The effect of stereotype-threat on memory and cortisol in older adults

by

Ashley Dawn Ryan

A thesis submitted in partial fulfilment
of the requirements for the degree of
Master of Arts

Department of Psychology
BROCK UNIVERSITY
St. Catharines, Ontario

Abstract

Stereotype-threat is characterized by underperformance on a task after exposure to a negative, self-relevant stereotype. In the case of older adults, there is a widely-held stereotype that older adults have poor memory function. It has been suggested that reminding older individuals of this stereotype results in poorer memory performance on effortful, but not automatic memory tasks. Further, testing older adults under certain conditions may increase cortisol levels, a biomarker associated with stress.

The present study investigated whether stereotype-threat affects implicit and explicit memory, and cortisol levels in older adults. We gave older adults (n = 62) an incidental encoding task wherein they rated a list of common words for pleasantness. Participants were randomly assigned to threat-activated or threat-eased groups, with each group reading a newspaper article designed to either induce or ease the salience of stereotype-threat. Memory was tested implicitly, via word stem completion task, and explicitly, via free recall task and forced choice recognition. Saliva samples were taken before encoding and after memory testing to assess changes in cortisol.

Stereotype threat had no effect on implicit or explicit memory, or the change in cortisol levels over time. However, there was a negative relationship between salivary cortisol levels and free recall in older men. We suggest that this finding may be explained by sex differences in reactivity and resilience to psychosocial stressors. Further, we discuss the difficulties involved with measuring stereotype-threat in older adults, who are often tested in youth-favouring settings.

Acknowledgements

I would like to begin by extending my gratitude to my supervisor, Dr. Karen Campbell. Dr. Campbell was, and continues to be, a continuous source of support and inspiration. Thank you for helping me build this project from an idea into a workable experiment. To my committee members, Dr. Emrich and Dr. McCormick, and my external examiner, Dr. Fiocco, I thank you for your time and expertise during the research process and preparation of my thesis. I feel very fortunate to have had your guidance.

I would also like to thank the members of the Campbell Neurocognitive Aging Lab, especially Amy Holliday, for assisting with collecting, scoring, and organizing my data. Your assistance was invaluable to getting me through this project. And to my fellow graduate students, Caitlyn, Emily, Sarah, and Tiago, thank you for being willing sounding boards and sources of support during this process. I am also grateful to the members of the McCormick lab for providing bench space and guidance in completing my assays.

I am extremely grateful to my family who have provided encouragement, and support throughout my university career. To my parents, Patrick and Kathleen, thank you for believing in me, even when I forget to believe in myself. I would like to thank my partner, Chris, and our 'fur-kids' for always providing with me with love, and an outlet for the frustrations involved with graduate school. Thank you for celebrating and commiserating with me. Finally, I would like to thank one of my biggest cheerleaders, my grandmother, Margaret, who passed away during completion of this project. She never doubted me for a minute, and for that I will be forever grateful.

Table of Contents

Abstract ii

Acknowledgments iii

Table of Contents iv

List of Tables vi

List of Figures vii

Introduction 1

Hypothesized mechanisms of stereotype-threat 5

Stereotype-threat and arousal 7

The current study 9

Hypotheses 10

Methods 11

Materials 11

Procedure 14

Statistical analyses 17

Results 19

Implicit and explicit memory 20

Cortisol 24

Correlations between cortisol and performance 25

Images of Aging 27

Subjective Experience 27

Discussion 32

References 39

Appendices 46

List of Tables

Table 1. Participant demographic and descriptive statistics ……………………………19

Table 2. Descriptive statistics of implicit and explicit memory……………………………20

List of Figures

Figure 1. Mean priming scores representing implicit memory ……………………21

Figure 2. Mean free recall representing explicit memory ……………………22

Figure 3. Mean percent correct during forced choice recognition ……………………22

Figure 4. Mean reaction time during forced choice recognition ……………………23

Figure 5. Means of salivary cortisol across timepoints by STT and sex ...…………..24

Figure 6. Correlation between cortisol and free recall ……………………25

Figure 7. Correlation between cortisol and recall in older men ……………………26

Figure 8. Correlation between cortisol and recall in older women ……………………27

Figure 9. Means of agreement ratings with STT article ……………………28

Figure 10. Means for finding the task stressful ……………………29

Figure 11. Means for enjoying participating ……………………30

Figure 12. Means for enjoying being challenged by mental tasks ……………………31

Introduction

A long line of research suggests that when an individual is faced with a task, the potential to confirm or disconfirm a stereotype about one's group can hinder their typical performance (Steele & Aronson, 1995; Spencer, Steele, & Quinn, 1999). This phenomenon is known as stereotype-threat (STT) (Steele & Aronson, 1995). In a classic example, women reminded of the stereotype that women are "bad at math" underperformed on a math test relative to those who were not under threat (Spencer et al., 1999). By manipulating test difficulty and instructions (sex biased vs sex neutral), researchers found evidence that performance discrepancies between men and women on math tests reflect stereotype-threat rather than a difference of ability (Spencer et al., 1999). This finding is not unique to sex-based stereotypes, and STT has been noted in many different stereotyped groups (Spencer et al., 1999; Steele, & Aronson, 1995).

In the case of older adults, there is a widely held stereotype that all older individuals have declining physical and cognitive abilities (Barber, 2017). Such attitudes have been shown to negatively impact both the physical health, and cognitive performance of older adults (Barber & Mather, 2014). In the case of cognition, many aging stereotypes tend to focus on a negative relationship between advanced age and memory function. While research shows that age-related memory decline is a reality for many, the stereotypes surrounding aging and memory are often exaggerated (Levy, 2003). Further to this, aging stereotypes are not solely held by younger people; across the lifespan, people of all ages are more likely to link memory problems to older adults' abilities (Barber, 2017; Levy, 2003). In a study that examined perceptions of memory failure in older and younger adults, participants attributed memory lapses in younger adults to effort and whether they were 'trying' (Erber & Rothberg, 1991). Conversely, when participants witnessed the same memory failures in older adults, errors were attributed to capabilities (Erber & Rothberg, 1991). That is, even when the same memory lapses occur in younger adults, only older adults' memory failures are attributed to mechanisms beyond their control (Erber & Rothberg, 1991; Levy, 2003).

Negative aging stereotypes are often held on a hidden (implicit) level, regardless of one's expressed beliefs (Levy, 2003). Research has shown that even preschool aged children are able to identify physical and behavioural aging stereotypes (Seefeldt, Jantz, Galper, & Serock, 1977). Further to this, young children also express apprehension about growing old (Levy & Banaji, 2002; Seefeldt, Jantz, Galper, & Serock, 1977). It is likely that the stereotypes learned in childhood are accepted as the norm of what it means to be an older adult. The cumulative exposure to negative aging stereotypes throughout one's life, may result in one holding implicit biases about their age group and themselves. Thus, the stereotypes learned in childhood become self-stereotypes as we age (Levy, 2003). Even when older adults view themselves as an 'exception to the rule' (Levy & Banaji, 2002), the implicit nature of stereotypes makes it difficult to determine how such beliefs influence cognition.

Previous work has shown that the language typically used in memory experiments may be enough to induce STT in older adults (Rahhal, Hasher, Colcombe, 2001). To explore the effect that instructions have on older adults, Rahhal, Hasher and Colcombe (2001) asked older adults to study the veracity of a list of trivia items for later use. During the learning phase, the researchers manipulated task instructions, with one set of instructions similar to those typically found in memory experiments. These instructions explicitly stated that the participants' memory for the trivia items would be tested. A separate set of instructions acted as a 'memory neutral' condition and framed the task as a test of participants' learning. The results showed that when the experiment was framed as a memory test, older adults underperformed compared to younger adults. However, when the instructions were memory neutral, no age differences were found. This research demonstrates that when emphasis is placed on memory, an area thought to decline with age, older adults experience performance difficulties.

The relationship between age, memory, and stereotype-threat salience was also demonstrated across a series of studies by Chasteen and colleagues (2005). Once again, researchers manipulated task instructions given to older adults. Older adults were either directly asked to remember a list of behavioural descriptions (remember condition) or asked to form impressions of the descriptions (impression condition) in the list. Across a series of studies, participants in the remember condition underperformed those in the impression condition on subsequent memory tests (Chasteen, Bhattacharyya, Horhota, Tam, & Hasher, 2005). Perceived STT (reported via questionnaire) was shown to mediate the relationship between participant age and memory performance. That is, the relationship between aging and memory can be partly explained by one's perceived experience of stereotype threat (Chasteen et al., 2005).

Research has shown that older adults do not exhibit the same patterns of age-related memory decline across all memory domains (e.g., Craik & Byrd, 1982). For instance, in a series of experiments by Light and Singh (1987), younger and older adults performed incidental encoding tasks followed by tests of implicit (automatic) and explicit (controlled) memory. Results indicate that while explicit memory was lower in older adult, implicit memory was relatively stable (Light & Singh, 1987).

Research also suggests that the neural mechanisms behind implicit and explicit memory processes differ (Stevens, Wig, & Schacter, 2008). Thus, separate memory processes may be differentially affected by STT. For example, reminding older adults of negative aging stereotypes has been shown to result in underperformance on controlled, but not automatic, memory retrieval (Mazerolle et al., 2012). In a 2012 study, older adults were required to read and remember a list of words for a subsequent memory test; they were given instructions that either highlighted or minimized age-related memory stereotypes (Mazerolle et al., 2012). Controlled and automatic memory processes were distinguished by using a variant of Jacoby's process dissociation procedure (1991). Specifically, participants completed a series of word stems wherein half of the stems required participants to recall words from their studied word list (inclusion stems), and the other half required them to generate new words (exclusion stems). This procedure allows for estimates of controlled and automatic retrieval to be calculated based on participants' responses to the word stems (Jacoby, 1991). Inclusion stems are thought to rely on both automatic and controlled retrieval, with any response being acceptable. In contrast, exclusion stems require controlled retrieval, and recalling a studied word in this case suggests a failure of one's controlled processes (Jacoby, 1991).

Mazerolle et al. (2012) found that older adults' controlled retrieval was worse in the threatened condition compared to the threat-eased condition, whereas their automatic retrieval appeared to increase in the threatened condition. This finding suggests that stereotype threat may differentially influence controlled and automatic processes.

Hypothesized mechanisms of stereotype threat:

There are several proposed mechanisms of STT. A common explanation throughout the literature suggests that STT increases off-task cognitive processes such as performance monitoring and intrusive thoughts (Popham & Hess, 2013; Maillet & Schacter, 2016). Engaging in performance monitoring often involves a trade-off by which individuals slow down to be more diligent and increase their overall score (Brodish & Devine, 2009; Popham & Hess, 2013). However, this heightened vigilance may still come at a cost to one's performance. For example, women exposed to the stereotype that women are bad at math were shown to avoid performance errors by attempting fewer math problems (Brodish & Devine, 2009). Whereas tackling fewer math problems can help minimize errors, making fewer attempts can still lower one's performance, as unanswered questions are typically considered wrong.

Older adults have also been shown to monitor their performance when under stereotype threat (Hess, Emery, & Queen, 2009). For example, in a 2013 study by Popham and Hess, older adults performed a simple letter-cancelling task (cross out all the e's on a sheet of random letters) under either a stereotype-threatened or stereotype-eased condition. In this study, fake news articles were used to manipulate the salience of STT. Participants were asked to either read an article confirming negative aging stereotypes or one that minimized age-related memory concerns. Older adults in the threatened condition showed decreased speed, but increased accuracy on the letter-cancelling task compared to the threat-eased group, suggesting that older adults respond to STT through increased performance monitoring (Popham & Hess, 2013).

Related work from the mind-wandering literature suggests that compared to younger adults, older adults show greater interest and motivation when completing experimental tasks (Maillet & Schacter, 2016). Increased motivation may result in older adults engaging in more self-evaluations and performance monitoring during tasks (Maillet & Schacter, 2016). Such thoughts, known as task-related-interference, increased under stereotype-threat (Jordano & Touron, 2017). In a 2017 study, older adults were exposed to memory-related stereotypes by having participants read fake news articles designed to highlight or downplay age-related stereotypes (Jordano & Touron, 2017). Using thought probes, researchers tested whether older adults under threat experienced more task-related interference during a working memory test. In addition to the STT group having lower recall accuracy than a comparison group, they also reported more task-related-interference (Jordano & Touron, 2017). That is, older adults who were under stereotype-threat performed significantly worse on a working memory task, while simultaneously spending more time worrying about how they were doing on the task compared to a threat-eased group.

Older adults report more anxiety when having their memory tested, and emotion regulation plays a role in dealing with such worries (Chasteen et al., 2005; Johns, Inzlicht, & Schmader 2008). Emotion regulation refers to the ability to control one's feelings and reactions to a given situation (Gaffey, Bergeman, Clark, & Wirth, 2016). Research has demonstrated that participants faced with stereotyping situations engage in spontaneous suppression of the negative emotions that arise (Johns et al., 2008). That is, they actively attempting to cope with the arousal and negative feelings brought on by the testing conditions. The researchers went on to demonstrate that the reappraisal of one's performance anxiety (attributing the feeling of anxiety to another source) was beneficial to their cognitive performance (Johns et al., 2008). Without reappraising the situation, individuals may ruminate on their negative feelings, increasing and prolonging the physical arousal associated with the psychosocial stressor (Zoccola, Dickerson, & Zaldivar, 2008).

Stereotype-threat and Arousal

In addition to the cognitive mechanisms discussed thus far, stereotype threat may also increase arousal, which in turn affects performance (Vick, Seery, Blascovich, & Weisbuch 2008). For instance, men and women completed a math test described as either biased (threated condition) or fair (eased condition) to women. Cardiovascular measures were collected while participants performed the test. In the eased condition, women experienced cardiovascular activity associated with challenge (Vick et al., 2008). In contrast, when testing conditions mentioned gender biases, the cardiovascular pattern in the threatened group showed an increase in cardiac output and a decrease in vascular resistance - a pattern associated with being under threat (Vick et al., 2008). This finding suggests that when participants were eased about stereotypes facing their group, they saw the math test as challenging, whereas when participants were concerned about confirming group stereotypes, they showed a physiological pattern associated with threat.

Similarly, threatening, or stressful situations result in increased activity in one of the major neuroendocrine systems, the hypothalamic-pituitary-adrenal (HPA) axis (Lupien et al., 2005; McEwen, 2012). The HPA axis works to maintain homeostasis, adjusting the body to both external and internal pressures by releasing cortisol, a stress hormone that mediates numerous metabolic processes (Lupien et al., 2005; Fries, Dettenborn, & Kirschbaum, 2009). Cortisol has widespread activation throughout the body and influences processes such as immune function, systemic and cerebral energy mobilization, and cognition (see McEwen & Seeman, 1999 for a more thorough discussion).

Psychosocial stressors, such as public speaking (Zoccola et al., 2008) and threats against one's identity (Townsend, Major, Gangi, & Mendes, 2011), have been shown to increase salivary cortisol. In a 2011 study, women who faced rejection based on sexism experienced an increase in cortisol, and engaged in active emotion coping strategies compared to women who were rejected based on merit (Townsend et al., 2011). Furthermore, studies investigating the role of STT on women's math performance have shown that women exhibited an increase in salivary cortisol after being given instructions on a math test in conditions consistent with STT activation (Rivardo, Rhodes, Camaione & Legg, 2011). The researchers suggested that the act of identifying one's sex, combined with the instructions for the math test, induced a stress response in the women (Rivardo, et al., 2011).

In a related study, changes in salivary cortisol were found in older adults when faced with conditions consistent with stereotype-threat activation (though not specifically designed to look at STT; Sindi et al., 2013). Sindi and colleagues (2013) examined the role of testing environment on salivary cortisol and recall. They used two environments: one favouring young adults, the other favouring older adults. The environment favouring older adults took place in a health care setting (Douglas Mental Health University Institute). In this condition, older adults were invited to the facility the day before testing, allowing them to become familiar with the environment. Further, the research assistant was an older individual (72 years old) who chatted with participants for a rest period before testing began. The youth-favouring environment took place in a psychology lab at McGill University, the research assistant was a young graduate student, and there was no pre-test acclimation period the day before testing. The second environment was similar to standard testing conditions in cognitive psychology research. Cortisol concentrations were collected in the participants' homes (to establish an at-home baseline) and in each testing environment.

Older adults showed higher cortisol levels in the youth-favouring environment compared to their at-home baseline. Further, older adults in the youth-favouring setting had worse performance on a delayed recall task compared to older adults in the old-favouring environment. Although there was no direct manipulation of STT, this work suggests that older adults in a STT-like situation experience increased arousal, which may affect their memory performance.

Thus, although many studies have shown that older adults' memory can be influenced by STT, no study to date has directly examined the influence of STT on salivary cortisol and the relationship between STT-induced cortisol changes and memory in healthy older adults.

The Current Study

In this study, we examined the relationship between STT, cortisol, and implicit/explicit memory in older adults. To this end, we adapted the paradigm used by Light & Singh (1987) to measure implicit and explicit memory within the same experiment. Community-dwelling older adults first completed an incidental encoding task wherein they rated a list of words in terms of pleasantness, unaware that their memory for these words would later be tested. To manipulate the salience of STT, older adults were given an article designed to activate or ease age-related memory stereotypes. After STT induction, implicit and explicit memory tests were given. Implicit memory was tested using a word stem completion task, and explicit memory was tested via free recall and forced choice recognition. To assess whether salivary cortisol levels differed between threat conditions, I obtained saliva samples at two timepoints: 1) before encoding (prior to threat manipulation) and 2) after memory testing was complete.

Hypotheses

Given that STT has been shown to impede controlled, but not automatic retrieval (Mazerolle, 2012), we hypothesized that older adults in the STT-activated condition would do worse than those in a STT-eased condition on the explicit memory tasks (free recall and recognition). In contrast, we expected that implicit memory would be relatively unaffected by STT manipulation. Furthermore, we predicted that individuals in the STT-activated condition would show increased levels of salivary cortisol compared to those in the STT-eased condition. Finally, we hypothesized that the change (across time points) in salivary cortisol would correlate with explicit memory in the threatened group, such that those who were more stressed by the STT manipulation would show worse explicit memory.

Methods

Participants

Initial sample size was based on previous studies examining salivary cortisol in response to psychosocial stressors (Sindi et al., 2013), but data collection is ongoing because studies looking at STT in particular tend to use larger samples (see Popham & Hess, 2013 for an example). Sixty-six participants were tested; however, four participants were excluded from all analyses. Two participants were excluded based on a MOCA score more than 2 standard deviations below the group mean (M = 25.68, SD = 2.50), one withdrew from the study and one was intoxicated at the time of testing. The final sample consisted of 62 healthy older adults, including 32 women (M = 69.44 yrs, SD = 5.69) and 30 men (M = 71.1 yrs, SD = 3.80). One male participant neglected to provide his age.

Men and women over 60 years old were recruited through Brock University's community research pool, Growing with Brock (GWB). Participants had to be fluent in English and able to use a standard keyboard. To screen for medical and psychological history that may influence cortisol levels, participants underwent a telephone screening interview. Exclusion criteria included: self-reports of severe chronic illness, medications intended to balance hormones (i.e. hormone replacement therapy), antipsychotics, and smoking. Participants provided written consent to take part in the study prior to beginning.

Materials

Demographic and Health Screening Questions

Before testing, participants were given a demographic and health questionnaire (Appendix A). In addition to typical demographic information, the questionnaire gathered details regarding language abilities, education, occupation/retirement status, wake-up time, as well as health information such as acute/recent illnesses, major illnesses (e.g., cancer, stroke) and current medications. Many of these factors have previously been shown to influence STT and/or cortisol, and thus the information was collected to be used as covariates in the analyses as necessary.

Images of Aging

The Images of Aging Scale (Appendix B) has been found to have good reliability and validity in assessing both the positive and negative stereotypes associated with aging (Levy, Kasl, & Gill, 2004). Participants rate a number of words that are associated with positive (e.g. wise, family-oriented) and negative (e.g. slow-moving, dying) aging stereotypes. The scale ranges from 0 to 6, and participants rate how well each word fits their image of an older person (with 0 being 'furthest from what you think' and 6 being 'closest to what you think'). Positive and Negative Images of Aging scores are then calculated by adding up the ratings for all words with either positive or negative valence (Levy et al., 2004). This results in two separate scores for each participant, which can range from 0-54; a high score on either scale suggests that the participant attributes more of those characteristics to older adults.

Performance Expectation Questionnaires (A/B)

For exploratory purposes, two questionnaires were designed to assess how participants felt about their performance on cognitive tasks. Participants rated performance related statements from 0 = "furthest from how I feel" to 6 = "closest to how I feel" (see Appendix C for statements). Version A was given before beginning the study and involved participants' describing how they typically perform on cognitive tasks. Version B was given after the tasks were completed (therefore also after the stereotype threat manipulation) and involved the same questions but was specific to the tasks completed during the present study.

Stereotype Threat Manipulation

Participants were randomly assigned to a stereotype-threat activated (STT-activated) or a stereotype-threat eased (STT-eased) condition. To manipulate stereotype threat, participants were assigned one of two fake news articles (Appendix D) that they were asked to read and to answer questions about their comprehension of the content (adapted from the methods of Wong & Gallo, 2016). Participants were told that their ratings were for future use. The STT-activated article suggested that age-related memory decline is inevitable, whereas the STT-eased article explained that individual differences occur, and many older adults maintain memory abilities by staying cognitively active.

Word Lists

Two lists of 20 target words were selected from the Toronto Word Pool (see Appendix E). These word lists were modelled after the stimuli used in Light & Singh (1987). Words consisted of 5 or 6 letters and were balanced for Kucera-Francis Frequeny, Subtlex US Frequency Rating, and number of possible solutions to their 3-letter work stems. Paired comparisons showed there were no significant differences between the word lists on any of these factors p's >.05. Twelve filler words were also selected for the encoding phase that did not appear in the subsequent word-stem completion task and did not overlap with the word stems of the target words. There were also three practice words that did not appear in the testing material and had no word-stem overlap with the target words.

Montreal Cognitive Assessment

The Montreal Cognitive Assessment (MoCA) is a widely used, highly sensitive test for cognitive impairment (Nasreddine et al., 2005) and was used to screen for cognitive impairment in our sample. The test (Appendix F) measures multiple cognitive domains that may be affected by cognitive impairment. Specifically, tasks assess: short-term memory; visuospatial abilities; executive functioning; attention, concentration, and working memory; language abilities; and time/place orientation (Nasreddine et al., 2005). Scores on the MoCA range from 0-30, with higher scores suggesting better cognitive performance.

Procedure

All procedures and materials used for this study were approved by Brock University's Research Ethics Board (file number: 17-215). Testing took place between 1:00PM-5:00PM to minimize circadian variation in cortisol concentrations (Engert et al., 2011). The study was conducted in a single, one-on-one session with a researcher from the Campbell Neurocognitive Aging Lab. Upon arriving at the lab, participants were familiarized with the testing environment and were given the consent form (Appendix G) to complete. Participants were given the background questionnaire, which involved information on demographics, health, and current medications. This measure was followed by the Images of Aging Scale, and Performance Expectation A. This portion of the procedure took approximately 20 minutes, to allow participants to acclimate to the testing environment (for a full timeline of the study procedure, see Appendix H).

Immediately after the initial questionnaires, participants provided the first saliva sample (Saliva1). Participants were instructed to place the saliva collection swab in their mouth for two minutes without chewing. The swab was returned to the tube and placed in a lab freezer (-20°C) until assays were run.

Participants then completed an incidental encoding task, which was presented as a word-rating task (Light & Singh, 1987). Words from one of the two target lists were presented in uppercase letters, with a scale ranging from 1 (very pleasant) to 7 (very unpleasant) presented below. Participants were told that the lists were being rated for future research; they were not instructed to remember the words. Participants had up to 5 seconds to respond to each word, with a response terminating the trial (followed by a fixation cross for 500 ms). The study list began with a primacy buffer of six filler words, followed by the 20 target words in a random order, and concluding with a recency buffer of six filler words. Participants were instructed to read the presented word, consider its meaning, and provide a rating.

Participants were pseudorandomly assigned to a stereotype-threat activated (STT-activated) or a stereotype-threat eased (STT-eased) condition, ensuring an equal number of men and women were assigned to each group. To manipulate stereotype threat, participants were assigned a fake article and instructed to read the article and then answer questions about their comprehension of the content (articles adapted from Wong & Gallo, 2016). Again, participants were told that their ratings/opinions of the article were for future use.

After reading the passages, participants completed three memory tasks: 1) an implicit word-stem completion task (5 minutes), 2) an explicit free-recall task (3 minutes), and 3) an explicit two-alternative forced choice recognition task (Light & Singh, 1987). On the 3-letter word-stem completion task (Light & Singh, 1987), participants were presented with 20 three-letter stems that could be solved with target words seen during the pleasantness rating task, and 20 that could be solved with words from the alternate target list (which was not seen during the individual participant's session). Participants' solution rates for the unseen list were used to calculate a baseline completion rate for each list. All 40 stems were presented on a single sheet of paper. Participants were instructed to fill in the blank with the first word that came to mind. Implicit memory scores were calculated as the number of stems completed using target words minus the baseline completion rate for that list. In Tasks-2 and -3, explicit memory was measured. In line with the methods used by Light & Singh (1987), Task-2 required participants to freely recall as many words as they could from the pleasantness rating task. They were instructed to recall the words aloud and the researcher would record their response. Only target words were considered correct (i.e., not primacy/recency buffers or practice words). In Task-3, participants were given 20 pairs of words (at a rate of 5 seconds/pair) with one word having been seen/rated by the participant and the other word from the alternate target list. They were instructed to choose the previously seen word from each pair and to guess if necessary. Recognition scores represent the percent correct on the forced choice trials.

Upon completion of the memory tasks, participants provided a second saliva sample (Saliva2) using the same technique as for Saliva1. They were then given

Performance Evaluation B followed by the MoCA and Shipley. Finally, the participants were debriefed about the study.

Saliva sampling & assay protocol

Salivette collection devices from Sarstedt Inc. were used to collect samples from participants across two time points (at encoding and immediately following memory testing). Salivary cortisol concentrations were determined using enzyme-linked immunosorbent assay (ELISA) kits from DRG International and a Biotek Synergy plate reader. After collection, samples were stored at -20°C until assays were conducted. Samples were centrifuged at 4°C and 1500 x g for 15 minutes. For the full protocol, consult DRG Salivary Cortisol ELISA instruction manual (DRG International, Springfield, NJ). Samples were run in duplicate, inter-assay coefficient of variability (CV)was less than 12% and intra-assay CV was less than 7%. When there was insufficient saliva for duplicate sampling, the single processed sample was used as a measure for that time point, when volume permitted duplicate analysis, an average of the two readings calculated and used for the concentration at that timepoint.

Statistical analyses

Statistical analyses were conducted in IBM SPSS version 25 with an alpha of $p < .05$ signifying significance. Behavioural measures of interest (i.e., implicit memory, recall, and recognition accuracy and reaction times) were submitted to separate analyses of variance (ANOVAs) with both STT Condition (Activated, Eased) and Sex (Male, Female) as between-subjects factors. Salivary cortisol levels were submitted to a mixed ANOVA with STT Condition (Activated, Eased) and Sex (Male, Female) as between-subjects factors and Time (pre-, post-manipulation) as a within-subject factor. Sex was included as an exploratory variable of interest in these analyses because cortisol levels are known to differ between men and women (Wolf, Schommer, Hellhammer, McEwen, & Kirschbaum, 2002), and the sexes may differ in their cortisol reactivity to psychosocial stressors (Wolf et al., 2002). Follow-up t-tests were used to explore interactions when justified. Correlation analyses between performance (implicit memory, free recall, recognition reaction times) and salivary cortisol levels were initially conducted across all participants, and then split by sex for exploratory analyses where indicated.

Results

To determine whether the eased and activated groups were matched on a number of variables known to influence STT and/or cortisol, a series of ANOVAs were conducted on the continuous variables, and a chi-square analysis was used to assess the categorical variable of sex. The results of this quality control check are presented in Table 1.

Table 1

Participant demographic and descriptive statistics

Variables	Condition	Mean	SE	Statistics *F*	p-value
Time awake	Eased	7.28	0.27	0.05	0.831
	Activated	7.20	0.26		
Baseline Salivary Cortisol	Eased	2.48	0.37	0.47	0.50
	Activated	2.13	0.35		
Overall health	Eased	8.52	0.22	0.10	0.748
	Activated	8.62	0.21		
Number of days bothered by illness	Eased	7.77	3.88	0.14	0.707
	Activated	5.76	3.64		
Total years of education	Eased	15.02	1.15	1.70	0.199
	Activated	17.08	1.08		
Time between samples	Eased	21.73	0.80	0.53	0.472
	Activated	22.52	0.75		
Age	Eased	70.59	1.12	0.02	0.881
	Activated	70.36	1.05		
MoCA score	Eased	25.86	0.57	0.00	0.976
	Activated	25.84	0.53		
Shipley	Eased	34.82	0.59	0.11	0.746
	Activated	35.08	0.55		
IA - Positive	Eased	39.32	1.69	0.47	0.495
	Activated	37.72	1.59		
IA - Negative	Eased	21.55	2.07	0.41	0.524

	Activated		19.72	1.95		
				N	**Chi-Square**	**p-value**
Sex	Eased	Men		15	0.06	0.806
	Eased	Women		15		
	Activated	Men		15		
	Activated	Women		17		

Note: SE = standard error; time awake reflects the hours between self-reported typical wake-up time and the time of testing; overall health was self-reported on a scale from 1 (poor) to 10 (excellent); number of days bothered by illness is over the 6-month period before testing; education represents the sum of years of education from grade school through post-secondary; IA – Positive/Negative refers to scores on the Images of Aging questionnaire subscales (0-54).

Table 2 provides an overview of the descriptive statistics for implicit and explicit memory measures by STT condition and participant sex.

Table 2

Means and standard errors for implicit and explicit memory scores by STT condition and sex

			Memory Means & Std. Error			
STT Condition	**Sex**	**N**	**Implicit**	**SE**	**Explicit**	**SE**
Activated	Male	15	2.13	0.89	1.47	0.52
	Female	17	1.47	0.56	3.06	0.42
Eased	Male	15	2.47	0.67	1.80	0.53
	Female	15	1.40	0.69	2.73	0.57

Note: SE = Standard error

Implicit memory

To examine the role of STT on implicit memory, a 2 (STT Condition: Activated, Eased) by 2 (Sex: Males, Females) ANOVA was conducted. The ANOVA showed no effect of STT condition, F (1,58) = 0.35, p= 0.853, or sex (F (1,58) = 1.51, p= 0.225), and no interaction between them, F (1,58) = 0.08, p= 0.775, on implicit memory scores (See Figure 1).

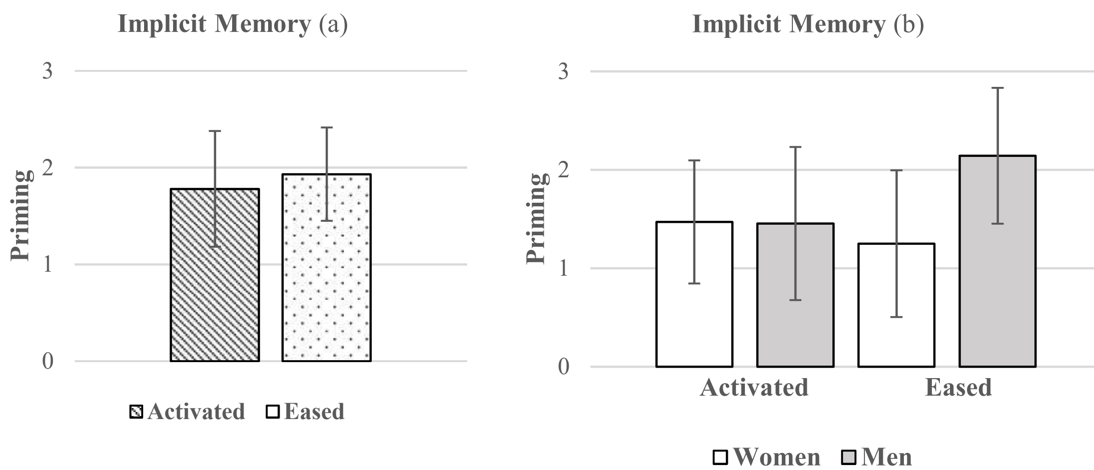


Figure 1. Mean (+/- S.E.M.) priming on word stem completion task by STT condition(a) and sex (b). Priming represents the total number of word stems completed with target words, minus the baseline completion rate for that list.

Explicit memory

To assess the effect of STT on explicit memory, the number of target words recalled, recognition accuracy, and recognition reaction time (ms) were submitted to separate 2 (STT Condition: Activated, Eased) by 2 (Sex: Males, Females) ANOVAs. For free recall, the main effect of STT condition was not significant, F (1,58) = 0.00, p= .994, η_p^2 = .000, but there was a main effect of sex, F (1,58) = 6.21, p= 0.016, η_p^2 = .097, with older women (M = 2.91, SD = 1.94) recalling more target words than older men (M =

1.63, *SD* = 1.99). The interaction between STT condition and sex was not significant, *F* (1,58) = .42, *p*= .518, η_p^2 = .007.

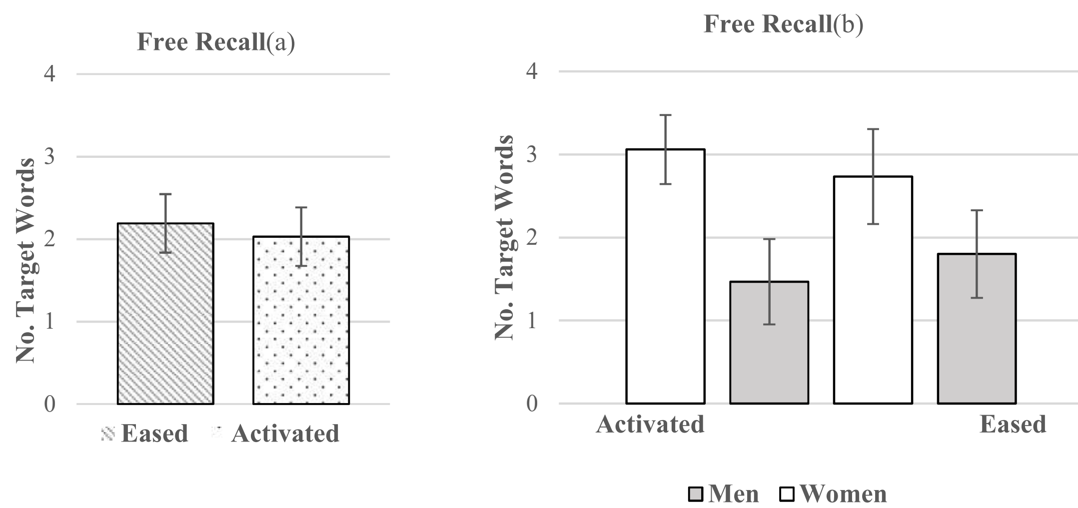


Figure 2. Mean (+/- S.E.M.) target words recalled during 3-minute free recall period by STT condition(a) and sex (b).

For recognition accuracy, the main effect of STT condition was not significant, *F* (1,58) = .11, *p*= .737, η_p^2 = .002. There was also no effect of sex, *F* (1,58) = .14, *p*= .706, η_p^2 = .002, nor was there an interaction between STT condition and sex, *F* (1,58) = 1.63, *p*= .207, η_p^2 = .027, on recognition accuracy.

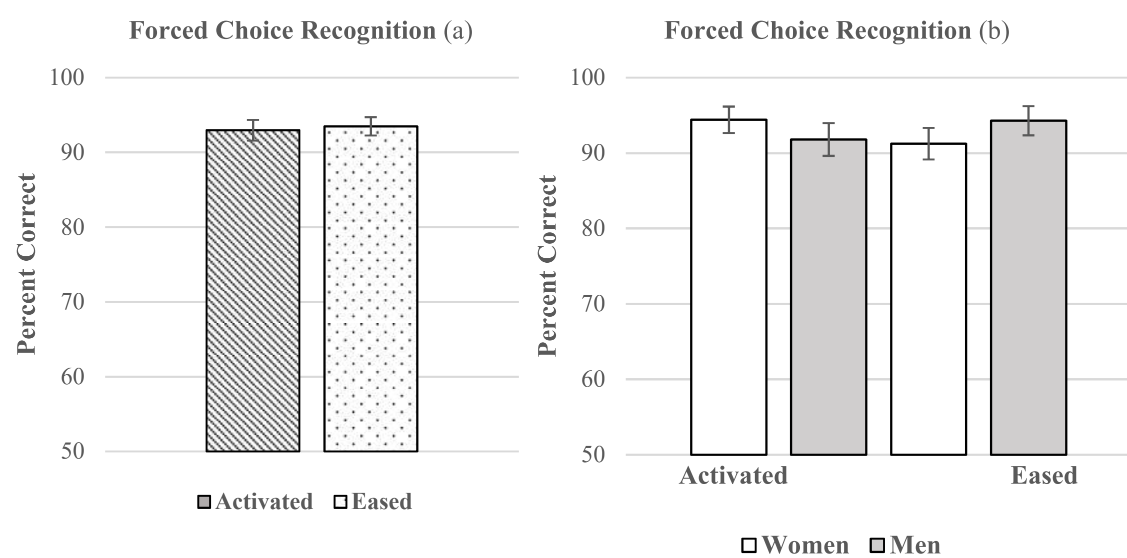


Figure 3. Mean (+/- S.E.M.) percent correct during forced choice recognition task by STT condition(a) and sex (b).

The average reaction times associated with the forced choice recognition task were trimmed at 2.5 SD +/- the mean for each participant. Only correct trials were used for the reaction time calculations. On average fewer than 10% of trials were trimmed for each participant. There was no effect of STT condition on recognition reaction times, F (1,58) = 1.32, p= 0.255, $\eta_p^2 = .022$). However, there was a main effect of sex, F (1,58) = 4.60, p= 0.036, $\eta_p^2 = .073$), with older women (M = 1718.22 ms, SD = 325.56) responding faster than older men (M = 1899.21 ms, SD = 348.69). The interaction between Condition and Sex was not significant, F (1,57) = 2.10, p= 0.153, $\eta_p^2 = .035$.

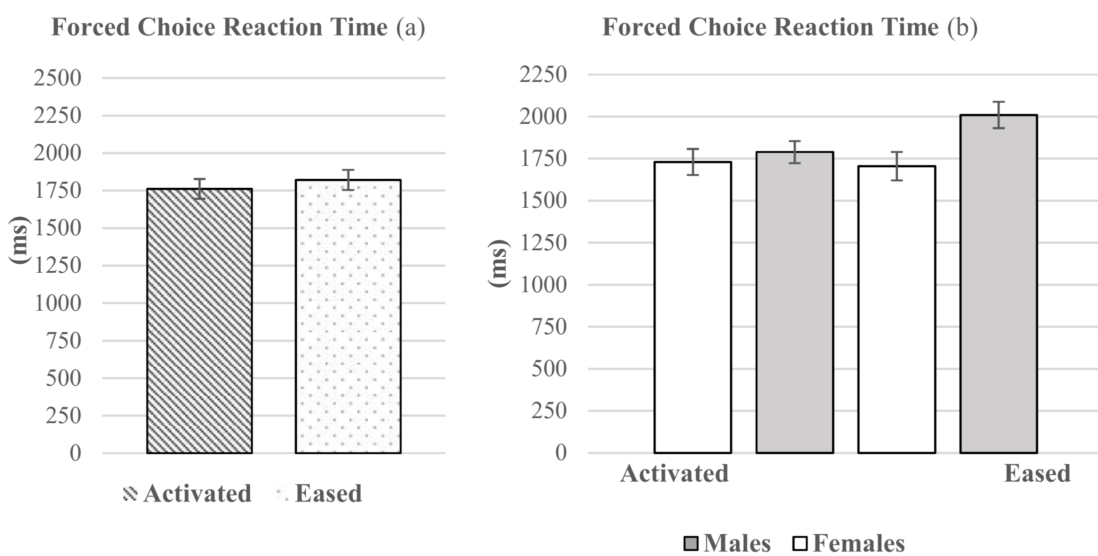


Figure 4. Mean (+/- S.E.M.) reaction time (ms) during forced choice recognition trials by STT condition(a) and sex (b).

Cortisol

Seven participants were removed from the salivary cortisol analyses due to insufficient saliva volume collected at testing, and another participant was excluded from the analyses due to average salivary cortisol levels exceeding 3 standard deviations of the mean across multiple measures. A mixed ANOVA testing a 2 (Time: Pre-manipulation, Post-manipulation) by 2 (STT Condition: Activated, Eased) by 2 (Sex: Males, Female) was conducted on the remaining 54 participants.

Within subjects, there was no effect of time, F (1,50) = 1.62, p =.209, time by sex interaction, F (1,50) = 0.721, p =.400, time by STT condition interaction, F (1,50) = 1.05, p =.310, or time by sex by STT Condition interaction, F (1,50) = 0.79, p =.380, on salivary cortisol concentration. Similarly, between subjects there was no main effect of STT condition on salivary cortisol, F (1,50) = 1.69, p =.199. However, a main effect of sex was found, F (1,50) = 6.83, p =.012, η_p^2 = .120, with older men (M = 2.45 ng/mL, SE = 0.23) showing a higher concentration of salivary cortisol than showed older women (M = 1.60 ng/mL, SE = 0.23).

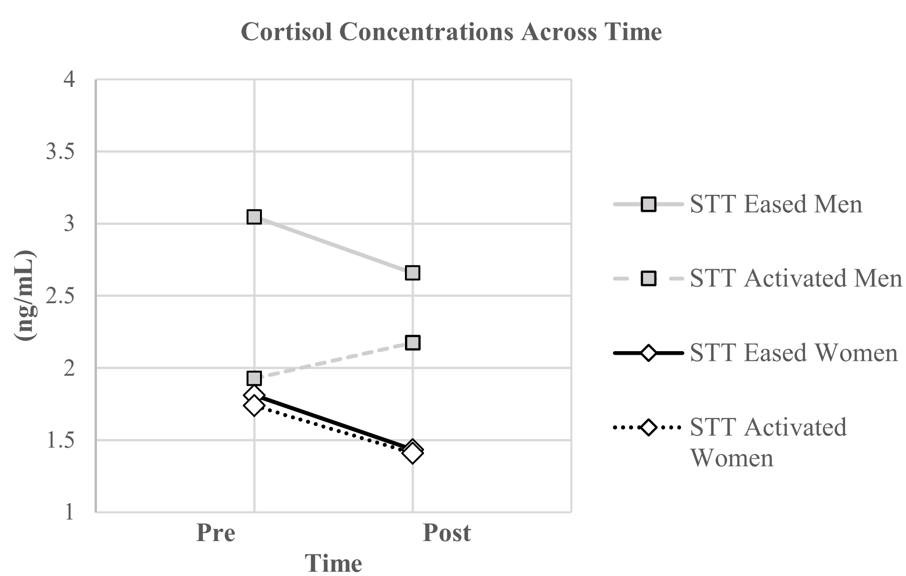


Figure 5. Estimated Marginal Means of salivary cortisol (ng/mL) by participant sex and STT condition.

Correlation of cortisol with performance

Because there was no effect of time or threat manipulation on cortisol levels, the subsequent analyses used average cortisol across the two time points and collapsed across STT groups to test the relationship between cortisol and performance. There was a negative correlation between average salivary cortisol concentration and the number of target words recalled (r = -.344, p = .011), such that higher cortisol levels related to poorer recall (Figure 6). The correlation between cortisol and recognition accuracy was not significant (r = -.032, p = .834), though this is likely explained by limited range (near ceiling) values obtained for recognition accuracy. There was no correlation between cortisol and the average reaction time on the forced choice recognition task (r = .234, p = .089).

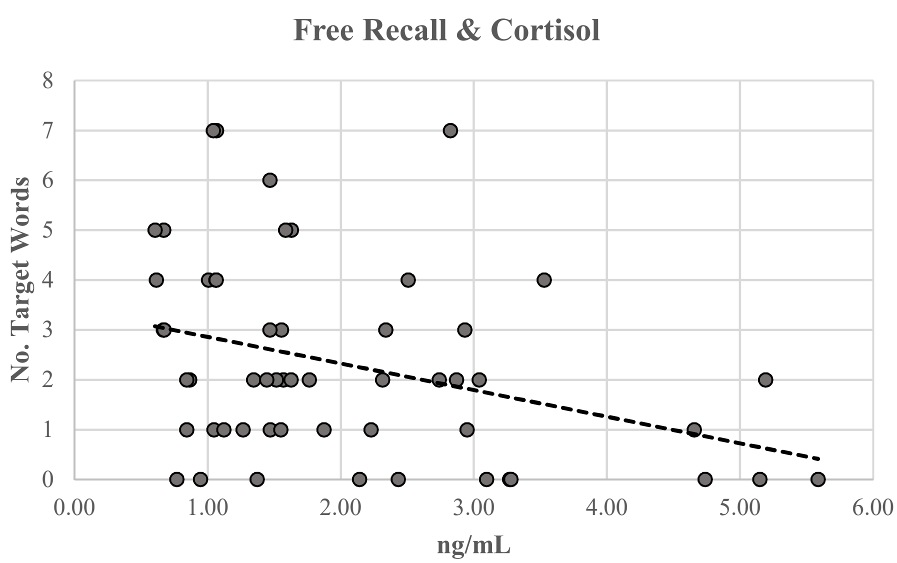


Figure 6. Correlation between cortisol concentration (ng/mL) and target word recall.

Because there was a significant effect of sex on cortisol concentrations, correlations were also assessed separately for men and women. There was a significant correlation between cortisol and free recall in older men (*r* = -.401, *p* = .042), but not in older women, (*r* = .037, *p* = .850; see Figures 7 & 8). Further, an r to z transformation showed that these correlations were significantly different from each other, $z_{observed} = -2.39$, $p<.05$.

The correlation between cortisol and recognition accuracy was not significant for men (r = -.046, p = .822) or women (r = .085, p = .669) (again, this is likely explained by the limited range of recognition scores).

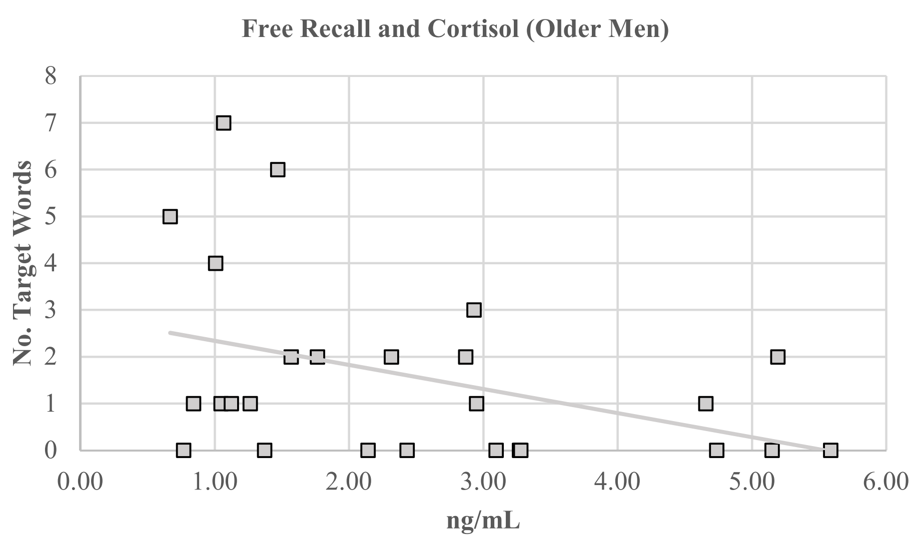


Figure 7. Correlation between cortisol concentration (ng/mL) and target word recall in older men.

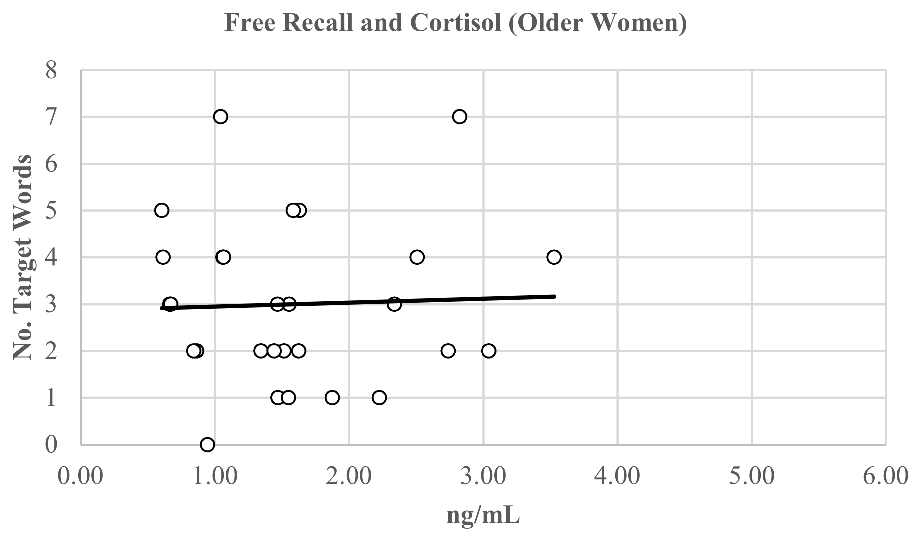


Figure 8. Correlation between cortisol concentration (ng/mL) and target word recall in older women.

Images of Aging

As an exploratory analysis, Negative and Positive Images of Aging (IA) scores were submitted to a 2 (STT Condition: Activated, Eased) by 2 (Sex: Males, Females) ANOVA. There was no effect of STT condition (*F* (1,58) = 1.24, p= 0.270), sex (*F* (1,58) = .34, p= 0.560), or interaction between the two (*F* (1,58) = 3.02, p= 0.087) on the negative IA ratings. For the Positive IA ratings, there was no effect of STT condition (*F* (1,58) = .15, p= 0.699), but there was a main effect of sex (*F* (1,58) = 4.05, p= 0.049, η_p^2 = .065), with older men (*M* = 40.37, *SD* = 8.82) rating positive age-related words higher than older women (*M* = 36.31, *SD* = 6.68, refer to Figure 8). There was no interaction between STT condition and sex (*F* (1,58) = .09, p= 0.76) on the positive IA ratings.

Subjective Experience (Questionnaires)

This summary is limited to statements that were rated significantly different across groups (refer to Appendix I for all subjective questions given to participants).

All ratings on the subjective performance questionnaires were submitted to a separate 2 (Condition: Activated, Eased) by 2 (Sex: Male, Female) ANOVAs. For the question "I agree with the statements made in the passage", there was a main effect of STT condition (F (1,57) = 6.98, p=.011, η_p^2 = .109), sex (F (1,57) = 6.12, p=.016, η_p^2 = .097) as well as a sex by STT condition interaction (F (1,57) = 11.10, p=.002, η_p^2 = .163). Follow-up analyses revealed that older women's agreement with the passage differed by condition, t (21.14) = -4.59, p<.001, 95%CI [-2.70, -1.01]. Those in the activated condition rated this statement further from how they felt (M = 3.41 SD= 1.54) than those in the eased (M = 5.27 SD= 0.59) condition. There was no difference in older men's responses across STT condition, t (28) = 0.604, p = .551, 95%CI [-0.64, 1.17].

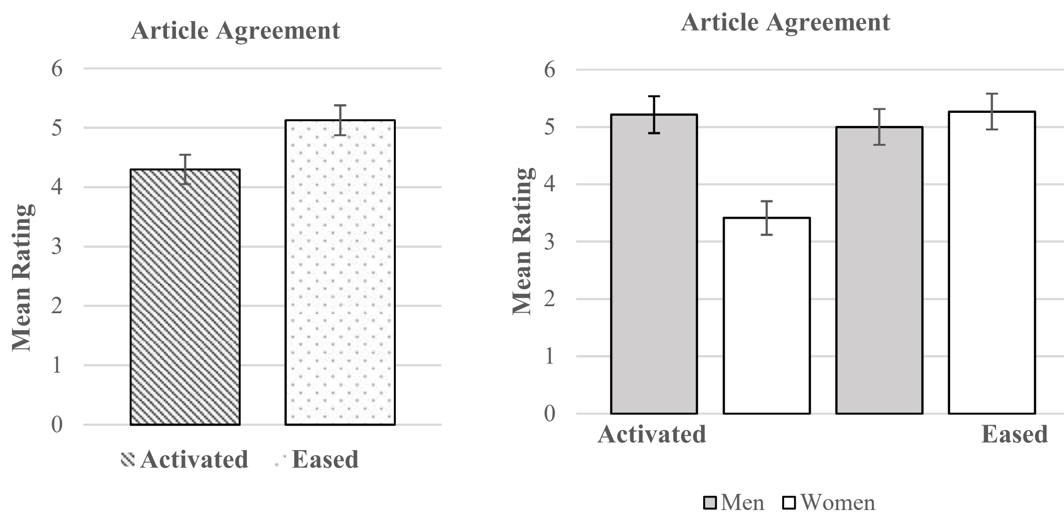


Figure 9. Estimated marginal means (+/- S.E.M.) for the question "I agree with the statements made in the passage." Ratings were from 0, "furthest from what how you feel" to 6, "closest to how you feel".

For the question "I found these tasks stressful", there was no main effect of sex (F (1,57) = 0.03, p=.872) or STT condition (F (1,57) = 1.20, p=.277). However, there was an interaction between sex and STT condition (F (1,57) = 5.44, p=.023, η_p^2 = .087). A follow-up analysis revealed that there was a significant difference between men and women in the eased condition, t (18.52) = -2.18, p = .042, 95%CI [-2.45, -0.05], such that men (M = 1.25, SD =1.01) found the task less stressful than women (M = 2.50, SD = 1.68). There was no difference in the STT activated condition, t (20) = .17, p = .867, 95%CI [-1.51, 1.78].

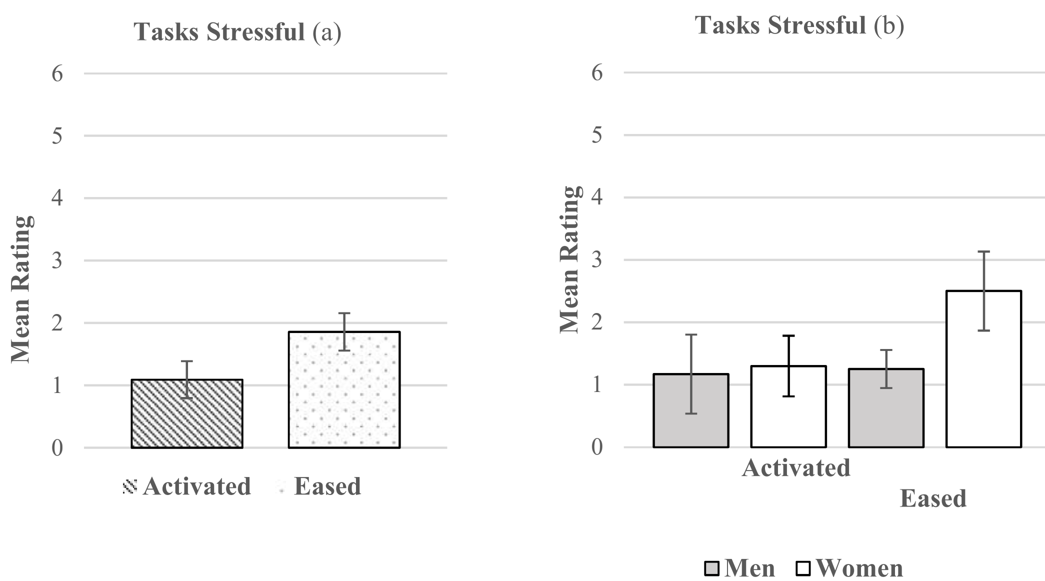


Figure 10. Means (+/- S.E.M.) for the question "I found these tasks stressful." Ratings were from 0, "furthest from what how you feel" to 6, "closest to how you feel" by STT condition(a) and sex (b).

A main effect of STT condition was found for the statement "I enjoyed participating in this research project" (F (1,57) = 7.29, p=.009, η_p^2 = .113). Participants in the activated condition (M = 5.81, SE = 0.17) rated this statement higher than those in the eased condition (*M* = 5.17, *SE* = 0.17). There was no effect of sex (F (1,57) = 1.42, p=.239, η_p^2 = .024) nor an interaction between sex and STT condition (F (1,57) = 1.82, p=.182, η_p^2 = .031).

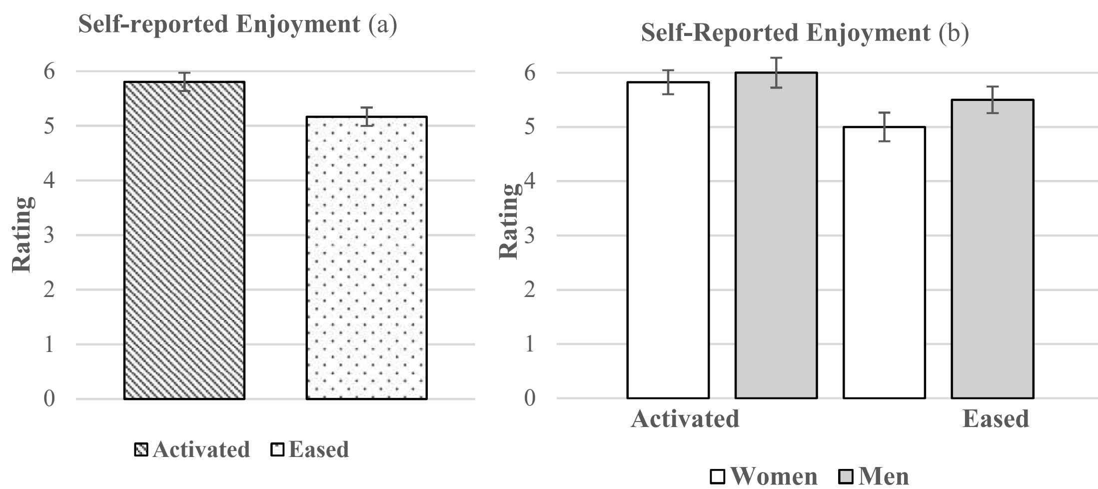


Figure 11. Means (+/- S.E.M.) for the question "I enjoyed participating in this research project." Ratings were from 0, "furthest from what how you feel" to 6, "closest to how you feel" by STT condition(a) and sex (b).

On the pre-manipulation question "I enjoy being challenged by mental tasks." there was a main effect of STT condition, F (1, 57) = 8.02, p =0.006, η_p^2 = .123. Those in the activated condition (*M* = 5.42, *SE* = 0.17) reported the statement higher than those in the eased condition (*M* = 4.73, *SE* = 0.17). This difference suggests that one STT group may have been more invested than the other, however both groups are above the neutral point of the scale. There was no effect of sex (F (1, 57) = 2.66, p =0.608, η_p^2 = .005) nor an interaction between sex and STT condition (F (1, 57) = 0.35, p =0.561, η_p^2 = .006).

For the statement "I believe I did well during testing today." there was no effect of STT condition (F (1, 57) = 0.10, p =0.749, *n2p* = .002) and no interaction between sex and STT (F (1, 57) = 0.02, p =0.902, $n2p$ = .000). However, there was a main effect of sex (F (1, 57) = 4.83, p =0.032, $n2p$ = .078). Contrary to the free recall difference between men and women, older men (M = 4.66, SE = 0.19) thought they did better on the tasks than older women (M = 4.09, SE = 0.18).

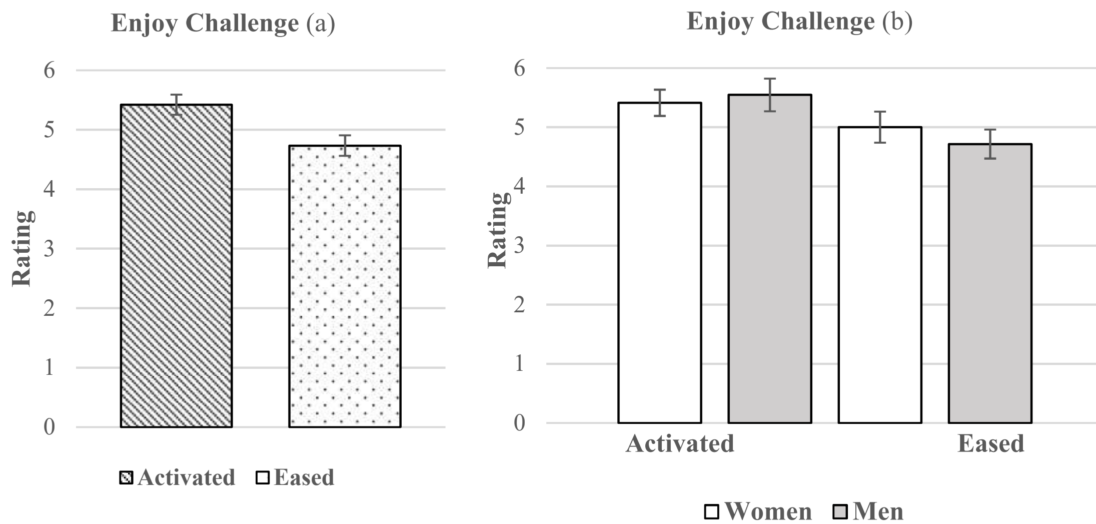


Figure 12. Means (+/- S.E.M.) for the question "I enjoy being challenged by mental tasks." Ratings were from 0, "furthest from what how you feel" to 6, "closest to how you feel" by STT condition(a) and sex (b).

Discussion

As the population ages, it is becoming increasingly important to accurately assess the normal (i.e., non-pathological) cognitive aging process. However, external factors such as STT may confound our understanding of memory processes in healthy older adults. With this in mind, the current study investigated the effects of STT on memory performance and salivary cortisol in older adults. The primary goal of this study was to determine whether aging stereotypes differentially affect implicit and explicit memory, and whether STT activation leads to increased cortisol levels in older adults. This study also aimed to further test the relationship between salivary cortisol and memory performance in older adults. To our knowledge, no studies have contrasted implicit and explicit memory performance and its relationship to cortisol under STT.

We found that STT had no effect on implicit or explicit memory. We expected STT to differentially affect controlled memory processes, such as those recruited by explicit memory tasks, and to have little impact on more automatic processes, such as those responsible for implicit memory (Mazarolle et al., 2012). However, our results indicate that older adults in the threat-activated and threat-eased groups performed similarly on both the implicit and explicit memory measures. We also found that STT had no effect on cortisol levels. We hypothesized that participants in the threat-activated condition would show an increase in cortisol compared to those in the threat-eased condition. However, there were no significant changes between pre- and post-manipulation cortisol levels across STT conditions.

Because we found no effect of STT manipulation on cortisol levels, an average cortisol concentration was used to assess the relationship between cortisol and memory.

Our data showed a clear relationship between cortisol concentrations and the number of target words recalled during the free recall task. Our exploratory analysis revealed that this relationship was entirely driven by the older men in our sample. That is, older men, but not women, showed a negative correlation between cortisol and explicit memory such that higher cortisol levels were associated with lower free recall scores.

While the present study intentionally increased stereotype salience in the threat-activated condition, the study procedures may have inadvertently activated stereotypes in both conditions. Previous research found that merely reminding participants of their membership to a stereotyped group was sometimes enough to activate STT (Rahhal, Hasher, & Colcombe, 2001; Spencer et al., 1999). In this study, we began by having participants fill out a demographic questionnaire that asked for their age and year of birth. Recall that identifying one's sex was enough to have women underperform on a test of mathematics (Rivardo, et al., 2011). Following the demographic questionnaire, participants also completed the Images of Aging scale in which they rated words commonly associated with aging. Some of these words are negative (i.e. senile, wrinkled) and may have been enough to produce STT. Indeed, previous research has shown that priming older adults with negative age-related phrases (some of which are similar to the Images of Aging words used in this study) is enough to induce STT (Hess, Auman, Colcombe, & Rahhal, 2003). These measures were given at the beginning of the testing session, with the intention that they would allow participants to acclimate to the testing environment. However, it is likely that the testing conditions were enough to implicitly induce STT in all participants, negating any affect of our manipulation.

This confound may also explain why we did not find an effect of STT on cortisol. Research has demonstrated that exposing older adults to a typical university testing environment increases their cortisol levels (compared to an at-home baseline) and decreases their memory performance (Sindi et al., 2013). Although comparisons of cortisol concentrations across separate studies can be difficult to interpret, our mean concentration (M = 2.01 ng/mL, SD = 1.27) is comparable to that found when older adults were tested in a youth-favouring environment and higher than that taken at home at a similar time (Sindi et al., 2013). Although we collected pre-and post-manipulation saliva samples, we did not include an at-home baseline to control for the influence of the testing environment. Thus, it is possible that cortisol levels were raised in all of our participants due to the stress associated with our testing conditions.

Nevertheless, the observed relationship between cortisol and memory performance in older men is intriguing. Average cortisol concentrations during the testing period predicted explicit memory performance in older men, but not in women. Additionally, women in the current sample had better free recall scores than their male counterparts. Sex differences in memory performance and cortisol concentration are often found (Hidalgo, Pulopulos, & Salvador, 2019). Indeed, there is extensive research that suggests that stress differentially affects cognition in men and women (Wolf et al., 2002; Bangasser, Eck, Telenson, & Salvatore, 2018). For example, research using the Trier Social Stress Test (TSST) demonstrated a correlation between reactive cortisol levels and recall and in young men, but not in women (Wolf et al., 2002; Hidalgo et al, 2019). Sex differences in older adults are understudied (Hidalgo et al., 2019), however the present findings suggest that sex differences in the relationship between stress and cognition observed in younger adults may also be true for older adults.

A possible explanation for stress-related differences between men and women is the levels of estrogen (a female sex hormone) present in the body. For example, research has shown that men, who have lower levels of estrogen than women, are also more reactive (in terms of cortisol) to psychosocial stressors (Pulopulos, Hidalgo, Puig-Pérez & Salvador, 2018). Further, differences in cortisol reactivity have been observed when comparing women of different menstrual phases, leading researchers to suggest that estrogen levels may play a role in (Pulopulos et al., 2018). While the role of estrogen is still being investigated, it may increase the concentration of binding proteins associated with cortisol, which results in less free, or physiologically active, cortisol (Kajantie & Phillips, 2006). That is, during periods of high estrogen production, women may have less physiologically active cortisol compared to those with lower estrogen levels. It should be noted that these findings are not always consistent and much of the research reflects estrogen and cortisol production in younger adults.

In older adults, research has shown that post-menopausal women use more active coping strategies to deal with psychosocial stressors, which also helps regulate the physiological response to stress (Pulopulos et al., 2018). Older adults who maintain fulfilling social support networks exhibit flexible emotion regulation abilities and healthier patterns of HPA axis activity (Gaffey, 2016). Indeed, research has shown that older adults with large social support networks are more resilient, recovering from challenges and stressors more quickly than those with low social support (Gaffey, 2016). As such, differences in the social support networks of men and women may help explain sex differences in resilience and emotion regulation under testing conditions. Older men report having smaller support networks to draw on, compared to age matched older women (Seeman, Singer, Ryff, Love, & Levy-Storms, 2002; Gaffey, 2016), suggesting that older men may be more vulnerable to the psychosocial stressors in the current study. Although cortisol changes did not reach significance in the present study, it is interesting to note that both threat-activated and -eased women experienced a decrease in cortisol levels following threat manipulation. Further to this, men in the threat-eased condition also experienced a decrease in cortisol, while those in the threat-activated condition showed an increase. Although our study did not collect information on social support networks, it is possible that these patterns and the sex differences observed are the result of differences in resilience between men and women faced with our testing conditions.

Our experimental subjective measures of performance did not map on to participants' actual performance. For example, despite having lower performance on free recall, older men thought they did better on the tasks than older women. Older men also agreed with the statements made in the false article regardless of which condition they were in. That is, the men in our sample did not appear to actively disagree with the article, even when it provided a negative account of age-related memory decline. This contrasts with older women who agreed less when they read the threat-activated article. It is possible that this further reflects sex differences in resilience and emotional regulation. Women may have been better equipped to cope with the issues raised in the STT-activated article, making them more willing to disagree with the statements made in the passage.

The current study has several limitations. As this project is part of a larger, on-going study, the current sample size has low observed power (0.4) for assessing STT. However this limitation is being rectified by expanding our sample size. Further to this, we believe that the testing environment itself caused a STT response, clouding any effects of our manipulation. Future studies should aim to minimize (or control for) the impact of the testing environment when assessing older adults. Ideally, testing environments that favour older adults should be used (Sindi, 2013).

Another limitation of the current study was our failure to collect an at-home baseline level of cortisol. Establishing a more accurate baseline in future work will allow us to better identify the role of the testing environment in older adults' cortisol levels. Additionally, although activity (and reactivity) of the HPA-axis is a measure of physiological stress (Wolf et al., 2002), the relationship between cortisol and subjective reports of stress are not always clear (Gaffey, 2016). That is, higher cortisol does not always relate to higher subjective ratings of stress. Thus, future work should also collect reliable subjective ratings of stress (e.g., Dundee Stress State Questionnaire) to clarify the relationship between cortisol and cognition.

In conclusion, while the current study failed to find evidence of STT, our results support a connection between cortisol concentrations and explicit memory in older adults. If testing environments act as a stressor, they may be enough to increase the salience of aging stereotypes and influence the performance of older adults. Since psychological research on aging and memory is often conducted in youth-favouring university settings, it is likely that STT muddles our understanding of age-related memory decline. Furthermore, sex differences in older adults' stress reactivity and memory performance likely also acts as artifacts in the data. Taken together, this suggests that our understanding of memory and aging is likely overstated or exaggerated in the literature. As the population ages it is becoming more important for research to provide accurate assessments of cognitive aging. By exploring and controlling for the confounds of STT, stress, and sex, research can get closer to observing true age-related changes in memory and cognition across the lifespan.

References

Barber, S. J. (2017). An examination of age-based stereotype threat about cognitive decline: Implications for stereotype-threat research and theory development. *Perspectives on Psychological Science*, *12*(1), 62–90. doi: 10.1177/1745691616656345

Barber, S. J., & Mather, M. (2014). Stereotype threat in older adults: When and why does it occur, and who is most affected? In P. Verhaeghen & C. Hertzog (Eds.), *The Oxford handbook of emotion, social cognition, and problem-solving during adulthood* (pp. 302–320). Oxford, UK: Oxford University Press.

Bangasser, D. A., Eck, S. R., Telenson, A. M., & Salvatore, M. (2018). Sex differences in stress regulation of arousal and cognition. *Physiology & Behavior,187*, 42-50. doi:10.1016/j.physbeh.2017.09.025

Brodish, A. B., & Devine, P. G. (2009). The role of performance avoidance goals and worry in mediating the relationship between stereotype threat and performance. *Journal of Experimental Social Psychology, 45*, 180–185.

Chasteen, A. L., Bhattacharyya, S., Horhota, M., Tam, R., & Hasher, L. (2005). How feelings of stereotype threat influence older adults' memory performance. *Experimental Aging Research, 31*, 235–260. doi:10.1080/03610730590948177

Craik, F. I., & Byrd, M. (1982). Aging and cognitive deficits. In *Aging and cognitive processes* (pp. 191-211). Springer, Boston, MA.

Delgado, A. R., & Prieto, G. (2008). Stereotype threat as validity threat: The anxiety-sex threat interaction. *Intelligence*, 36, 635–640. https://doi.org/10.1016/j.intell.2008.01.008

Engert, V., Vogel, S., Efanov, S. I., Duchesne, A., Corbo, V., Ali, N., & Pruessner, J. C. (2011). Investigation into the cross-correlation of salivary cortisol and alpha-amylase responses to psychological stress. *Psychoneuroendocrinology*, *36*(9), 1294–1302. https://doi.org/10.1016/j.psyneuen.2011.02.018

Erber, J. T., & Rothberg, S. T. (1991). Here's looking at you: The relative effect of age and attractiveness on judgments about memory failure. *Journal of Gerontology: Psychological Sciences*, 46, 116–123.

Evans, P., Hucklebridge, F., Loveday, C., & Clow, A. (2012). The cortisol awakening response is related to executive function in older age. *International Journal of Psychophysiology*, *84*(2), 201–204. https://doi.org/10.1016/j.ijpsycho.2012.02.008

Gaffey, A. E., Bergeman, C.S., Clark, L.A., & Wirth, M. M. (2016). Aging and the HPA axis: Stress and resilience in older adults. *Neuroscience and Biobehavioural Reviews, 68*, 928-945. http://dx.doi.org/10.1016/j.neubiorev.2016.05.036

Fries, E., Dettenborn, L., Kirschbaum, C. (2009). The cortisol awakening response (CAR): Facts and future directions. *International Journal of Psychophysiology, 72* (1), 67–73, doi:10.1016/j.ijpsycho.2008.03.014.

Hidalgo, V., Pulopulos, M. M., & Salvador, A. (2019). Acute psychosocial stress effects on memory performance: Relevance of age and sex. *Neurobiology of Learning and Memory*, *157*, 48–60. https://doi.org/10.1016/j.nlm.2018.11.013

Hess, T. M., Auman, C., Colcombe, S. J., & Rahhal, T. A. (2003). The impact of stereotype threat on age differences in memory performance. *The Journals of Gerontology: Series B: Psychological Sciences and Social Sciences*, *58*, 3–11. https://doi.org/10.1093/geronb/58.1.P3

Hess, T. M., Emery, L., & Queen, T. L. (2009). Task demands moderate stereotype threat effects on memory performance. *The Journals of Gerontology: Series B: Psychological Sciences and Social Sciences, 64,* 482–486. doi:10.1093/geronb/gbp044

Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language, 30*(5), 513-541. https://doi.org/10.1016/0749-596X(91)90025-F

Johns, M., Inzlicht, M., & Schmader, T. (2008). Stereotype threat and executive resource depletion: Examining the influence of emotion regulation. *Journal of Experimental Psychology: General, 137*, 691–705. doi:10.1037/a0013834

Jordano, M. L., & Touron, D. R. (2017). Stereotype threat as a trigger of mind-wandering in older adults, *Psychology and Aging, 32*(3), 307–313. doi: 10.1037/pag0000167

Kajantie, E., & Phillips, D. I. W. (2006). The effects of sex and hormonal status on the physiological response to acute psychosocial stress. *Psychoneuroendocrinology, 31*(2), 151–178. doi:10.1016/j.psyneuen.2005.07.002

Levy, B. R. (2003). Mind matters: Cognitive and physical effects of aging self-stereotypes. *The Journals of Gerontology*, *58B*(4), 203-211.

Levy, B. R., & Banaji, M. R. (2002). Implicit ageism. In T. D. Nelson (Ed.), *Ageism: Stereotyping and prejudice against older persons* (pp. 49-75). Cambridge, MA, US: The MIT Press.

Levy, B. R., Kasl, S. V., & Gill, T. M. (2004). Image of Aging Scale. *Perceptual and Motor Skills, 99*(1), 208–210. https://doi.org/10.2466/pms.99.1.208-210

Light, L. L. & Singh, A. (1987). Implicit and explicit memory in young and older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *13*(4), 531–541.

Lupien, S. J., Fiocco, A., Wan, N., Maheu, F., Lord, C., Schramek, T., & Tu, M. T. (2005). Stress hormones and human memory function across the lifespan. *Psychoneuroendocrinology, 30*(3), 225–242. https://doi.org/10.1016/j.psyneuen.2004.08.003

Maillet, D., & Schacter, D. L. (2016). From mind wandering to involuntary retrieval: Age-related differences in spontaneous cognitive processes, *Neuropsychologia 80*, 142–156. doi: 10.1016/j.neuropsychologia.2015.11.017

Mazerolle, M., Régner, I., Morisset, P., Rigalleau, F., & Huguet, P. (2012). Stereotype threat strengthens automatic recall and undermines controlled processes in older adults. *Psychological Science, 23*(7), 723-727. https://doi.org/10.1177/0956797612437607

McEwen, B. S. (2012). Brain on stress: how the social environment gets under the skin. *Proceedings of the National Academy of Sciences of the United States of America*, *109*, 17180–17185. https://doi.org/10.1073/pnas.1121254109

McEwen, B. S., & Seeman, T. (1999). Protective and Damaging Effects of Mediators of Stress: Elaborating and Testing the Concepts of Allostasis and Allostatic Load. *Annals of the New York Academy of Sciences*, *896*(1), 30–47. doi: 10.1111/j.1749-6632.1999.tb08103.x

Nasreddine, Z.S., Phillips, N.A., Bedirian, v. Charbonneau, S., Whitehead, V., Collin, I., Cummings, J. L., & Chertkow, H. (2005). The Montreal cognitive assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society, 53*(4), 695-699.

Pulopulos, M. M., Hidalgo, V., Puig-Pérez, S., & Salvador, A. (2018). Psychophysiological response to social stressors: Relevance of sex and age. *Psicothema*, *30*(2). https://doi.org/10.7334/psicothema2017.200

Popham, L. E., & Hess, T. M. (2013). Age Differences in the Underlying Mechanisms of Stereotype Threat Effects, *70*(2), 223–232. https://doi.org/10.1093/geronb/gbt093

Rahhal, T. A., Hasher, L., & Colcombe, S. (2001). Instructional manipulations and age differences in memory: Now you see them, now you don't. *Psychology and Aging, 16,* 697-706.

Rivardo, M. G., Rhodes, M. E., Camaione, T. C., & Legg, J. M. (2011). Stereotype threat leads to reduction in number of math problems women attempt. *North American Journal of Psychology*, *13*(1), 5–16.

Seefeldt, C., Jantz, R. K., Galper, A., & Serock, K. (1977). Using pictures to explore children's attitudes toward the elderly. *The Gerontologist, 17*(6), 506-512. doi:10.1093/geront/17.6.506

Seeman, T. E., Singer, B. H., Ryff, C. D., Love, G. D., & Levy-Storms, L. (2002). Social Relationships, Gender, and Allostatic Load Across Two Age Cohorts. *Psychosomatic Medicine,64*(3), 395-406. doi:10.1097/00006842-200205000-00004

Sindi, S., Fiocco, A. J., Juster, R. P., Pruessner, J., & Lupien, S. J. (2013). When we test, do we stress? Impact of the testing environment on cortisol secretion and memory performance in older adults. *Psychoneuroendocrinology*, *38*(8), 1388–1396. https://doi.org/10.1016/j.psyneuen.2012.12.004

Spencer, S. J., Steele, C. M., & Quinn, D. M. (1999). Stereotype Threat and Women ' s Math Performance. *Journal of Experimental Social Psychology*, *28*, 4–28.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology*, *69*, 791 −811.

Stevens, W., Wig, G., & Schacter, D. (2008). Implicit Memory and Priming. *Learning and Memory: A Comprehensive Reference*, 623–644. doi: 10.1016/b978-012370509-9.00150-9

Townsend, S. S. M., Major, B., Gangi, C. E., & Mendes, W. B. (2011). From "In the Air" to "Under the Skin": Cortisol Responses to Social Identity Threat. *Personality and Social Psychology Bulletin*, *37*(2), 151–164. doi: 10.1177/0146167210392384

Vick, S. B., Seery, M. D., Blascovich, J., & Weisbuch, M. (2008). The effect of gender stereotype activation on challenge and threat motivational states. *Journal of Experimental Social Psychology, 44*, 624–630. https://doi.org/10.1016/j.jesp.2007.02.007

Wolf, O. T., Schommer, N. C. Hellhammer, D. H., McEwen, B. S., & Kirschbaum, C. (2002). The relationship between stress induced cortisol levels and memory differs between men and women. *Psychoneuroendocrinology*, *26*, 711–720. https://doi.org/10.1016/s0306-4530(01)00025-7

Wong, J. T., & Gallo, D. A. (2016). Stereotype threat reduces false recognition when older adults are forewarned. *Memory, 24*(5), 650–658. doi:10.1080/09658211.2015.1036885

Zoccola PM, Dickerson SD, Zaldivar FP. (2008) Rumination and cortisol responses to laboratory stressors. *Psychosomatic Medicine, 70*, 661– 667. doi: 0033-3174/08/7006-0661

APPENDICIES

APPENDIX A

Today's Date: ____

Day Month Year

Age: _______ Sex: ( ) Female ( ) Male Date of birth: ___________________

Month Day Year

Are you right or left-handed? ( ) Right ( ) Left

Were you born in Canada? ( ) Yes ( ) No

--If not born in Canada, how old were you when you first came here? _________

What is your first (native) language? ____

--If not English, how old were you when you first learned English? ___________

Please list all the languages you speak:

- _____________________Age learned: __________used daily?: __________
-
- _____________________Age learned: __________used daily?: __________
-
- _____________________Age learned: __________used daily?: __________
-
- _____________________Age learned: __________used daily?: __________
-
- _____________________Age learned: __________used daily?: __________
-

Please rate the following for your FIRST LANGUAGE :________________

Speech comprehension:	1	2	3	4	5	6	7
Conversational fluency:	1	2	3	4	5	6	7
Reading:	1	2	3	4	5	6	7
Writing:	1	2	3	4	5	6	7

Please rate the following for your SECOND LANGUAGE :________________

Speech comprehension:	1	2	3	4	5	6	7
Conversational fluency:	1	2	3	4	5	6	7
Reading:	1	2	3	4	5	6	7

Writing: 1 2 3 4 5 6 7

Education:
Please specify the number of years at each educational institute.
_____ Grade school (grades 1-13) _____ Community college
_____ Vocational/technical school _____ University
_____ Continuing education _____ Other: ______________________

_____ Total number of years of education (Add all years including grade school)

Please check any diplomas/degrees you have completed:
( ) Grade/highschool diploma ( ) Community college diploma
( ) Vocational/technical school diploma
( ) B.A./B.Sc. ( ) M.A./M.Sc. ( ) Ph.D. ( ) Other: ___________________

What is your marital status? ( ) Single ( ) Common law ( ) Married
( ) Widowed ( ) Divorced ( ) Separated

What has been your major occupation during most of your life?
____

What has been your spouse's major occupation?

Are you retired? ( ) Yes ( ) No
--If you are retired, in what year did you retire? ____________________________

What time do you typically wake up: ____________AM/PM

HEALTH INFORMATION

How many days have you been bothered by illness during the past 6 months? ________
--How serious an illness was it? ( ) Very serious ( ) Serious ( ) Not serious

Please check the appropriate box regarding the following health conditions:

Hearing problems: ( ) Yes ( ) No
--If yes, do you wear a hearing aid? ( ) Yes ( ) No

--Is your hearing corrected to normal with the hearing aid? ( ) Yes ( ) No

Vision problems: ( ) Yes ( ) No
--If yes, do you wear glasses/contacts? ( ) Yes ( ) No
--Is your vision corrected to 20/20 with glasses/contacts? ( ) Yes ( ) No
Neurological problems (e.g., epilepsy): ( ) Yes ( ) No

Arthritis: ( ) Yes ( ) No
--If yes, is it serious enough to impinge on daily activities? ( ) Yes ( ) No
Diabetes ( ) Yes ( ) No
Cancer ( ) Yes ( ) No
Stroke ( ) Yes ( ) No
--If yes, when did you have a stroke? ___________________
High blood pressure ( ) Yes ( ) No
Heart problems ( ) Yes ( ) No
Stomach ulcers ( ) Yes ( ) No
Other: ____
Are you colourblind? ( ) Yes ( ) No If yes, what type? ______________________

What medications do you take on a regular basis?
Drug Name For which ailment?
____
____
____
____
____
¬¬¬¬________________

Have you ever been knocked unconscious (e.g., sports injury or accident)?
( ) Yes ( ) No
-If yes, how old were you? ________________
-What was the cause?
____
-How long were you unconscious?
____
-Did you have trouble remembering events after regaining consciousness? ( ) Yes ( ) No -If yes, please explain
____

Indicate if you are often bothered by any of the following:
( ) Colds/flu ( ) Depression ( ) Feeling generally run down
( ) Headaches ( ) Difficulty sleeping ( ) Difficulty eating
( ) Nervousness/tenseness

In general, how satisified are you with your health and physical condition?
( ) Satisfied ( ) Somewhat satisfied ( ) Somewhat dissatisfied ( ) Dissatified

On a scale from 1 (poor) -10 (excellent), how would you rate your overall health? _____

PERSONAL INFORMATION

What is your ethnic background? (Try to be as specific as possible).

____
____

APPENDIX B

Image of Aging Scale

After each word or phrase, please tell me the number from 0 to 6 that best shows how well the word matches your image or picture of old people in general, with 0 being furthest from what you think and 6 being closest to what you think.

	Furthest from what you think					Closest to what you think	
1. senile	0	1	2	3	4	5	6
2. helpless	0	1	2	3	4	5	6
3. active	0	1	2	3	4	5	6
4. positive outlook	0	1	2	3	4	5	6
5. family-oriented	0	1	2	3	4	5	6
6. healthy	0	1	2	3	4	5	6
7. given up	0	1	2	3	4	5	6
8. well-groomed	0	1	2	3	4	5	6
9. wrinkled	0	1	2	3	4	5	6
10. walks slowly	0	1	2	3	4	5	6
11. sick	0	1	2	3	4	5	6
12. grumpy	0	1	2	3	4	5	6
13. full of life	0	1	2	3	4	5	6
14. wise	0	1	2	3	4	5	6
15. lonely	0	1	2	3	4	5	6
16. will to live	0	1	2	3	4	5	6
17. dying	0	1	2	3	4	5	6
18. capable	0	1	2	3	4	5	6

APPENDIX C

Performance Questionnaire (Pre-testing phase)

Please rate the following statements about your performance on a number from 0 to 6, with 0 being furthest from how you feel and 6 being closest to what you feel.

Statement:	Furthest from how I feel			Neutral			Closest to How I Feel
I will perform to the best of my abilities.	0	1	2	3	4	5	6
I am easily frustrated by some tasks.	0	1	2	3	4	5	6
I expect to do well during testing today.	0	1	2	3	4	5	6
I enjoy participating in research projects.	0	1	2	3	4	5	6
I am worried about my performance.	0	1	2	3	4	5	6
I consider myself to be stress-free most of the time.	0	1	2	3	4	5	6
I find some mental tasks stressful.	0	1	2	3	4	5	6
It is important to me that I do well on most tasks.	0	1	2	3	4	5	6
I enjoy being challenged by mental tasks.	0	1	2	3	4	5	6
I find most tasks easy.	0	1	2	3	4	5	6
I am having a stressful day.	0	1	2	3	4	5	6

Performance Questionnaire (post-testing phase)

Please rate the following statements about your performance on today's tasks. Just like before, the scale is from 0 to 6, with 0 being furthest from how you feel and 6 being closest to what you feel.

Statement:	Furthest from how I feel			Neutral			Closest to How I Feel
I performed to the best of my abilities.	0	1	2	3	4	5	6
I was frustrated by some of the tasks.	0	1	2	3	4	5	6
I believe I did well during testing today.	0	1	2	3	4	5	6
I am happy with my performance today.	0	1	2	3	4	5	6
I am worried about my performance on the tasks today.	0	1	2	3	4	5	6
I found the tasks easy.	0	1	2	3	4	5	6
I enjoyed participating in this research project.	0	1	2	3	4	5	6
I found these tasks stressful.	0	1	2	3	4	5	6

Appendix D

Stereotype-Threat Passage:

It is a common belief that cognitive abilities, such as memory, decline with old age. Such beliefs about age-related declines are not groundless. Adults over the age of 60 report more memory problems in everyday life when compared to younger adults. It seems that even individuals who report good overall health suffer from memory decline and cognitive problems.

Older adults perform worse than younger adults on standardised memory tests, as well as on laboratory tests of both recall and recognition. Furthermore, age-related declines in memory cannot be attributed to artificial laboratory tasks. Research shows that older adults perform more poorly than younger adults on tasks that are designed to simulate "real life", such as remembering information on medicine labels, faces of people or layouts of places they have visited.

Neuroscience research confirms these findings. Using brain imaging techniques, older adults showed more brain atrophy than younger adults, particularly in the hippocampus – a structure important for memory processing. Researchers believe that degeneration of the hippocampus and other neural structures is linked to their impairments in memory and cognition that are seen in older adults.

In summary, research indicates that aging can be associated with impaired performance in a variety of cognitive domains.

Stereotype-Eased Passage:

It is a common belief that cognitive abilities, such as memory, decline with old age. However, such beliefs about age-related declines are not entirely factual. Research suggests that there are factors that protect against cognitive decline. It seems that older adults who report good overall health (exercising, mentally stimulating tasks) suffer from less memory decline and cognitive problems.

Although some older adults perform worse than younger adults on standardised memory tests, this difference is not true for everyone. For individuals who engage with cognitive tasks, many of the differences between the age groups are minimized. In fact, given the right set of circumstances there may be no difference between the cognitive abilities of younger and older adults at all.

Neuroscience research suggests that older adults who match younger adults on cognitive abilities recruit different neural networks than those who underperform on the same tasks. Using brain imaging techniques, older adults who performed well on cognitive tasks showed more activation than those who performed poorly on the same task.

In summary, research indicates that individual differences and life factors can be associated with stable memory and cognitive functioning in older adults.

Questions to follow the passage:

Please rate the following statements about the passage you read. The scale is from 0 to 6 with 0 being furthest from how you feel and 6 being closest to what you feel.

Statement:	Furthest from how I feel			Neutral			Closest to How I Feel
I enjoyed the passage.	0	1	2	3	4	5	6
The reading was easy to understand.	0	1	2	3	4	5	6
I feel confident about what I read.	0	1	2	3	4	5	6
I could explain this information to another person.	0	1	2	3	4	5	6
I agree with the statements made in the passage.	0	1	2	3	4	5	6

Please share any other thoughts you have regarding the passage you read:
____
____
____
____
____

APPENDIX E

List 1

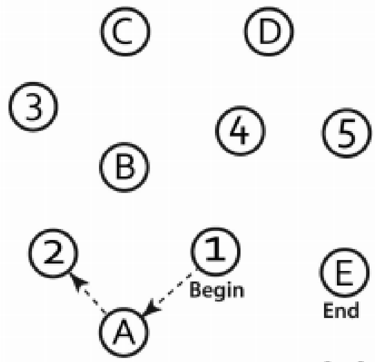
Word	Type	Stem
CHAIN	filler	Not tested
HAVING	filler	Not tested
EARNS	filler	Not tested
NEARBY	filler	Not tested
SCALE	filler	Not tested
LEGAL	filler	Not tested
REMOTE	target	REM_____
DRUMS	target	DRU_____
RESTS	target	RES_____
PATCHY	target	PAT_____
HEARTS	target	HEA_____
STRICT	target	STR_____
LOOTED	target	LOO_____
FILTHY	target	FIL_____
LASHES	target	LAS_____
CARED	target	CAR_____
PANIC	target	PAN_____
BEATEN	target	BEA_____
LIMES	target	LIM_____
SHELL	target	SHE_____
POSTER	target	POS_____
DONATE	target	DON_____
MUSCLE	target	MUS_____
CRITIC	target	CRI_____
WARTS	target	WAR_____
FARMER	target	FAR_____
REGION	filler	Not tested
GLOSS	filler	Not tested
ACCEPT	filler	Not tested
JUNKER	filler	Not tested
HANDLE	filler	Not tested
CHOOSE	filler	Not tested

APPENDIX F

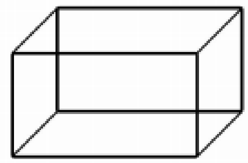
MONTREAL COGNITIVE ASSESSMENT (MOCA®)
Version 7.2 Alternative Version

NAME :
Education : Date of birth :
Sex : DATE :

		POINTS
VISUOSPATIAL / EXECUTIVE	Copy rectangle / Draw CLOCK (Five past four) (3 points)	



Copy rectangle

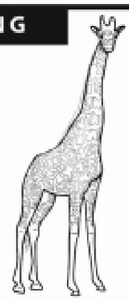


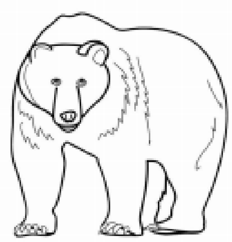
[ ] [ ]

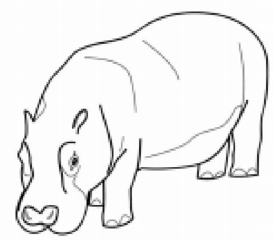
Draw CLOCK (Five past four) (3 points)

[ ] Contour [ ] Numbers [ ] Hands ___/5

NAMING


[ ]


[ ]


[ ] ___/3

MEMORY Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.

	TRUCK	BANANA	VIOLIN	DESK	GREEN
1st trial					
2nd trial					

No points

ATTENTION Read list of digits (1 digit/ sec.).
Subject has to repeat them in the forward order [ ] 3 2 9 6 5
Subject has to repeat them in the backward order [ ] 8 5 2 ___/2

Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors
[ ] F B A C M N A A J K L B A F A K D E A A A J A M O F A A B ___/1

Serial 7 subtraction starting at 90 [ ] 83 [ ] 76 [ ] 69 [ ] 62 [ ] 55
4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt** ___/3

LANGUAGE Repeat : A bird can fly into closed windows when it's dark and windy. [ ]
The caring grandmother sent groceries over a week ago. [ ] ___/2

Fluency / Name maximum number of words in one minute that begin with the letter S [ ] _____ (N ≥ 11 words) ___/1

ABSTRACTION Similarity between e.g. carrot - potato = vegetable. [ ] diamond - ruby [ ] cannon - rifle ___/2

DELAYED RECALL	Has to recall words **WITH NO CUE**	TRUCK [ ]	BANANA [ ]	VIOLIN [ ]	DESK [ ]	GREEN [ ]	Points for UNCUED recall only	___/5
Optional	Category cue							
	Multiple choice cue							

ORIENTATION [ ] Date [ ] Month [ ] Year [ ] Day [ ] Place [ ] City ___/6

Adapted by : Z. Nasreddine MD, N. Phillips PhD, H. Chertkow MD
 www.mocatest.org
Administered by: ____________________

Normal ≥ 26 / 30 TOTAL ___/30
Add 1 point if ≤ 12 yr edu

APPENDIX G

Consent Form

Date: 2018
Project Title: Hormone Levels Across the Lifespan
Principal Investigator (PI): Dr. Karen Campbell, Department of Psychology, Brock University,
905-668-5550 ext. 4281, karen.campbell@brocku.ca
Student Investigator: Dawn Ryan, MA student, dr16yd@brocku.ca

INVITATION
You are invited to participate in a research project designed to explore how hormone levels influence cognitive tasks across the lifespan.

WHAT'S INVOLVED
In this study we ask that you allow us to collect saliva samples and complete some cognitive/problem-solving tasks. We will pay $10.00 per hour as a token of our appreciation for your time. The rate will round up to the nearest half hour in $5 increments. For students, a research participation credit can be provided in lieu of payment.

Research has shown that in some situations hormone levels are related to task performance. As such, we would like to collect saliva samples while you complete some short tasks involving vocabulary and basic cognitive functions. You will also be asked to complete a background questionnaire regarding your health/current ailments, medication(s), education, and ethnicity.

When done, you will be given a feedback letter explaining the purpose of the experiment in more detail. This debriefing letter includes contact information should you have further questions about the research or the results.

POTENTIAL BENEFITS AND RISKS
Potential risks include fatigue and minor anxiety about task performance. To minimize these risks, regular breaks will be provided and research assistants will address any concerns about the tasks. There may also be physical contact with the experimenter while the saliva sample is collected, however gloves and hand sanitizer will be available.

Possible benefits include gaining knowledge of how hormone levels change according to cognitive tasks across the lifespan. You will also contribute to our further understanding of how the mind and brain change with normal, healthy aging

CONFIDENTIALITY
All information you provide is considered confidential; your name will not be included with your data. We will use a code number to match your files, to the background

questionnaire you complete. Your files will not be seen by anyone outside of the research team. Furthermore, because our interest is in the average responses of the entire group of participants, you will not be identified individually in any way in written reports of this research. We will keep a list of participants in order to ensure that each participant does not take part in the study more than once which will be kept for 5 years, and this information will not be connected to your responses in the study.

Data collected during this study will be stored in the Campbell Neurocognitive Aging Laboratory, which will be secured at all times. Consent forms will be destroyed once data collection for this study is complete. De-identified data (i.e., scores on the tasks that cannot be linked to your name) will be kept indefinitely. Access to this data will be restricted to Dr. Karen Campbell and researchers in Dr. Campbell's laboratory (all of whom agree to maintain confidentiality).

VOLUNTARY PARTICIPATION

Participation in this study is voluntary and participants have the right to request the withdrawal of their data. If you wish, you may decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time. If you decide not to participate, your compensation will be pro-rated. For participants receiving monetary compensation, payment will be proportional to the time you have spent in the study ($10.00/hour). For Brock students receiving course credit, one half credit will be given for every half hour of the study you have completed (and you will not be penalized on Brock University's SONA system). If you choose to withdraw after data have been collected (either on the day of the study or after completion), acquired data will be destroyed and deleted from our records upon request.

PUBLICATION OF RESULTS

Results of this study may be published in professional journals and presented at conferences. While we cannot provide individual feedback to participants, general feedback about this study will be available as soon as data collection is complete in approximately one year. If you are interested in receiving feedback about the results of the study, please indicate below and Dr. Karen Campbell or Dawn Ryan will send you a copy of the findings.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact Dr. Karen Campbell using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University [file number XXXXXX]. If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Thank you for your assistance in this project. Please sign this form and return to the researcher.

CONSENT FORM

I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

I hereby consent to participate.

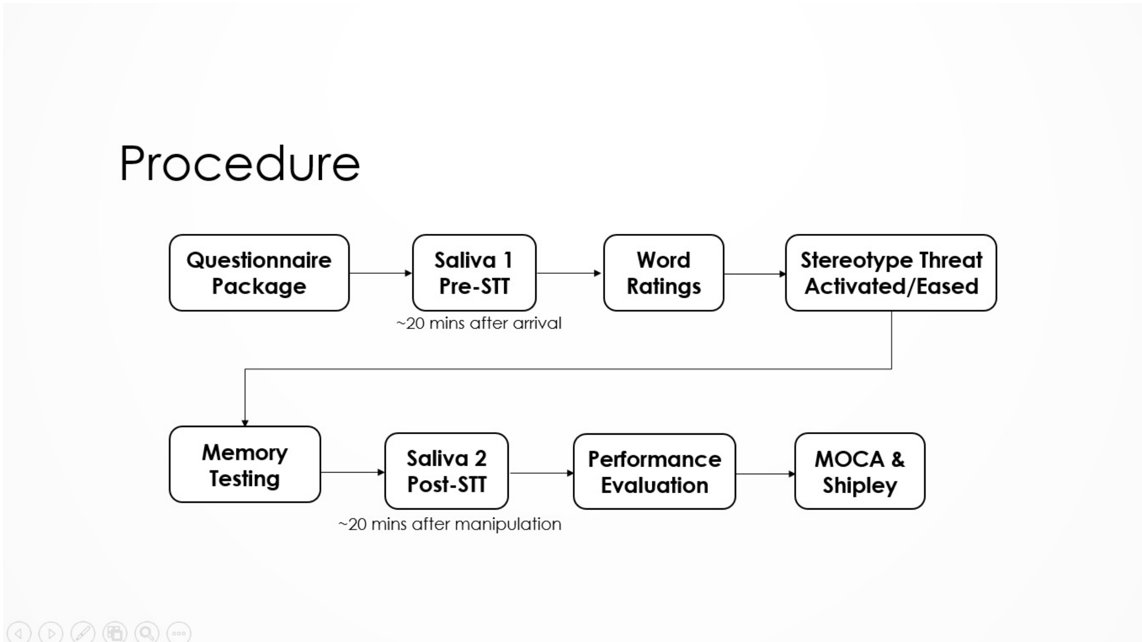
I am participating in this experiment for $ ____/hr.

______________________________	______________________________
Signature of Participant	Signature of Experimenter

If you are interested, in receiving feedback about the overall results of the study please provide your email address below.

Email Address:

APPENDIX H


Procedure
Questionnaire Package
Saliva 1 Pre-STT
~20 mins after arrival
Word Ratings
Stereotype Threat Activated/Eased
Memory Testing
Saliva 2 Post-STT
~20 mins after manipulation
Performance Evaluation
MOCA & Shipley

APPENDIX I

Performance Questionnaire (A)

Please rate the following statements about your performance on a number from 0 to 6, with 0 being furthest from how you feel and 6 being closest to what you feel.

Statement:	Furthest from how I feel			Neutral			Closest to How I Feel
I will perform to the best of my abilities.	0	1	2	3	4	5	6
I am easily frustrated by some tasks.	0	1	2	3	4	5	6
I expect to do well during testing today.	0	1	2	3	4	5	6
I enjoy participating in research projects.	0	1	2	3	4	5	6
I am worried about my performance.	0	1	2	3	4	5	6
I consider myself to be stress-free most of the time.	0	1	2	3	4	5	6
I find some mental tasks stressful.	0	1	2	3	4	5	6
It is important to me that I do well on most tasks.	0	1	2	3	4	5	6
I enjoy being challenged by mental tasks.	0	1	2	3	4	5	6
I find most tasks easy.	0	1	2	3	4	5	6
I am having a stressful day.	0	1	2	3	4	5	6

Performance Questionnaire (B)

Please rate the following statements about your performance on today's tasks. Just like before, the scale is from 0 to 6, with 0 being furthest from how you feel and 6 being closest to what you feel.

Statement:	Furthest from how I feel			Neutral			Closest to How I Feel
I performed to the best of my abilities.	0	1	2	3	4	5	6
I was frustrated by some of the tasks.	0	1	2	3	4	5	6
I believe I did well during testing today.	0	1	2	3	4	5	6
I am happy with my performance today.	0	1	2	3	4	5	6

I am worried about my performance on the tasks today.	0	1	2	3	4	5	6
I found the tasks easy.	0	1	2	3	4	5	6
I enjoyed participating in this research project.	0	1	2	3	4	5	6
I found these tasks stressful.	0	1	2	3	4	5	6