009) found no differences across groups (i.e., threat and non-threat) in working memory using a computational span task. However, Mazerolle et al. (2012) showed that working memory performance was worse for those in the threat condition. Further, Barber and Mather (2013) showed that the effects of stereotype threat on executive function depend on the reward structure of the task. It is thought that stereotype threat induces a prevention focus, which promotes an
approach that emphasizes losses. Barber and Mather (2013) showed that if the reward structure of a task is loss-based, then introducing a stereotype threat manipulation improves performance on both working memory and recognition tasks. In contrast, if the task is gains-based, which contradicts the focus that is induced by threat (i.e., no regulatory fit), the threat will negatively impact executive function and recognition. Popham and Hess (2015) provided additional support for regulatory fit as a mechanism by which stereotype threat may be affecting older adults. Moreover, Popham and Hess found that older adults under stereotype threat approached the task with a prevention focus. That is, older adults’ performance was characterized by increased response time (i.e., overall slower) but improved accuracy. Taken together, it appears that the effect of stereotype threat may depend on an array of variables, including the label and reward structure of the task at hand.

Our results indicated that, in general, all three groups (i.e., neutral, memory threat, processing speed threat) showed global switch costs (i.e., increased RT for non-switch trials versus blocked). This finding is similar to previous research, which consistently shows that even under no manipulated threat older adults show robust global switch costs (e.g., Kray & Lindenberger, 2000; Mayr, 2001). Interestingly, we did find differences across groups, which suggests that participants in the processing speed threat condition were faster than those in the neutral and memory threat groups. As such, it is possible that (a) slowing is not a relevant stereotype to older adults or (b) what we, as experimenters, expected to be a threat, was perceived as a reminder of the task’s objective. All groups received a series of instructions highlighting that they should answer as quickly as possible. Next, all participants took part in a practice session. Following the practice session, participants received their corresponding blurbs. Those in the processing speed threat group were told that older adults are slower, which might
have prompted a reminder about speed that was not introduced to the other groups. As a result, this reminder may have served as a motivator to disprove the stereotype that had just been introduced.

Global switch costs look at working memory or the ability to maintain a relevant task set in mind. One of our main objectives was to determine whether or not inducing a threat related to memory would impair working memory performance. Desrichard and Köpetz (2005) found that performance is only affected when the cognitive task is framed as a memory assessment. Thus, we predicted that although the task-switching paradigm has a strong executive function component, those in the memory threat group would show larger switch costs compared to the neutral and processing speed threat groups. Our findings did not support our initial hypothesis. Introducing a memory threat prior to a task-switching paradigm did not increase global switch costs. In fact, those in the memory threat group were numerically faster in non-switch trials than those in the neutral condition (p>.05). Given that working memory resources do not appear to be significantly affected in the memory threat group (compared to neutral and processing speed threat groups), we do not have enough evidence to support the notion that working memory is a possible mechanism by which stereotype threat affects older adults.

All groups showed large local switch costs (i.e., higher RT for switch trials than non-switch). Notably, the processing speed threat group was marginally faster across trial types than the neutral group, but not the memory threat group. Local switch costs are thought to reflect the ability to inhibit a task set. No interaction between Trial type and Group was found, thus our findings appear to indicate that stereotype threat does not significantly impair inhibitory processes. Moreover, alternating switch costs yielded an interesting pattern of results. Those in the neutral and memory threat conditions were faster for alternating trials (compared to switch
trials); however, the processing speed threat group was faster for switch trials (compared to alternating trials). Overcoming an already imposed inhibition comes at a cost for those in the processing threat condition, while participants in the neutral and memory threat conditions (both which are slower than the processing threat group) benefit when returning to a previously abandoned task. Reduced speed during alternating trials (observed in memory threat group) may be an indicator of successful inhibition, given that coming back to an abandoned trial (i.e., backward inhibition) reflects inflated RTs.

Our findings also do not provide support for the regulatory fit hypothesis. Popham and Hess (2015) found that those in the threat condition slowed down, but were also more accurate (i.e., consistent with a prevention focus approach). We found no differences in accuracy across groups (>89% trials correct) across all switch costs.

It is important to note that the majority of the studies that examine working memory under stereotype threat in older adults implement span tasks (e.g., operation and sentence span tasks). Mazerolle et al. discovered a significant effect of threat on working memory when utilizing a memory task label. It is possible that these observed differences in working memory across groups arise when the task has a strong working memory component along with a more explicit memory component (i.e., recall). In our task-switching paradigm participants make six possible judgments at any given time. Participants may become more acquainted with the memory aspect of the task after repeated trials, which might in turn make them approach it as a multitasking test. While span tasks never lose the memory component. Participants perform the task in sets with increasing number of problems. The list of items to remember in this task far exceeds the six possible judgments performed in our task. Thus, it may be more difficult to observe differences in performance across threat groups when the nature of the task does not have a salient memory
component (i.e., age-related stereotype).

This study had several limitations that should be addressed. First, the processing speed threat group was added after the recruitment for the neutral and memory threat group was over. Consequently, there was no random assignment to that condition. Second, participants in the processing threat group were significantly younger than those in the memory threat group. However, further analyses with age-matched groups confirmed that differences in RT across groups were not due to age. Third, participants in the memory threat group reported, on average, more medical conditions than participants in the other two conditions. Finally, all participants, independent of threat manipulation, reported a similar score on the Perceived Stereotype Threat Scale (mean 2.66, F<1). Hence, it may be possible that older adults in our study did not feel the pressure of confirming negative stereotypes about their age group.
4.5. Figures

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*Figure 4.1. Letters represent trials. To examine global switch costs (A) we compared blocked trials in a single-task blocks versus non-switch trials embedded in mixed-task blocks. We compared non-switch trials versus switch trials to examine local switch costs (B). To assess alternating switch costs (C), a type of local switch cost, we compared alternating trials with non-alternating trials.*
Figure 4.2. Ambiguous stimuli were used in this task-switching paradigm. Each stimulus displayed all three judgments categories (i.e., color, fill-pattern, and shape).
Figure 4.3. Effects of stereotype threat on global switch costs. Average response times as function of trial type and group. A significant Trial type by Group interaction was revealed (p=.03) for global switch costs.
Figure 4.4. No interaction between Trial type and Group was found for accuracy when making global switches (p=.099).
Figure 4.5. Average response times is represented as a function of trial type and group. No interaction of Trial type and Group was found for local switch costs (p=.089).
Figure 4.6. No differences across groups was found for accuracy of local switch trials.

Moreover, no differences were revealed for Trial type (p=.733).
Figure 4.7. Alternating switch costs are displayed. Analyses revealed a significant interaction of Trial type and Group (p=.031).
Figure 4.8. No interaction was found for accuracy of alternating switch trials (p=.801).
CHAPTER 5. Summary and Conclusion

The main objective of this dissertation was to determine mechanisms by which stereotype threat affects cognitive performance in older adults. We examined whether or not threat affected executive function in *Study 3* (Chapter 4). Our data replicates the general effect seen in aging studies of task-switching (e.g., Mayr, 2001). More specifically, we observed global and local switch costs across groups. We found that when stereotype threat was related to memory it did not impact global, local, or alternating switch costs any differently than it did when information presented was neutral in content. We found that when stereotype threat was related to processing speed participants were overall faster and showed less switch costs (e.g., lower global switch costs) than the neutral and memory threat conditions. Accuracy was not different across groups for none of the switch costs. These findings suggest that the content or type of threat may affect performance differently depending on the task that participants are performing. We believe that the processing threat blurb served to remind participants of the task’s objective (i.e., fast speed), which made them perform the task faster and show less global switch costs. As previously mentioned, the memory threat group did not show more pronounced switch costs when compared to the neutral group, which does not fit with an executive function hypothesis. Accuracy did change across groups, which would not be predicted by a regulatory fit hypothesis. The literature that has examined executive function under threat has mainly used span tasks, which may have a more explicit memory component than task-switching paradigms.

*Study 1* (Chapter 2) assessed whether threat affected metacognitive control and how older adults selectively remember high-value information. McGillivray and Castel (2011) found that older adults’ metacognition improved with task experience. Furthermore, findings in the McGillivray and Castel paper showed that older adults were as sensitive to value as young
adults. Furthermore, our findings show that threat affected metacognition, but spared its effect on value. Metacognitive processes strongly overlap with those underlying executive control (e.g., monitoring). These results suggest that threat competes for executive resources, which in turn, disrupts older adults’ ability to monitor information that would permit generation of an optimal strategy. The fact that threat does not affect value is unexpected. The regulatory fit paradigm would have predicted that the prevention focus induced by threat would have promoted conservative betting when value is taken into account (Seibt & Förster, 2004). In contrast, we found that neutral and threat groups bet and recall words of similar value. These findings imply that stereotype threat’s effect is not general or broad, it does not impoverish memory performance in its entirety. Moreover, we did not find a single factor that can account for differences in total score. It appears that small differences across points lost, betting, and recall, come together to impose a significant impact on group scores.

**Study 2** (Chapter 3) aimed to assess the impact of threat on retrieval. In light of previous research which found that threat affected retrieval on recognition tasks, we were interested in studying whether retrieval was also taxed during recall. Our findings did not demonstrate that threat impacted retrieval in free recall and cued recall tasks. Our study provided participants with more encoding time (i.e., 1 additional minute) than previous studies that have observed threat effects on recall (i.e., when threat is introduced before encoding; Hess et al. 2003; Barber and Mather 2013a). Allowing additional time may have been detrimental to performance by increasing disengagement, which likely interfered with rehearsal.

These findings show partial support for an executive function hypothesis (see Chapter 2), but no support for a regulatory fit hypothesis. Results from **Study 1** (Chapter 2) can inform interventions to lessen stereotype threat in important situations, such as, neuropsychological
assessments of dementia. Haslam et al. (2012) published a research study that highlighted the impact of stereotype threat in the neuropsychological assessment of older adults, which is, arguably, one of the most valuable applications of this research topic. The authors found that when older adults in their sample were under the effects of stereotype threat, 70% met criteria for a dementia diagnosis. In contrast, only 14% of those in the non-stereotype threat condition met criteria for diagnosis. Misdiagnosis not only affects the individual and caretakers, but it also heavily burdens the health care system. Research with older adults has found that older adults show good memory for high-value information. This finding has also been found in more traditional laboratory memory tasks that examine value (e.g., Castel et al. 2002), but also in tasks that closely resemble memory use in daily lives (e.g., memory for grocery prices; Castel, 2005). Moreover, our study showed that value is unaffected by age-based stereotype threat. Interventions aimed to lessen the burden of threat in neuropsychological assessments may incorporate value, which should provide a more reliable measure of older adult’s memory performance.

Study 3 (Chapter 4) highlighted that presenting participants with information related to age-related stereotypes that is (a) relevant to the task at hand (e.g., being slow in a processing speed task) and (b) not related to memory, improves performance. Doing so appears to motivate older adults to disprove the stereotype (e.g., older adults are slow) by boosting speed and decreasing costs associated with multitasking. These findings underscore the importance of deemphasizing the memory component from neuropsychological tasks that do not intend to measure memory.

Taken together, our findings underscore the importance of studying stereotypes and how they impact the day-to-day of older adults. Policy makers and legislators need to be aware of (a)
the effects of stereotype threat on older adult’s cognitive performance, (b) the abilities that are spared from the negative effects of aging (e.g., memory selectivity), and (c) the cognitive processes that are less susceptible to stereotype threat (i.e., sensitivity to information of high value; See Study 1). Educating policy makers and legislators on these subjects can transform how societal systems treat older adults. For example, older adults in California are required to take a driving exam in person every five years after the age of 70. First, legislators should know that older adults’ performance on a written exam may be contaminated by the concern of confirming negative stereotypes of their age group’s driving performance. Finding ways to lessen the effect of threat in this scenario is imperative. Second, older adults are able to prioritize high value information, which is an ability that has been shown to be spared from the negative impact of stereotype threat. As such, the driving exam should emphasize high value information (as opposed to trivial/obscure details) related to driving, which would not only be a more practical way to assess a person’s driving ability but also a better indicator of their ability to obey traffic laws. The AARP has recently focused on “changing the story we tell ourselves about aging.” This statement highlights the importance of “the story we tell ourselves.” Unfortunately, as we have learned, many of these “stories” are tainted with negative stereotypes related to aging. Although societal views of aging are slowly shifting, the narrative must change from within in order to see more immediate results in how older adults navigate daily activities that involve the use of cognition. Future research should focus on finding effective ways to change internalized narratives about aging.
REFERENCES


