Lifespan researchers have consistently demonstrated a pattern of enhanced emotional well-being in later life. Increasing evidence from controlled experimental studies also suggests that older adults have superior emotion regulation abilities over younger adults. These studies have primarily examined older and younger adults’ ability to regulate disgust or sadness induced by pictures or video clips. It, therefore, remains unclear (a) precisely how older adults achieve adaptive emotion regulation outcomes, (b) whether age-related advantages observed in the regulation of responses to mild emotional stimuli extend to high arousal stressful situations, and (c) to what extent the physiological costs of achieving adaptive emotional outcomes are greater in older age. To address these gaps in the literature, I investigated age differences in the regulation of emotional and physiological responses to a social-evaluative stressor (i.e., an impromptu speech). To better understand older and younger adults’ emotion regulation inclinations, the stressful task was presented under unstructured (control) and guided (positive reappraisal) emotion regulation conditions. Extending previous research, I found evidence of age-related advantages in regulating emotional responses to the social-evaluative stressor when individuals were given the freedom to regulate their emotions however they would like. Age differences in emotion regulation disappeared, however, when participants were provided with guided instructions to apply positive reappraisal to the stressful situation. As predicted, the guided instructions improved younger adults’ emotional outcomes. Older adults’ emotional outcomes, in contrast, were virtually unchanged by the guided instructions. This finding suggests that
when allowed the freedom to let their intuition guide their own emotion regulation process, older adults were more likely than younger adults to implement an adaptive strategy that does not burden cognitive resources. As expected, however, achieving positive emotional outcomes comes with greater physiological costs in older versus younger adults. Specifically, older adults’ systolic and diastolic blood pressure reactivity was exaggerated and prolonged compared with younger adults’. Taken together, these results suggest that avoidance may be the most favorable strategy for older adults due to the potential physiological costs. However, when older adults must confront an acute psychosocial stressor, they are capable of gathering the resources necessary to tackle the problem head on while simultaneously modulating their emotional responses to the stressor.
Age Differences in the Regulation of Subjective Emotional and Physiological Responses to a Social-Evaluative Stressor

by
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A dissertation submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy

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Introduction

Lifespan researchers were at one time surprised to find that individuals demonstrated maintained or enhanced emotional well-being well into their later years. This so-called paradoxical effect of aging—given the greater proportion of losses over gains in later life (Baltes, 1997)—has been a highly reliable finding. Despite numerous studies demonstrating age-related stability or improvement in emotional profiles (e.g., Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Gross et al., 1997; Grühn, Kotter-Grühn, & Röcke, 2010), relatively few studies have directly examined age differences in the online regulation of emotions. There is a need for such studies given that it could be argued that older adults’ positive emotional profiles are primarily supported by increased selectivity regarding the negative situations or stimuli with which they choose to engage. For instance, research on the positivity effect suggests that older adults attend to and recall proportionally less negative than positive information compared with younger adults (for review, see Mather & Carstensen, 2003; Reed & Carstensen, 2012). In addition, older individuals have been observed to limit their social network mainly to those with whom they have emotionally meaningful ties (Fredrickson & Carstensen, 1990; Lang & Carstensen, 1994), and they are more likely to use passive strategies for dealing with relationship conflicts (Blanchard-Fields, 2007; Charles, Piazza, Luong, & Almeida, 2009).

Avoidance strategies or limited processing of negative stimuli such as those mentioned above are thought to serve mood-regulatory functions in older age (Isaacowitz & Blanchard-Fields, 2012; Reed & Carstensen, 2012), as predicted by socioemotional selectivity theory (SST; Carstensen, Isaacowitz, & Charles, 1999). SST suggests that as time
becomes increasingly limited in later life, individuals become more motivated by emotional goals, whereas knowledge-seeking goals prevail at younger ages when future time is perceived to be expansive. Although this theory posits why older adults may be motivated to maintain positive affect, perhaps by altering their behavior to minimize exposure to negative stimuli, it does not account for the ways in which accrued experiences throughout the lifespan may shape and modify the emotion regulation process when a negative situation cannot be avoided.

**Experience May Underlie Age-Related Enhancements in Emotion Regulation**

Age-related increases in the motivation to maintain emotional well-being—as predicted by SST (Carstensen et al., 1999)—do not necessarily result in an increased ability to do so. It is possible that experience is the mechanism underlying age-related improvements in emotion regulation. There are two pathways through which experience could benefit emotion regulation attempts. First, rich and varied life experiences may lead to enhanced emotional flexibility for dealing with unavoidable negative situations. In other words, it is possible that older adults have in-depth knowledge of emotional experiences and the best ways of coping with those experiences, leading to their use of adaptive strategies that work with the demands of the situation. Support for this pathway comes from Orgeta (2009) who found that, compared with young adults, older adults report better clarity and awareness of their own emotions and greater access to emotion regulation strategies. Second, frequent use of a given explicit strategy can render the initiation of the strategy more automatic during regulation, thus making it more implicit over time (Gyurak, Gross, & Etkin, 2011). Through
repeated practice over the years, emotion regulation may, to a certain extent, become more automatic and less effortful in older age. Thus, the first pathway relates to the selection of appropriate and adaptive emotion regulation strategies. The second pathway may account for the reduced cognitive demands of emotion regulation in older adults, due to the initiation of the strategy being automatic and less effortful. In other words, experience can be viewed as a proxy for wisdom (first pathway) and a proxy for practice (second pathway). Both pathways are likely interacting across the lifespan.

Based on these two proposed age- and experience-related pathways, it is possible that older adults (vs. younger adults) may be superior in their ability to (a) spontaneously implement adaptive strategies (e.g., reappraisal vs. suppression) and (b) use strategies more effectively and with less effort. As more emotion-relevant knowledge is acquired over the years, it may assist in the subsequent regulation of emotional episodes, perhaps through the use and development of repeated emotional schemas. Even in novel or less frequently encountered negative situations, older people may be able to integrate such experiences with existing emotional schemas, thereby providing them with the means to effectively cope.

Evidence of Age Differences in Emotion Regulation

Emotion regulation studies employing self-report methods often find age-related advantages. For example, older adults report greater ability to control the internal experience of emotions than younger adults (Carstensen et al., 2000; Gross et al., 1997). Older adults also report greater use of reappraisal than younger adults, and reappraisal has been found to partially mediate age-related increases in positive emotions (Yeung, Wong, & Lok, 2011).
Experimental studies examining the outcome of instructions to regulate emotional responses typically find age-related stability or improvement. For example, Kunzmann, Kupperbusch, and Levenson (2005) found that older and younger adults were equally able to amplify or suppress their facial expressions in response to film clips meant to elicit disgust. Likewise, Shiota and Levenson (2009) found no age differences in the ability to implement expressive suppression. Larcom and Isaacowitz (2009) found that older adults exposed to a negative film clip were able to repair their negative mood more quickly than younger adults.

Two emotion regulation strategies that have been studied extensively are reappraisal and suppression. Although these strategies do not represent the full range of possible strategies (Orgeta, 2009), they are frequently examined in experimental studies as they allow one to engage with the emotional stimulus as opposed to strategies that involve changing the situation (e.g., problem solving, avoidance) (Aldao & Nolen-Hoeksema, 2010). Reappraisal is typically viewed as an adaptive strategy involving the reinterpretation of a situation to decrease its negative emotionality (Gross, 1998; Gross & Thompson, 2007). However, Aldao (2013) has astutely pointed out that whether a given strategy is adaptive or maladaptive is dependent on the context. Reappraisal is an anticipatory-focused strategy because it occurs early in the emotion generative process, although subsequent to the initial appraisal. That is, the initial appraisal is a bottom-up emotion-generative process, whereas reappraisal is a top-down emotion regulatory process (Ochsner & Gross, 2007). Although older adults indicate that they typically use reappraisal more than younger adults (John & Gross, 2004), the experimental findings regarding their ability to implement this strategy have been somewhat mixed. Shiota and Levenson (2009) found that older adults were more successful than
younger adults in using positive reappraisal, but they were less successful than younger adults in using detached (or cognitive) reappraisal. Mirroring the latter finding, Tucker, Feuerstein, Mende-Siedlecki, Ochsner, and Stern (2012) found that older adults benefited less from using cognitive (or detached) reappraisal to down-regulate negative emotions compared with younger adults.

One potential explanation for inconsistent findings may relate to the way that reappraisal is defined and operationalized. In the traditional sense, cognitive (or detached) reappraisal involves taking a detached view of an unpleasant stimulus so as to view it in non-emotional terms (Shiota & Levenson, 2012). For example, if one were observing surgery being performed, one could try to take a detached perspective and view the patient undergoing surgery as an object rather than a person. Positive reappraisal—or the ability to reflect on a negative event and reinterpret its outcome in a more positive light, to see its potential benefits, or silver linings—is probably more representative of real life reinterpretations of unpleasant events (Shiota & Levenson, 2012). For example, a challenging experience may be reappraised in a positive light by considering the ways one has grown as a person from facing that challenge. Cognitive (or detached) reappraisal is a cognitively taxing emotion regulation strategy and has been found to consume working memory resources\(^1\) (Schmeichel, Volokhov, & Demaree, 2008), perhaps making it more difficult for older adults to use given their limited cognitive resources. On the other hand, positive reappraisal may represent a more ecologically-based strategy for the ways in which people reinterpret

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\(^1\) This is surprising given that reappraisal is supposed to occur early in the emotion generative process, and thus should not affect subsequent resources.
negative events in their lives, making it easier to implement for those with lots of life experience.

Suppression is a response-focused strategy aimed at modifying an emotional response after it has fully developed (Gross & Thompson, 2007). Suppressing an emotional response can operate at both experiential (inner feelings) and behavioral (outward) levels. Behavioral suppression involves continual monitoring of one’s outward expression of emotion. Experiential suppression has been likened to attempts to push an air-filled beach ball beneath the surface of the water. The emotion one is trying to suppress may disappear from awareness momentarily, but it will pop back up to the surface without constant efforts to push it under. Most research suggests that emotional suppression has the opposite effect of what is intended because it ultimately exaggerates the very emotional response one is attempting to decrease (John & Gross, 2004). Suppression also hinders one’s ability to perform in the present moment due to the burden it places on cognitive resources, thereby having a negative impact on social interactions (English & John, 2012) and memory (Richards & Gross, 2000). For instance, Egloff, Schmukle, Burns, and Schwerdtfeger (2006) found that although spontaneously engaging in suppression during an evaluative speech task decreased outward signs of anxiety, it heightened physiological responses, impaired memory, and failed to attenuate anxious feelings compared to those who spontaneously engaged in reappraisal.

Past research has found that older adults report using suppression less than younger individuals (John & Gross, 2004), which suggests that over the lifespan people eventually learn that suppression is typically a less adaptive strategy. Although suppression is a less than
ideal way to manage emotions in a lot of situations, there is some evidence that more experience using suppression can make individuals more successful at using this strategy. In an experience-sampling study, older workers who used emotional suppression to combat negative emotions while at work tended to experience a subsequent decrease in negative emotion, at least momentarily (Yeung & Fung, 2012). Younger workers, however, did not experience the same benefits from using suppression. In terms of expressive suppression, there is no evidence that either older or younger adults are better at suppressing their behavioral expressions while viewing emotional stimuli (Emery & Hess, 2011; Kunzmann et al., 2005; Shiota & Levenson, 2009).

Age-related advantages have been observed regarding the cognitive consequences of emotion regulation. In a study with young adults, Richards and Gross (2000) found that engaging in emotional suppression had a detrimental effect on working memory abilities, which suggests that this strategy consumes cognitive resources. Emery and Hess (2011), however, found that engaging in expressive suppression while viewing negative images did not impair the memory of older adults as it did in younger adults. Likewise, when Scheibe and Blanchard-Fields (2009) asked participants to down-regulate disgust (with no restrictions on strategy selection), young adults showed working memory decrements, whereas older adults did not. Thus, there is some initial evidence that emotion regulation can be achieved more efficiently in older than younger adults. Overall, studies in the online regulation of emotion are beginning to show a pattern of age-related advantages in terms of strategy selection (first pathway) and in terms of implementing emotion regulation strategies effectively and efficiently (second pathway).
Aging Negatively Impacts Stress-Related Physiological Responses

It is unlikely that age-related advantages in managing subjective emotions would extend to physiological systems that support coping efforts (e.g., blood pressure and heart rate). Charles’ (2010) theory of strength and vulnerability integration (SAVI) posits that older adults may demonstrate strengths in areas that involve maximizing their emotional well-being (e.g., avoiding negative social interactions), yet they may be more vulnerable to the physiological repercussions of stressors, particularly those that are prolonged or unavoidable. Greater heart rate variability indicates a cardiovascular system that is flexible enough to adapt to demands placed upon the system (De Meersman & Stein, 2007). Age-related decreases in heart rate variability reflect reduced vagal modulation, which is evidence of reduced cardiovascular flexibility in older age (De Meersman & Stein, 2007; Kogan, Edelstein, & McKee, 2000). This is one reason why the SAVI model predicts that older adults will be more susceptible than younger adults to high levels of physiological arousal.

The wear and tear of biological aging on the sympathetic and autonomic nervous system results in some reliable changes. Most notably, age-related changes are observed in maximum heart rate and heart rate variability, with age-related decreases in both (Kogan et al., 2000; Uchino, Birmingham, & Berg, 2010). Blood pressure reflects differences in cardiac output and peripheral resistance, and aging of the vascular system results in increased total peripheral resistance and arterial rigidity, resulting in increased blood pressure responses in older adults (Kogan et al., 2000). Such age-related changes have been found to make a difference in how older adults respond to stressors. In a meta-analysis, Uchino et al. (2010) found that older adults’ heart rates were less reactive to emotion-based laboratory tasks
relative to younger adults, although the effect size was small. In a review of twenty studies, Lau, Edelstein, and Larkin (2001) found that younger adults showed greater heart rate increases than older adults during the stressor period. The meta-analysis by Uchino et al. (2010) also revealed that age was related to greater increases in blood pressure, particularly for systolic blood pressure (SBP). Consistent with this finding, Ong, Rothstein, and Uchino (2012) observed greater SBP reactivity and slower SBP and DBP recovery in older than younger adults in response to acute psychosocial stress. Uchino and colleagues point to blood pressure reactivity as the best index of self-regulatory capacity in older adults because blood pressure shows context-related sensitivity. Overall, although older adults may show some emotion regulation advantages, the physiological processes that support coping efforts will be more strongly affected by the stressor and the recovery rates slower in older compared with younger adults (Aldwin & Yancura, 2010; Charles, 2010).

**Theories of Aging and Emotion Regulation**

Dynamic integration theory posits that higher levels of activation should make age differences in reactivity more pronounced (Labouvie-Vief, 2008). The SAVI model (Charles, 2010) also posits that older adults may struggle with regulating subjective distress when faced with a high arousal, unavoidable stressor. Both theories would predict age-related physiological and emotional disadvantages under stressful conditions. Despite these predictions, no study has simultaneously observed these two processes together in older and younger adults under stressful conditions.
Summary

The literature shows a fairly consistent pattern of enhanced emotional well-being in later life. Part of older adults’ well-being can be attributed to being selective about the negative situations with which they choose to engage, but it is also becoming increasingly evident that older individuals tend to have better emotion regulation abilities. What remains unclear is precisely how older adults down-regulate negative emotions. Although we have some understanding of how older adults fare in relation to younger adults in implementing certain strategies while viewing negative pictures or video clips, we do not know what older adults spontaneously choose to do to manage their emotions, or how successful they are in other types of emotion-altering situations (e.g., stressful situations).

In general, it appears that older adults can implement suppression as well as younger adults, and further, there is some evidence that they do so more efficiently, with less cognitive effort. Although older adults report using reappraisal in everyday life, experimental studies that have given reappraisal instructions to participants have found inconsistent age-related results. Different definitions of reappraisal may be the culprit of such discrepancies across studies. Detached/cognitive reappraisal may not be used very often in everyday situations, whereas positive reappraisal seems to be more closely aligned with the so-called “silver lining” thinking people apply to unfortunate situations in the real world.

Despite evidence to suggest age-related improvements in the ability to regulate subjective emotions, physiological responses elicited by emotional stimuli seem to be less well-controlled in older than younger adults due to biological aging of the cardiovascular system. Charles (2010) has indicated that more aging research needs to examine these
processes together to depict a more complete picture of the strengths and vulnerabilities older adults display in emotion regulation. Both dynamic integration theory and the SAVI model predict that at high levels of emotional arousal older adults will be more vulnerable than younger adults to emotional and physiological repercussions. A stressful context is particularly useful for examining these predictions.

Present Study

The overarching goal of this study is to further investigate age differences in emotion regulation processes by examining subjective, behavioral, and physiological responses to a stressful situation. The present study used a social-evaluative stressor (i.e., an impromptu speech task) to assess the regulation abilities of older and younger adults. In order to better understand the underlying reasons for age differences in emotion regulation, the speech task was presented under two different conditions: unstructured versus guided emotion regulation. Participants in the unstructured condition were told to regulate their emotions in whatever manner they choose, whereas participants in the guided condition were explicitly told how to regulate their emotions using positive reappraisal. This manipulation made it possible to examine the extent to which older and younger adults spontaneously select different strategies to regulate their emotions, and it was also possible to examine how successfully older and younger adults are able to implement positive reappraisal when provided with specific instructions about how to do so.

The Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993)—which typically includes a short speech preparation period, presentation of the speech to a
critical, unsupportive audience, and a cognitive test—is a strong and reliable manipulation for eliciting physiological stress responses, including hypothalamic-pituitary-adrenal (HPA) axis responses, blood pressure, skin conductance, and heart rate (Dickerson, Gruenwald, & Kemeny, 2004; Dickerson & Kemeny, 2004). Dickerson, Gruenewald, and Kemeny (2009) argue that physiological reactivity to a social-evaluative stressor has an adaptive function. That is, increases in cortisol and heart rate, for example, mobilize energy resources to cope with the demands of an acute social threat, enabling individuals to act to preserve their social selves in whatever manner required in the situation. It is maladaptive and potentially damaging to physiological systems, however, when activation becomes too strong during stressor exposure, or if physiological activation fails to return to baseline quickly once the stressor has been extinguished (Dickerson et al., 2009).

Traditionally, studies employing the TSST protocol have focused on objective physiological measures, paying little attention to the experiential component of anxiety (Campbell & Ehlert, 2012). Thus, there are only a few aging studies that have assessed subjective self-reported emotions and reported the results of an analysis that included age and the subjective measure. In one of these rare instances, Ong, Rothstein, and Uchino (2012) reported that older and younger adults experienced equivalent levels of subjective anxiety and frustration in response to the speech task, but older adults experienced elevated SBP and DBP compared with younger adults. Despite the paucity of studies comparing age groups’ subjective responses, there is an abundance of research demonstrating that the TSST is an effective stress induction for adults, as indexed by elevated physiological responses (for

2 Studies that assess subjective anxiety may not report age analyses, presumably because no age differences were observed.
review, see Dickerson & Kemeny, 2004). Individuals across the adult lifespan exhibit HPA axis reactivity using this stress induction (Almela, Hidalgo, Villada, van der Meij, Espin, Gomez-Amor, & Salvador, 2011; Armbruster, Mueller, Strobel, Lesch, Brocke, & Kirschbaum, 2011; Kudielka, Buske-Kirschbaum, Hellhammer, & Kirschbaum, 2004; Kudielka, Hellhammer, & Kirschbaum, 2007; Kudielka, Schommer, Hellhammer, & Kirschbaum, 2004), indicating that the impromptu speech task is an effective stress induction for both younger and older adults. Strong stress responses in both age groups is crucial for demonstrating that subsequent age differences reflect differential ability to regulate subjective emotional aspects of the stress response (Gross, Sheppes, & Urry, 2011). An evaluative speech task, therefore, appears to be an appropriate context to assess age differences in the online regulation of stress-related emotions such as anxiety.

Research Questions

The specific aims of the project and associated hypotheses are as follows:

**Do older and younger adults differ in the emotion regulation strategies they select to regulate anxiety?** How successful are their attempts? To date, no studies have examined whether older and younger individuals differ in the strategies they spontaneously implement to manage emotions elicited in stressful situations. In the unstructured condition, I hypothesized that when given the freedom to select an emotion regulation strategy older adults would capitalize on their wisdom and experience by choosing adaptive strategies. Positive reappraisal is likely an adaptive strategy in this context because it should be effective for reducing negative emotions while simultaneously freeing up cognitive resources
for preparing and performing the speech. Younger adults, who have less experience regulating their emotions than older adults, were expected to rely on suppression, which is maladaptive in this context because it is typically ineffective for reducing negative emotions and it is demanding of cognitive resources. Self-selected strategies were identified in the present study by examining responses to a follow-up questionnaire given at the end of the speech (see Measures section). This enabled an examination of whether age differences exist in the selection and implementation of emotion regulation strategies, and whether their self-selected strategies were adaptive for a social-evaluative situation. Given my hypothesis that older adults would select more adaptive strategies than younger adults under unstructured conditions, I therefore expected to see more improvement in regulation outcomes in younger adults provided with guided emotion regulation instructions than their older counterparts. Age differences were predicted to be greater in unstructured versus guided conditions.

**Are older adults more vulnerable than younger adults to detrimental stress-induced physiological costs characterized by prolonged, exaggerated, and hyporesponsive activation?** Physiological activation in response to social threat is thought to reflect an adaptive biological mechanism entrenched in self-preservation efforts (Dickerson et al., 2009). It can be damaging, however, when physiological activation is exaggerated or prolonged. It is also maladaptive when there is insufficient reactivity (i.e., hyporesponsivity) as it means the physiological system has failed to mobilize the resources needed to cope with the stressor (Dickerson et al., 2009). Consistent with Charles (2010), I anticipated that older adults across conditions would exhibit maladaptive physiological activation patterns characterized by prolonged and exaggerated systolic and diastolic blood
pressure and insufficient increases in heart rate. Prolonged, exaggerated, and hyporesponsive activation was determined based on comparisons with the younger adult sample. In younger adults, I anticipated that those in the unstructured condition would be more likely to use emotional suppression, which would result in greater increases in blood pressure and heart rate under stress relative to their same-age counterparts in the guided condition.

Do age-related advantages in regulating subjective emotional responses hold up under stressful, high arousal conditions? Most of the existing evidence suggests that older adults tend to show emotional advantages. Prior studies have used emotional inductions such as pictures or video clips, which are extraneous to the self and require little engagement with the stimuli. It remains to be seen whether age-related advantages would hold up in a more personally relevant, demanding, high arousal and stressful situation. Examining age differences in emotion regulation in a stressful social-evaluative context was, therefore, an important next step to determine the parameters of age-related emotional advantages. Both age groups were expected to experience a peak in stress right before the speech, a finding that has been observed in past studies (Campbell & Ehlert, 2012). The peak in subjective stress was predicted to be less pronounced in older than younger adults in both conditions, but a larger effect size was anticipated for age differences in the unstructured versus guided condition. Consistent with this notion, Teachman and Gordon (2009) found that younger adults retrospectively reported higher peak anxiety than older adults. Because anxiety was only assessed retrospectively following the stressor, it is not possible to say whether age differences were due to different emotion regulation abilities.
In general, I expected to find results consistent with previous research, but I acknowledged the possibility that older adults would actually show emotional disadvantages, as predicted by the SAVI model and dynamic integration theory. I, therefore, predicted that older adults would show strengths in managing their subjective responses to a stressful situation, with age differences being stronger in the unstructured versus guided condition. Consistent with past studies, I expected that emotion regulation would be more cognitively costly for younger than older adults, and that instructed use of positive reappraisal would help reduce these costs in younger adults. I also anticipated that older adults would exhibit less behavioral anxiety than younger adults, a prediction that was based on my hypothesis that older adults would have more success regulating their subjective emotions than would younger adults. Likewise, given that I expected the guided instructions to enhance younger adults’ ability to regulate their emotional experience, I further predicted that younger adults in the unstructured condition would exhibit more behavioral anxiety than their same-age peers in the guided condition.

**Method**

**Design**

A 2 (age group: older vs. younger adults) X 2 (emotion regulation instructions: unstructured vs. guided) between-subjects design was used. Half of the participants in each age group were randomly assigned to an instructional condition.
Participants

Older and younger adults were recruited from the community in Raleigh, NC using online advertisements and a database of volunteers who had participated previously in studies in the Adult Development Lab. Participants were told that the purpose of the study is to assess how people manage mild stress that they may encounter in their everyday lives. They were told the study would involve measuring blood pressure and heart rate in a non-invasive way, and that they would be paid $30 for approximately an hour and a half of their time. Although they were not informed about the actual nature of the stressor, participants were informed about it when they came to the lab and were permitted to withdraw from the study without penalty. The North Carolina State University Institutional Review Board reviewed my procedure and found it to safeguard the rights of participants. In order to minimize “potential confounds between health- and age-related processes” (Ong et al., 2012), participants were screened for coronary artery disease, insulin-dependent diabetes, uncontrolled hypertension, or use of Beta-blockers, Beta-agonists, or use of corticosteroids in the past 3 months. Participants were not informed about making the speech at the time of recruitment.

Sixty-eight older and 69 younger adults came to the laboratory for individual testing sessions. Three older and three younger adults refused to continue after learning about the speech, and two older adults were excluded due to systolic blood pressure exceeding 160 at baseline, possibly indicating hypertension. This resulted in a final sample of 63 older adults whose ages ranged from 64 to 80, and 66 younger adults whose ages ranged from 20 to 35.
Fifty-four percent of the older adult sample and 49% of the younger adult sample was female. See Table 1 for additional participant characteristics.

**Materials and Measures**

**Working memory.** The Letter-Number Sequencing (LNS; Wechsler, 1997) was used to assess working memory at baseline and again while participants were under stress. In this task, participants were presented with series of letters and numbers, starting with two number-letter combinations and becoming increasingly difficult. Participants were instructed to repeat the series by, first, repeating the numbers in ascending order, and then the letters in alphabetical order (e.g., 5-V-T-2; correct response is 2-5-T-V). The test was discontinued once participants missed three sequences at a given level of difficulty (e.g., missing all 6-item series). Each correctly repeated sequence was given a score of 1. Scores were then summed to create an index of working memory capacity.

**Subjective emotion ratings.** The Visual Analogue Scale (VAS) was used to assess self-reported emotions during the testing session. The VAS was chosen because it is the most common subjective emotion assessment used in TSST studies (Campbell & Ehlert, 2012), and its simplicity makes it ideal for frequent, repeated assessments (van Duinen, Rickelt, & Griez, 2008). At six occasions during the session, participants were asked to make a vertical mark along a horizontal line indicating how “stressed [they] feel right now, in this moment.” The left endpoint was labeled “not at all” and the right endpoint was labeled “extremely.” Scores were measured with a ruler on a 100-pt scale, with each millimeter representing 1-pt. In addition to rating stress, participants also rated how *excited, positive,* and *negative* they
felt at each occasion. Given that self-conscious emotions tend to be heightened after facing a social-evaluative stressor (Gruenewald, Kemeny, Aziz, & Fahey, 2006), participants also rated how *foolish, ashamed, self-conscious, humiliated*, and *embarrassed* they felt immediately after the speech and again several minutes later.

**Physiological arousal.** Three measures were used to assess stress-induced physiological responses: systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR). Nineteen participants’ blood pressure and heart rate were assessed continuously during the testing session, except for when they went to a different room to present their speeches, using a Finometer MIDI (Finapres Medical Systems, Amsterdam, Netherlands) finger cuff placed on the index finger of the non-dominant hand. The BeatScope data recording program was used to calculate moment-to-moment finger arterial pressure. During the session the experimenter marked the beginning and end of 1-min periods at each point of interest. Mean SBP, DBP, and HR scores were then calculated for each of these assessment periods. After 19 participants had been tested using this method, equipment problems occurred, necessitating the use of a standard arm cuff (Omron 10-series Upper Arm Blood Pressure Monitor) to assess SBP, DBP, and HR in the remaining participants.

**Article.** In order for participants to have something novel to present in their speeches, participants read a fabricated newspaper article about an alleged shoplifting incident. Instead of allowing participants to form an opinion about whether the man was guilty of the crime, half of the participants in each age group and instruction condition were told to take a
position that the alleged shoplifter was guilty, while the remaining participants were told to
take an innocent position, regardless of their own opinion. The article was, therefore,
constructed such that equal amounts of details from the case could be construed as supportive
of the man’s guilt or innocence. After presenting the speech, participants took a 30-item
recognition test based on details from the article. The purpose of the recognition test was to
determine whether age and emotion regulation instructions impacted individuals’ ability to
attend to and remember details from the article.

Follow-up questionnaire. After presenting their speeches, participants completed a
follow-up questionnaire to examine whether older and younger adults differed in the extent
to which they used various methods to decrease stress during the speech task. Specifically, it
included six questions developed by Egloff et al. (2006) to assess the extent to which
individuals used reappraisal and suppression strategies to decrease stress while undergoing
the TSST protocol. The six questions developed by Egloff et al. were based on the well-
established Emotion Regulation Questionnaire (Gross & John, 2003). Although not described
as positive reappraisal specifically, endorsement of the reappraisal items suggests a positive
outlook of the situation: “I tried to see the situation as positive as possible,” “I viewed the
situation as a challenge,” and “I thought of the situation in a way that made me feel calm.”
The suppression items appear to be focused on expressive suppression specifically: “During
the situation, I controlled my emotions,” “One could see my feelings during the situation,”
and “I showed my emotions.” The latter two are reverse scored. Each item was rated on a
scale from 0 (not at all) to 3 (strongly). Both reappraisal and suppression scales have been
found to have adequate internal consistency (.73).
In addition to rating their use of reappraisal and suppression, individuals provided written descriptions of what they did to regulate or control their emotions while both (a) anticipating the speech and (b) presenting the speech. Open-ended responses were gathered because they had the potential to provide some insight into the range of emotion regulation strategies that people use.

Using a 0 to 3 scale, participants were also asked to reflect on aspects of their performance, including: (a) the extent to which they felt evaluated by the two researchers who observed their speech; (b) how successfully they felt they regulated their emotions during the task; and (c) [for those in the guided condition] how successfully they felt they regulated their emotions during the task *using the instructed strategy*.

Two final items were asked within the context of “things in general” using a 5-pt scale: (d) how much experience they had with giving speeches; and (e) how important they think it is to be able to regulate one’s emotions.³

**Video recordings.** In order to assess behavioral expressions of anxiety as well as ratings of speech quality, participants’ speeches were recorded and later coded according to a speech rating system adapted from Peter Monti et al. (1984) and Egloff et al. (2006). Each dimension was rated on a 4-point scale, with higher scores indicating more anxiety:

**Self-manipulations.** A high score on this dimension was given for frequent fidgeting and self-adjustment, such as picking at clothes or touching hair, face, body, or accessories.

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³Ideally, these final two questions could have been assessed at baseline or in the background questionnaires, but that would have run the risk of alerting participants to the nature of the tasks they would complete during the session.
Facial expressions. A high score on this dimension was assigned for frequent and exaggerated instances of discomfort/tension in the face (e.g., worried expression, clenched jaw, scowl, biting lip, twisting mouth, lip or cheek biting).

Posture. Rigid, tense posture, with hands clasped behind back or, conversely, shoulders rolling forward and head drooping forward counted as high scores on this dimension.

Orienting. High scores were assigned when participants oriented their eyes and/or body away from the judges for most of the speech.

Speech dysfluency. Excessive use of two or more of the following types of speech dysfluency warranted a high score: a) sentence or grammatical irregularities (e.g., “Swanson was trying to stoled the camera”); b) filler words such as “um” or “uh” or “mm”; or c) terminating sentences and words before finishing them (e.g., “He was going to…” or “Swa…wait”).

Speech rate and pressure. High scores represent rushed and rapid-fire speech, which is indicative of stress and anxiety.

Voice quality and tone. High scores were assigned to those who had a quavering voice, and/or quiet, unconfident speech.

Persuasiveness of speech. Speech persuasiveness was chosen as a measure of the quality of the content of the speeches. For this dimension, higher scores indicate a well-structured speech, with specific examples from the article and a clear objective or argument.
**Ability measures.** To characterize the sample, the WAIS-III Vocabulary and Digit-Symbol Substitution subtests (Wechsler, 1997) were administered to assess vocabulary abilities and processing speed, respectively.

**Additional measures.** Self-rated mental and physical health were measured with the SF-36 (Ware, 1993). The expanded form of the Positive and Negative Affect Schedule (PANAS-X; Watson & Clark, 1994) assessed participants’ emotional states in the past week. The trait scale of the Spielberger State-Trait Anxiety Inventory (STAI-T; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) measured dispositional anxiety. See Table 1 for participant characteristics as a function of age group.

**Procedure**

Prior to the session, older and younger adults completed a background questionnaire that included the SF-36, PANAS-X, and the STAI-T, which they then brought with them to the lab for the individual testing session. (See Figure 1 for the sequence of events during testing.)
When individuals arrived for their appointment, an experimenter, who wore a white lab coat to increase stress, gave participants an informed consent form to read, sign and date. The informed consent reiterated the same information provided during recruitment. Following the informed consent, participants were given 10 min to quietly read a magazine or some other neutral material before assessing their baseline blood pressure, heart rate, and emotions. Baseline working memory capacity was then assessed by administering the LNS to participants. Next, participants were informed of the impromptu speech task.

You will have five minutes to read a crime report from a local newspaper. Based on what you read, we would like you to prepare a speech that is meant to persuade a panel of expert judges who will be evaluating your speech. Following the preparation period, you will complete a cognitive test that is like the one you completed previously.

Afterward, you will be brought into a room with a podium and microphone to present your speech for five minutes in front of a panel of researchers who will be observing and making notes on your performance. Your speech performance will also be videotaped so that a panel of expert judges can later evaluate the content of your speech.
The experimenter then measured physiological responses and had participants rate their emotions (T1). Participants in the unstructured condition were read the following instructions:

*It is quite normal to feel some discomfort or anxiety when giving a speech. I would like you to try to manage any negative feelings that you may be experiencing in whatever manner you would like. Before we move on, I would like you to sit quietly with your eyes closed for one minute. During this time, please handle your feelings in whatever manner you would like. I will inform you when the one minute has expired.*

Participants in the positive reappraisal condition were read the following positive reappraisal instructions, which have been validated in a previous study (Hofmann, Heering, Sawyer, & Asnaani, 2009):

*It is quite normal to feel some discomfort or anxiety when giving a speech. I would like you to try to adopt a positive perspective of this task, by recognizing that this is just an experiment and there are no negative consequences to you. There may even be some unrecognized benefits from these tasks that can help you grow as an individual. Before we move on, I would like you to sit quietly with your eyes closed for one minute. During this time, please handle your feelings in the manner I suggested. I will inform you when the one minute has expired.*

After the emotion regulation instructions, participants were given the article about a man accused of shoplifting. Right before reading the article, half of participants in each age group and condition were told to prepare a speech meant to persuade the panel that the alleged shoplifter was innocent, regardless of their personal opinion. The other half of participants were told to prepare a speech meant to persuade the panel that the man was guilty. After the 5-min speech preparation period, participants rated their emotions and had their physiological responses measured (T2). Participants then completed the LNS again, but the letter-number sequences had been changed so that the test was not identical. Participants

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4 Time points are represented as T1 through T5 for repeated assessments of subjective emotions and physiological measures.
were then given one minute to look over any notes they took for the speech before they rated their emotions and had their physiological responses measured (T3).

Participants were then taken to another room where they stood in front of a podium and recording microphone before two stern researchers in white lab coats\textsuperscript{5}. The two researchers did not encounter participants prior to observing their speeches. One of the researchers turned on the video camera, returned to the table, and asked the participant to press the timer on the podium, as it would count down their 5 min. To increase the social-evaluative nature of the task, the researchers did not smile or nod their heads in agreement or encouragement during the speech. Instead, the researchers stared at participants with cold, neutral affect and made notes on a clipboard approximately every 30 s. If participants tried to stop before the 5 min were up, one of the researchers prompted them to continue by saying, “You have (this amount) of time remaining. Please try to continue.”

After the speech, participants were brought back to the smaller testing room so that their SBP, DBP, and HR could be measured and so they could rate their emotions (T4). Participants were then given the recognition test to assess their memory for details of the article, after which they completed the follow-up questionnaire. Participants then indicated their emotions for the last time, and the experimenter took a final physiological measurement (T5) to assess post-stressor recovery. Lastly, the experimenter debriefed participants and gave them an opportunity to take a break before moving onto the ability measures.

Participants were then thanked and paid the honorarium.

\textsuperscript{5}I was consistently one of the critical researchers who observed the speeches. I am a 27-year old female. The second researcher varied based on availability. The second researcher was either a male or female who ranged in age from 21 to 28.
Results

Sample Characteristics

To determine whether dispositional anxiety or experience with public speaking varied as function of age or instruction condition, separate Age Group X Instructions analyses of variance (ANOVAs) were conducted on these variables. A main effect of age group was the only significant effect observed for dispositional levels of anxiety, $F(1,124) = 6.01, p = .02, \eta^2_p = .05$, with older adults ($M = 1.61, SD = 0.46$) reporting that they generally felt less anxiety than younger adults ($M = 1.81, SD = 0.46$). The scale ranged from 1 (almost never) to 4 (almost always), suggesting that trait anxiety was relatively low in both age groups.

There were no significant effects associated with self-reported amounts of public speaking experience ($p_s \geq 14$). Given the absence of strong age or instruction differences, I did not control for trait anxiety or public speaking experience in the main analyses.

Subjective Emotion Ratings

To examine emotional responses to the stressful event, Age Group X Instructions X Time repeated measures ANCOVAs were conducted on changes in subjective emotions during stress exposure (T1-T3) and recovery (T3-T5). A baseline rating of the pertinent emotion was included as a covariate in each of the subjective emotion analyses. The decision to examine stress responses and recovery separately was based on the analytic method used in Ong et al. (2012). Given the large number of analyses, Bonferonni corrections were used here and elsewhere in all follow-up analyses to minimize the possibility of Type I errors.

Relative to older adults, I expected that younger adults would exhibit greater increases in stress and negative emotion and greater decreases in excitement and positive emotion.
when exposed to stress. Older adults were also predicted to be able to emotionally recover more quickly than younger adults, as evidenced by greater increases in positive emotion and excitement and greater decreases in stress and negative emotion following the stressor. Additionally, I expected the instructions to moderate the effects of age and time, with the age-related advantages in regulating subjective emotions being greater when older and younger adults must rely on their emotion regulation inclinations in the unstructured conditions. Attenuation of these age effects was expected when given specific instructions about how to use positive reappraisal in this particular situation.

**Stress ratings.** Examination of stress ratings during stress exposure revealed a marginally significant Age Group X Time interaction, $F(2,123) = 2.92, p = .06, \eta^2_p = .05$ (Figure 2). Comparisons between age groups revealed that the interaction was driven by younger adults ($M = 35.16, SE = 2.30$) reporting more subjective stress than older adults ($M = 28.85, SE = 2.36$) immediately after they were informed of the speech (T1), $F(1,124) = 3.66, p = .06, \eta^2_p = .03$. There was a marginally significant Age Group X Instructions interaction, $F(1,124) = 3.18, p = .08, \eta^2_p = .03$. Due to a priori expectations, I conducted a follow-up test comparing age groups. Consistent with expectations, younger adults reported more subjective stress ($M = 39.92, SE = 3.09$) than older adults ($M = 31.75, SE = 3.14$) under unstructured conditions, $F(1,124) = 3.45, p = .07, \eta^2_p = .03$, but age differences disappeared under guided use of positive reappraisal, $F < 1$. All other main effects and interactions were not significant, $Fs < 1$. Inconsistent with expectations, examination of the recovery period revealed no significant effects on stress ratings, $Fs < 1$. 
Figure 2. Stress ratings during stress exposure and recovery. The speech occurred after T3 ratings. Baseline stress is included as a covariate. Error bars represent +/- 1 Standard Error.

Excitement ratings. Contrary to expectations, there were no significant effects involving excitement ratings during stress exposure ($ps > .20$) (Figure 3). There was, however, a significant main effect of age group during the recovery period, $F(1,124) = 4.34$, $p = .04$, $\eta_p^2 = .03$, revealing that older adults ($M = 41.12, SE = 2.35$) indicated higher levels of excitement than younger adults ($M = 34.26, SE = 2.29$).
Figure 3. Excitement ratings during stress exposure and recovery. Baseline excitement is included as a covariate. Error bars represent +/- 1 Standard Error.

**Positive and negative emotion ratings.** Positive and negative emotions were negatively correlated at each time point ($rs = -.36$ to $-.60$; $p < .001$). To minimize the number of analyses conducted, I combined positive and negative emotion ratings by subtracting negative from positive emotion ratings at each time point. Higher ratings on the composite score, therefore, represent more positive emotional responses. Examination of composite ratings during stress exposure revealed no significant effects, including the absence of the predicted Age Group X Time interaction, $F(2,123) = 1.59, p = .12, \eta_p^2 = .03$ (Figure 4).

Consistent with expectations, an Age Group X Time interaction was observed during recovery, $F(2,123) = 3.30, p = .04, \eta_p^2 = .05$. A follow-up analysis comparing within-person changes across time revealed that older adults experienced increased positive emotion from
T3 to immediately following the speech (T4), $F(1, 124) = 10.13$, $p = .00$, $\eta^2_p = .08$, whereas younger adults did not, $F < 1$. Comparisons across age groups revealed that older adults reported more positive than negative emotion compared with younger adults immediately after the speech (T4), $F(1, 124) = 5.38$, $p = .02$, $\eta^2_p = .04$, but by the second post-stressor assessment (T5) age differences disappeared, $F < 1$. Contrary to predictions, the Age Group X Instructions and the Age Group X Instructions X Time interactions were not significant, $F$s $< 1$.

Figure 4. Positive (minus negative) emotion ratings during stress exposure and recovery. Baseline rating was included as a covariate. Error bars represent $+/- 1$ Standard Error.
**Self-conscious emotions.** Because ratings of self-conscious emotion were significantly intercorrelated \((rs = .56\) to \(.89; ps < .001\))\), the mean of all five emotion ratings—foolish, ashamed, self-conscious, humiliated, and embarrassed—was computed to create a composite score representing self-conscious emotions (Figure 5). An Age Group X Instructions X Time repeated measures ANOVA was conducted on self-conscious emotions experienced immediately after the speech (T4) and again several minutes later (T5). A significant Age Group X Time interaction was observed, \(F(1,123) = 6.75, p = .01, \eta_p^2 = .05\). Age-group comparisons across time revealed that younger adults reported higher levels of self-conscious emotions than did older adults immediately after the speech at T4, \(F(1,123) = 8.45, p = .01, \eta_p^2 = .06\). However, after approximately 10 more minutes had elapsed (T5), younger adults’ self-conscious emotions had decreased to levels comparable to that of older adults, \(F(1,123) = 2.01, p = .16, \eta_p^2 = .02\).
Summary. Examination of subjective emotional responses produced mixed results. After initial exposure to the stressor, younger adults’ subjective reports of stress increased right away, whereas older adults’ subjective stress ratings did not increase significantly until they started preparing for the speech. Under unstructured emotion regulation conditions, older adults reported less stress than younger adults while being exposed to the stressor. When participants were given specific instructions to use positive reappraisal, however, younger and older adults showed comparable ability to regulate stress while being exposed to the stressor. This finding is consistent with the prediction that age differences would be more likely under unstructured than guided conditions. Unlike the impact of instructions on
subjective stress ratings across age groups, neither age group nor instructions impacted the subjective experience of excitement, positive, or negative emotion during stress exposure.

Consistent with predictions, however, emotion ratings during the recovery phase point to modest age-related advantages. Specifically, older adults, but not younger adults, were able to increase positive and decrease negative emotion immediately after presenting their speeches. Younger adults felt more self-conscious emotions immediately after the speech compared with their older counterparts. Age-related advantages in emotional recovery were relatively short-lived, however, because both age groups reached equivalent levels of emotional recovery after another 10 minutes had passed.

**Cognitive Consequences of Regulating Stress**

I next examined the cognitive consequences of emotion regulation using a repeated measures Age Group X Instructions X Time ANOVA, in which baseline working memory performance was compared to that following the emotion regulation instructions when participants were about to present their speeches. I expected that, relative to older adults, stress exposure would more severely burden younger adults’ cognitive resources, as evidenced by decreases in working memory while under stress. I also expected these age differences in the cognitive costs of stress regulation to be greater under unstructured versus guided emotion regulation conditions, with the benefits of positive reappraisal being greater for the younger than for the older adults.

Not surprisingly, there was a main effect of age, $F(1,125) = 22.72, p < .001, \eta_p^2 = .15$, with younger adults achieving higher working memory scores than older adults (Figure 6). There was also a main effect of instructions, $F(1,125) = 4.22, p = .04, \eta_p^2 = .03$, with those in
the unstructured condition performing worse than those in the guided condition. The
Instructions X Time interaction did not reach significance, $F(1,125) = 4.15$, $p = .10$, $\eta^2_p = .02$. Importantly, the expected Age Group X Time interaction was significant, $F(1,125) = 16.53$, $p < .001$, $\eta^2 = .12$. Follow-up analyses conducted on within-person changes in working memory from baseline to performance during stress exposure demonstrated that younger adults experienced decreases in working memory, $F(1,125) = 4.30$, $p = .04$, $\eta^2_p = .03$, whereas older adults actually experienced increases in working memory during exposure to stress, $F(1,125) = 13.38$, $p < .001$, $\eta^2 = .10$. This finding lends support to the hypothesis that stress regulation does not burden older adults’ cognitive resources the way it does younger adults.

Although the predicted Age Group X Instructions X Time interaction did not reach significance, $F(1,125) = 2.67$, $p = .11$, $\eta^2_p = .02$, more focused analyses examining condition effects within each age group were warranted to test a priori predictions. Consistent with expectations, there was a significant Instructions X Time interaction in the young group, $F(1,64) = 6.19$, $p = .02$, $\eta^2_p = .09$. This reflected the fact that decreases in working memory under stress were observed for younger adults given unstructured emotion regulation instructions, $F(1,64) = 11.22$, $p = .001$, $\eta^2_p = .15$, whereas the younger adults who received guided instructions were able to maintain working memory performance under stress exposure, $F < 1$. As expected, older adults in guided and unstructured emotion regulation conditions behaved similarly in that stress exposure had little impact on their working memory abilities, $F < 1$. 
Figure 6. Stress-related changes in working memory as a function of age group and emotion regulation instructions. Working memory was assessed with two different versions of the Letter-Number Sequencing. Error bars represent +/- 1 Standard Error.

To further examine the effects of age and instructions on the cognitive consequences of regulating stress, an Age Group X Instructions X Position ANOVA was conducted on the proportion of questions answered correctly on the recognition memory test. Position—that is, assignment to argue for guilt or innocence – was included in this analysis to examine the possibility that position influenced memory for the article. Results revealed a main effect of age, $F(1,121) = 6.04$, $p = .02$, $\eta_p^2 = .05$, with older adults ($M = 0.85$, $SD = 0.07$) remembering less about the article than younger adults ($M = 0.88$, $SD = 0.06$). Despite predictions, the Age Group X Instructions interaction was not significant, $F(1,121) = 1.37$, $p = .25$, $\eta_p^2 = .01$. No other effects were significant.
Physiological Responses

To examine physiological responses to stress, separate Age Group X Instructions X Time repeated measures ANCOVAs were conducted on SBP, DBP, and HR during stress exposure (T1-T3) and recovery (T3-T5). Baseline measurements were included as covariates to control for normative age-related changes in blood pressure and heart rate. I expected that older adults would show exaggerated SBP and DBP elevations compared with younger adults, but smaller HR elevations due to age-related decreases in maximum HR. Additionally, older adults were expected to exhibit prolonged elevation of SBP and DBP during recovery relative to younger adults. Unstructured instructions were also expected to lead to greater elevations in SBP, DBP, and HR during stress exposure compared with guided instructions, with instructions expected to have a greater impact on physiological reactivity in younger than older adults.

Systolic blood pressure. Examination of age group and instruction differences in SBP reactivity during stress exposure (Figure 7) revealed the expected main effect of age, \( F(1,123) = 7.02, p = .01, \eta_p^2 = .05 \), with older adults (\( M = 129.30 \) mm Hg; \( SE = 1.43 \)) experiencing greater elevations in SBP than younger adults (\( M = 123.68 \) mm Hg; \( SE = 1.45 \)) during stress exposure. Examination of SBP recovery revealed similar results in that the only significant finding was a main effect of age group, \( F(1,124) = 17.44, p < .001, \eta_p^2 = .12 \), with higher SBP in older adults (\( M = 132.77 \) mm Hg; \( SE = 1.37 \)) than younger adults (\( M = 124.43 \) mm Hg; \( SE = 1.34 \)). All other effects and interactions were not significant, \( Fs < 1 \).

To examine the extent to which SBP increased relative to baseline and to compare age groups in the strength of stressor-related changes, I conducted a follow-up analysis with
an Age Group X Instructions X Time repeated measures ANOVA on SBP from baseline to T5. The predicted Age Group X Time interaction was significant, $F(5,120) = 3.66, p < .001$, $\eta^2_p = .13$. As expected, both age groups experienced stressor-related SBP elevations, but the strength of the effect was more than twice as large in older adults, $F(5,120) = 21.58, p < .001$, $\eta^2_p = .47$, than it was in younger adults, $F(5,120) = 7.31, p < .001$, $\eta^2_p = .23$. Relative to baseline, younger adults did not experience significant increases in SBP until immediately prior to the speech (T3), $p < .001$, whereas stressor-related SBP reactivity occurred earlier in older adults, with significant SBP increases occurring immediately upon learning about the speech (T1), $p = .01$. During the stress recovery phase, younger adults’ SBP returned to baseline levels before the end of the session, $p = 1.00$, whereas older adults’ SBP remained significantly elevated by more than 9 mm Hg, $p < .001$.

Figure 7. Systolic blood pressure (SBP) during stress exposure and recovery as a function of age group. Error bars represent +/- 1 Standard Error.
**Diastolic blood pressure.** Examination of age group and instruction differences in DBP reactivity during stress exposure (Figure 8) revealed the predicted Age Group X Time interaction, $F(2,122) = 5.00, p = .01, \eta^2_p = .08$. Relative to younger adults, older adults’ DBP was elevated immediately prior to presenting the speech (T3), $F(1,123) = 4.94, p = .03, \eta^2_p = .04$. Examination of DBP recovery revealed a main effect of age group, $F(1,124) = 6.33, p = .01, \eta^2_p = .05$, with older adults’ DBP ($M = 80.55$ mm Hg; $SE = 0.87$) remaining higher than younger adults’ ($M = 77.49$ mm Hg; $SE = 0.85$) after the stressor. All remaining effects and interactions were not significant, $Fs < 1$.

To examine the extent to which DBP increased relative to baseline and to compare age groups in the strength of stressor-related changes, I conducted a follow-up analysis with an Age Group X Instructions X Time repeated measures ANOVA on DBP from baseline to T5. The predicted Age Group X Time interaction was significant, $F(5,120) = 2.71, p = .02, \eta^2_p = .10$. As expected, both age groups experienced stressor-related DBP elevations, but the strength of the effect was greater in older adults, $F(5,120) = 18.39, p < .00, \eta^2_p = .43$, than younger adults, $F(5,120) = 10.32, p < .00, \eta^2_p = .30$. Both age groups experienced increases in DBP immediately upon learning about the speech (T1) (younger: $p = .05$; older: $p < .001$). As expected, however, older adults’ DBP remained elevated by more than 5 mm Hg at the end of the recovery phase, $p < .001$, whereas younger adults’ DBP returned to a level comparable to baseline, $p = .59$. 
**Heart Rate.** Examination of age group and instruction differences in HR reactivity during stress exposure (Figure 9) revealed a marginally significant main effect of age group, $F(1,121) = 3.32, p = .07, \eta^2_p = .03$. As expected, the stressor had a weaker effect on older adults’ HR ($M = 74.70$ bpm, $SE = 0.73$) relative to younger adults’ ($M = 76.58$ bpm, $SE = 0.72$). The Age Group X Time interaction was not significant, $F(2,120) = 2.12, p = .13, \eta^2_p = .03$. The predicted effect of instructions, $F(1,121) = 3.86, p = .05, \eta^2_p = .03$, revealed that those in the unstructured condition ($M = 76.63$ bpm; $SE = 0.69$) experiencing higher HRs overall compared to those provided with guided instructions ($M = 74.65$ bpm; $SE = 0.73$). This was qualified by a Time X Instructions interaction, $F(2,120) = 3.07, p = .05, \eta^2_p = .05$.

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Figure 8. Diastolic blood pressure (DBP) changes during stress exposure and recovery as a function of age group. Error bars represent +/- 1 Standard Error.

$^6$ BPM = beats per minute.
The impact of instructions on HR was observed at T2, $F(1,121) = 6.08, p = .02, \eta^2_p = .05$, which was the first physiological assessment after the instructions. As expected, those provided with instructions to use positive reappraisal had lower HRs than those given unstructured instructions at T2. The instructions lost their impact on HR when participants were about to present their speeches (T3), $F(1,121) = 2.76, p = .10, \eta^2_p = .02$. All other effects and interactions were not significant, $Fs < 1$. As expected, no effects were observed for HR during recovery, $Fs < 1$.

![Figure 9. Heart rate (HR) changes during stress exposure and recovery as a function of age group and emotion regulation instructions. Error bars represent +/- 1 Standard Error.](image)

**Summary.** In general, the results were consistent with the expectation that the stressor would have a stronger effect on SBP and DBP reactivity in older than younger adults and that the effect would be prolonged in older adults but would eventually recover to
baseline levels in younger adults. The prediction that older adults’ HR would increase less than that of younger adults approached but did not reach significance. Although the emotion regulation instructions did not have the expected effect on blood pressure, guided use of positive reappraisal lessened the impact of the stressor on HR reactivity relative to those given unstructured instructions. More specifically, the impact of instructions on HR was greatest immediately after participants were given the different sets of instructions.

**Behavioral Indicators of Anxiety**

I next turned to examining behavioral indices reflective of stress or anxiety. I expected to see less behavioral anxiety in older adults than younger adults, particularly in the unstructured condition. To examine these predictions, two research assistants rated all available videos of participants’ speeches—one video was lost due to a technical failure. The intraclass correlation coefficients between the two coders’ ratings ranged from .63 to .86 on the various dimensions reflecting anxiety. To enhance reliability, the coders’ ratings were then averaged together to create a score on each dimension for each participant. An examination of intercorrelations among the dimensions revealed that the three visible indicators of anxiety—facial expressions, self-manipulations, and posture—were significantly related (correlations ranging from $r = .21$ to $.44$, $p = .02$ to $< .001$), and the two audible indicators of anxiety—speech dysfluency and voice quality and tone—were also significantly related, $r = .36$, $p < .001$. Therefore, in order to reduce the number of analyses and probability of Type I error, I created two composite scores based on the behavioral ratings: visible indicators of anxiety and audible indicators of anxiety.
An Age Group X Instructions X Position (Guilty vs. Innocent) MANOVA on visible and audible indicators of anxiety while presenting the speech (Figure 10) revealed an Age Group X Instructions interaction, $F(1,119) = 3.22, p = .04, \eta_p^2 = .05$. Follow-up analyses revealed age differences in behavioral anxiety among those given unstructured emotion regulation instructions. Compared with older adults, younger adults in the unstructured condition tended to project more anxiety in their voice quality/tone and through dysfluent speech, $F(1,120) = 16.69, p < .001, \eta_p^2 = .12$, and show more visual signs of anxiety, $F(1,120) = 6.11, p = .02, \eta_p^2 = .05$. Under guided emotion regulation, however, age-related advantages disappeared for both visible, $F(1,120) = 1.18, p = .28, \eta_p^2 = .01$, and audible anxiety indicators, $F(1,120) = 3.13, p = .08, \eta_p^2 = .03$.

An unexpected interaction was observed between instructions and assignment to take a position of guilt or innocence for the speech, $F(2,119) = 3.14, p = .05, \eta_p^2 = .05$. The follow-up analysis revealed that the interaction was driven by position differences under guided instructions. Participants in the guided condition showed more visible indicators of anxiety when instructed to argue for guilt ($M = 1.24; SE = 0.11$) versus innocence ($M = 0.73; SE = 0.11$), $F(1,120) = 10.58, p = .001, \eta_p^2 = .08$, and they also showed more audible indicators of anxiety when instructed to argue for guilt ($M = 1.33; SE = 0.10$) versus innocence ($M = 0.97; SE = 0.10$), $F(1,120) = 6.50, p = .01, \eta_p^2 = .05$. No other interactions were observed for behavioral indicators of anxiety.
Feelings of Evaluation and Emotion-Related Beliefs

A series of Age X Instruction ANOVAs were conducted on a few questions asked of participants after the speech.

**Feeling evaluated by the judges.** No significant effects or interactions are predicted for this measure because it was used as a manipulation check. Overall, participants rated that they felt harshly evaluated by the judges during their speeches, with an average rating of 2.36 ($SD = 0.80$) for younger adults and 2.47 ($SD = 0.68$) for older adults on a 0 to 3 scale. This was true regardless of age or instructions, $F$s < 1, suggesting that the researchers who observed participants’ speeches were effective at evoking social-evaluative stress in both age
groups. Importantly, there were no age differences in this, which suggests that the speech task was equally effective at inducing evaluation concerns across age groups.

**Perception of emotion regulation success.** A main effect of age group was expected to reveal that older adults perceived their emotion regulation attempts as more successful than younger adults. Consistent with expectations, but not entirely consistent with moment-to-moment emotion ratings, older adults ($M = 2.27, SD = 0.65$) were more likely to say they were successful in regulating their emotional responses to the stressful task compared with younger adults ($M = 1.95, SD = 0.70$), $F(1,125) = 7.06, p = .01, \eta_p^2 = .05$.

**Perception of success using positive reappraisal.** This question was only asked of those provided with guided emotion regulation instructions. A main effect of age was expected to reveal that older adults perceived their attempts to implement positive reappraisal in this situation more highly than younger adults. Contrary to expectations, younger ($M = 1.91, SD = 0.69$) and older adults ($M = 2.00, SD = 0.66$) reported equivalent levels of perceived success implementing the instructed strategy, $F < 1$.

**Emotion regulation beliefs.** I predicted that older adults will rate emotion regulation abilities as more important than will younger adults. Contrary to expectations, there were no age differences in the amount of importance individuals placed on the ability to regulate one’s emotions, $F(1,125) = 2.27, p = .13, \eta_p^2 = .02$, which may have been due to the unfortunate timing of this question (i.e., after evaluating their own emotion regulation success).
Self-reported Use of Emotion Regulation Strategies

The final set of analyses focused on participants’ self-reported emotion regulation strategy use, which was measured in two ways: (a) six questions from Egloff et al. (2006) assessing engagement in positive reappraisal and expressive suppression; and (b) self-generated descriptions regarding control and regulation of emotions while preparing for and subsequently presenting the speech.

**Use of positive reappraisal and suppression.** Whereas I expected young adults to report engaging in suppression more and positive reappraisal less than older adults in the unstructured condition, I did not necessarily expect to see age differences among those in the guided condition in the use of these two strategies. I also expected the guided instructions would increase younger adults’ use of positive reappraisal and perhaps decrease their use of suppression compared with their counterparts in the unstructured condition. Because I hypothesized that older adults may already be engaging in positive reappraisal when left to their own devices, I did not anticipate the guided instructions to lead to an appreciable increase in their use of this strategy.

Internal consistency among the three positive reappraisal questions was .52. An Age Group X Instructions ANOVA was conducted on a composite positive reappraisal score based on the average ratings of these items. Older adults reported greater use of positive reappraisal than did younger adults, $F(1,125) = 19.39$, $p < .001$, $\eta_p^2 = .13$. The predicted 2-way interaction was also observed, $F(1,125) = 4.77$, $p = .03$, $\eta_p^2 = .04$, with previously reported age effect being specific to the unstructured condition, $F(1,125) = 22.57$, $p < .001$, $\eta_p^2 = .15$. Means and standard deviations are presented in Table 2.
A similar analysis on mean expressive suppression ratings revealed no significant effects, $F$s $< 1$.

**Self-generated emotion regulation strategy descriptions.** Participants provided answers to open-ended questions regarding how they controlled or regulated their emotions (a) while preparing for the speech, and (b) while presenting the speech. Given the qualitative nature of these descriptions, I reviewed participants’ responses to see whether any regulatory strategies repeatedly emerged. The strategies participants used while preparing for the speech fell into one or more of the following categories: *goal-directed attention, detached reappraisal, relaxation techniques, optimism, and denial*. The strategies participants used while presenting their speeches fell into one or more of the following categories: *focusing on the speech, behavioral control, internal control, confidence, and feelings of nervousness*. Two research assistants coded participants’ descriptions for the presence or absence of each of these strategies. Detailed descriptions of the categories and the frequency with which they were reported are presented in Table 3.

Several Age Group X Instruction chi-square analyses were conducted to examine whether age or instructions impacted the likelihood of using any particular emotion regulation strategy while anticipating and preparing for the speech. Given the exploratory nature of these chi-square analyses, only significant findings are reported. First, age differences were observed in the use of *detached reappraisal* while preparing for the speech, $X^2(1) = 5.14, p = .02$. Younger adults (35%) were more likely than older adults (16%) to indicate that they attempted to reframe their perception of the impromptu speech task in detached, unemotional terms in order to lessen the pressure to perform well. Second, among
those provided with guided instructions, age differences were observed in the use of goal-directed attention to regulate emotions while preparing for the speech, $X^2(1) = 5.47, p = .02$. Among those provided with guided instructions, older adults were more likely to report focusing their attention toward the task at hand (73%) compared with younger adults (41%).

Identical chi-square analyses were conducted on participants’ descriptions of emotion regulation strategies used while presenting their speeches. The only significant difference that emerged was between age groups in the use of behavioral control as a regulatory strategy, $X^2(1) = 6.07, p = .01$. In the guided condition, younger adults (41%) were more likely than older adults (10%) to report using behavioral control (i.e., attempts to monitor and control speech rate and pressure).

**Summary.** The behavioral anxiety findings lend support to the prediction that under unstructured conditions younger adults would be less effective at regulating their emotions during the speech than older adults. Consistent with expectations, the results of the follow-up questionnaire suggest that older adults tended to use positive reappraisal more than younger adults when participants had to rely on their own set of emotion regulation strategies. Inconsistent with expectations, no age or instruction differences were observed in self-reported use of expressive suppression. This is actually a relatively conservative test of age differences in strategy use given that these questions asked about expressive rather than experiential suppression. In the open-ended questions, younger adults across conditions tended to report greater use of detached reappraisal to regulate their emotions than older adults while preparing for the speech. Older adults in the guided condition tended to regulate their emotions by focusing on the task at hand while preparing for the speech. During the
speech, younger adults in the guided condition were more likely to report using behavioral control to regulate the outward expression of anxiety than older adults, which suggests that they struggled to implement the positive reappraisal instructions successfully.

**Discussion**

The goals of the present study were to investigate (a) whether previously-identified age-related emotion-regulation advantages will hold up under high arousal, stressful conditions, (b) whether older adults will be more vulnerable to the physiological costs of stress than younger adults, and (c) whether comparisons across age groups and experimental and control conditions will yield insights into emotion-regulation strategy inclinations in older and younger adults.

First, consistent with my expectations, older adults tended to have better emotional and cognitive outcomes than younger adults when participants were allowed to rely on their own emotion regulation inclinations. In terms of managing emotional responses to the stressor, younger adults reported more subjective stress than older adults, although there were no age differences in the regulation of positive emotion, negative emotion, or excitement during stressor exposure. Once the stressor was over, older adults demonstrated that they were able to improve their emotional state more quickly than younger adults, a finding which is consistent with past research (Larcom & Isaacowitz, 2009). In the present study, older adults were able to up-regulate positive relative to negative emotion more quickly than younger adults, and they experienced less self-conscious emotion than younger adults immediately after the speech. Age-related advantages were short-lived, however, as younger adults’ emotions improved to levels comparable to those of older adults after another 10
minutes. Excitement was the only emotion that remained higher in older than younger adults throughout recovery.

Extending past research (Emery & Hess, 2011; Scheibe & Blanchard-Fields, 2009), I also observed that emotion regulation was more cognitively taxing for younger than for older adults. Age differences in the cognitive costs of emotion regulation, however, only occurred under unstructured conditions when individuals had to use their own emotion regulation inclinations. Ratings of participants’ behavior during their speeches also revealed that younger adults showed more behavioral signs of anxiety than older adults in the unstructured condition.

Overall, these results suggest that older adults can cope better with social-evaluative stress than younger adults when allowed to rely on their own regulation inclinations. Theories of aging and emotion regulation such as SAVI (Charles, 2010) and dynamic integration theory (Labouvie-Vief, 2008) may have predicted that older adults’ emotion regulation would suffer under such stressful conditions due to the demands placed on limited cognitive resources and the disruptive effects of high levels of physiological arousal. The results of the present study, therefore, push the boundaries of the previously untested limits of age-related improvements in emotion regulation.

A second important finding is that, although older adults in the present study showed some advantages in emotion regulation, they experienced greater physiological vulnerability to stress than younger adults, a finding that is consistent with SAVI (Charles, 2010). Older adults experienced exaggerated and prolonged systolic and diastolic blood pressure reactivity relative to younger adults. Although older adults demonstrated enhanced emotion regulation
based on their subjective self-reports, reduced behavioral anxiety during the speech, and minimal cognitive consequences of regulating stress, achieving such adaptive levels of performance came with great physiological costs.

Finally, this study is the first to attempt to identify whether self-selected emotion regulation strategies differ between older and younger adults. The way that I attempted to identify self-selected strategies in the present study was to examine within- and between-age group comparisons across experimental (guided) and control (unstructured) conditions using subjective self-report measures and objective (cognitive and behavioral) measures. When participants were told to regulate their emotions using whatever method they would like, older adults were more likely than younger adults to report using positive reappraisal, which is consistent with previous survey-based research (John & Gross, 2004). Consistent with past research in which younger adults’ working memory benefited from instructions to reappraise an emotional stimulus (Richards & Gross, 2000), guided use of positive reappraisal in the present study mitigated the detrimental effect of the stressor on younger adults’ working memory. As predicted, examining the impact of instructions across age groups revealed that the guided instructions improved many of younger adults’ outcomes, but as expected the instructions had no effect on older adults. This suggests that when left to their own emotion regulation inclinations, older adults may have tended to spontaneously engage in positive reappraisal or another adaptive strategy that did not burden cognitive resources. This finding is consistent with previous studies which have found more efficient emotion regulation in older adults, as indicated by their ability to achieve adaptive emotional outcomes with fewer cognitive costs than younger adults (Emery & Hess, 2011; Scheibe & Blanchard-Fields,
Among those who were instructed to use positive reappraisal, younger adults were able to implement the instructed strategy as well as older adults. The only piece of evidence to suggest otherwise came from participants’ descriptions of the emotion regulation strategies they used during the speech. Younger adults in the guided condition resorted to behavioral control, which is akin to expressive suppression, to minimize visible and audible signs of anxiety. Such efforts would not have been necessary had the younger adults used positive reappraisal successfully.

In sum, as predicted, age differences tended to be greater in unstructured versus guided conditions, with instructions having a greater impact on younger adults’ outcomes. As expected, the instructions did not impact older adults’ outcomes, with the implication being that older adults in the unstructured condition were already using an adaptive strategy such as positive reappraisal. Taken together, the results of the present study provide some support for the notion that older adults’ emotion regulation advantages are a result of using an adaptive strategy for which they have years of experience perfecting. However, in contrast to Shiota and Levenson (2009), there was little to no evidence that older adults were able to implement positive reappraisal with greater success than younger adults who were told how to use this strategy. The only small piece of evidence that positive reappraisal came more easily to older adults was that many younger adults in the guided condition reported using a type of expressive suppression during the speech, which suggests that their emotions were not well under control at that point.
Limitations and Future Directions

A limitation of the present study is that by excluding middle-aged adults, it is not possible to examine whether the emotion regulation advantages I observed in older adults actually begin earlier in the lifespan. As the aging and emotion regulation literature expands, it will be important for future studies to examine the point in the lifespan when regulatory advantages begin to emerge.

The beneficial effects of positive reappraisal on the availability of cognitive resources may also be less direct than I have suggested here. Based on previous research, I inferred these benefits to be due to the resource requirements of using an antecedent-focused strategy that—unlike response-focused strategies—does not require sustained cognitive effort. However, given that stress can directly impact cognition, it may be that positive reappraisal actually alleviates subjective distress, which in turn reduces stress-related effects on cognitive resources. It is, therefore, important that future research attempts to disentangle the effects of subjective distress and emotion regulation strategies on cognitive resources.

Given that I found reduced cognitive costs of emotion regulation in older adults and that this appears to be related to older adults’ spontaneous use of positive reappraisal, it will be important for future research to examine whether older adults can use suppression, a response-focused strategy, more efficiently than younger adults.

Because participants were explicitly told to regulate their emotions in the control condition, even though they were not provided with specific instructions about how to do so, this study is actually a conservative test of age differences in emotion regulation. The fact that I observed any age-related advantages under such conditions points to the possibility that
In future studies employing similar methods, I would suggest assessing strategy use and cognitive resource depletion during recovery, as this is when many age-related advantages were observed. Older adults in the present study may have felt positive about their speech performance, whereas younger adults may have been more likely to ruminate about their performance. While I think the speech task is a good context for examining emotion regulation in both age groups, it will be important to identify other sorts of stressful contexts in which to examine age differences in emotion regulation.

**Conclusion**

The present study yields several important contributions to our understanding of aging and emotion regulation. First, helping to bridge some of the gaps in the literature, the present study is the first to demonstrate age-related enhancements in the moment-to-moment regulation of emotions evoked by a high arousal stressor in a controlled setting. Previous studies have primarily examined older and younger adults’ ability to regulate disgust or sadness, both of which are lower in arousal than emotions evoked by social-evaluative stress. By using a demanding and self-relevant task, the present study also addresses the concern that in previous studies older adults were able to get out of a negative mood because they disengaged from the emotion-altering stimulus (i.e., video clip or picture) by letting their thoughts or eyes wander. This is an important distinction because research on the age-related positivity effect suggests that older adults meet their emotion-related goals primarily by avoiding or disengaging from negative stimuli and selectively attending to and engaging in
positive experiences. The TSST protocol was deliberately chosen to circumvent these kinds of passive strategies. Second, although older adults were able to achieve more adaptive outcomes than younger adults when relying on their emotion regulation inclinations, I found that these adaptive outcomes come with greater physiological costs in older adults. Lastly, I found that older adults tended to rely on adaptive strategies such as positive reappraisal, which likely contributed to their achieving slightly better emotional and cognitive outcomes than younger adults. This latter finding may be viewed as initial support for a wisdom-related pathway underlying age-related enhancements in emotion regulation.
REFERENCES


Ware, J. E., Jr. (1993). *SF-36 Health Survey*. Boston, MA: The Health Institute, New England Medical Center.


APPENDICES
APPENDIX A

Table 1
Participant Characteristics as a Function of Age Group

<table>
<thead>
<tr>
<th></th>
<th>Younger Adults</th>
<th></th>
<th>Older Adults</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td>Age*</td>
<td>27.55</td>
<td>4.78</td>
<td>66</td>
<td>71.50</td>
</tr>
<tr>
<td>Education</td>
<td>15.60</td>
<td>1.64</td>
<td>65</td>
<td>16.16</td>
</tr>
<tr>
<td>Digit-Symbol*</td>
<td>87.32</td>
<td>16.68</td>
<td>65</td>
<td>66.11</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>50.71</td>
<td>9.04</td>
<td>63</td>
<td>51.74</td>
</tr>
<tr>
<td>Physical Health</td>
<td>48.77</td>
<td>7.50</td>
<td>65</td>
<td>46.52</td>
</tr>
<tr>
<td>Mental Health*</td>
<td>51.59</td>
<td>8.33</td>
<td>65</td>
<td>55.67</td>
</tr>
<tr>
<td>General Negative Affect*</td>
<td>15.80</td>
<td>4.26</td>
<td>65</td>
<td>13.54</td>
</tr>
<tr>
<td>Fear*</td>
<td>8.82</td>
<td>2.57</td>
<td>65</td>
<td>7.54</td>
</tr>
<tr>
<td>Sadness</td>
<td>8.52</td>
<td>3.61</td>
<td>65</td>
<td>7.92</td>
</tr>
<tr>
<td>Guilt</td>
<td>8.68</td>
<td>3.49</td>
<td>65</td>
<td>7.67</td>
</tr>
<tr>
<td>Hostility</td>
<td>7.20</td>
<td>2.03</td>
<td>65</td>
<td>6.71</td>
</tr>
<tr>
<td>General Positive Affect</td>
<td>35.14</td>
<td>7.13</td>
<td>65</td>
<td>37.27</td>
</tr>
<tr>
<td>Joviality</td>
<td>24.60</td>
<td>5.89</td>
<td>65</td>
<td>25.79</td>
</tr>
<tr>
<td>Self-assurance</td>
<td>18.60</td>
<td>4.68</td>
<td>65</td>
<td>19.34</td>
</tr>
<tr>
<td>Attentiveness</td>
<td>14.09</td>
<td>2.82</td>
<td>65</td>
<td>15.00</td>
</tr>
</tbody>
</table>

Note. Physical and mental health were calculated from the SF-36. Emotional states were computed from PANAS-X ratings. Trait anxiety is reported in the text.
*Denotes significant age difference at $p < .05$. 
APPENDIX B

Table 2

Use of Reappraisal and Suppression among Participants in the Unstructured Condition.

<table>
<thead>
<tr>
<th></th>
<th>Younger Adults</th>
<th>Older Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive Reappraisal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. I tried to see the situation as positively as possible.</td>
<td>1.96 0.92</td>
<td>2.79 0.42</td>
</tr>
<tr>
<td>2. I viewed the situation as a challenge.</td>
<td>2.07 1.06</td>
<td>2.58 0.66</td>
</tr>
<tr>
<td>3. I thought of the situation in a way that made me feel calm.</td>
<td>1.91 0.87</td>
<td>2.36 0.60</td>
</tr>
<tr>
<td><strong>Expressive Suppression</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. During the situation, I controlled my emotions.</td>
<td>2.09 0.84</td>
<td>2.24 0.61</td>
</tr>
<tr>
<td>2. One could see my feelings during the situation. (reverse scored)</td>
<td>1.15 0.97</td>
<td>1.09 0.88</td>
</tr>
<tr>
<td>3. I showed my emotions. (reverse scored)</td>
<td>1.45 0.83</td>
<td>1.39 0.97</td>
</tr>
</tbody>
</table>

**Notes.**

1. Means and SDs are presented only for those in the unstructured condition because this is where age differences were observed.
2. Instructions asked participants to rate the extent to which they used various methods to decrease stress during the speech task.
3. Ratings were on a scale from 0 (not at all) to 3 (strongly)
Table 3
Participants’ Descriptions of the Emotion Regulation Strategies They Reported Using.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>Frequency±</th>
<th>KappaK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal-Directed Attention</td>
<td>Directing much of one’s effort and attention towards the task at hand.</td>
<td>53.49%</td>
<td>.91</td>
</tr>
<tr>
<td>Detached Reappraisal</td>
<td>Reframing the task in unemotional terms by detaching one’s sense of self from one’s performance in order to lessen the pressure to perform well.</td>
<td>25.58%</td>
<td>.92</td>
</tr>
<tr>
<td>Relaxation Techniques</td>
<td>Efforts to regulate breathing and awareness (e.g., mindfulness meditation).</td>
<td>19.37%</td>
<td>.93</td>
</tr>
<tr>
<td>Optimism</td>
<td>Thinking positive thoughts (e.g., expecting to perform well).</td>
<td>19.37%</td>
<td>.93</td>
</tr>
<tr>
<td>Denial</td>
<td>Assuming they would not actually have to give speech.</td>
<td>10.85%</td>
<td>.84</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>Frequency±</th>
<th>KappaK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focusing on Speech</td>
<td>Simply trying one’s best to present a good argument to the judges.</td>
<td>61.24%</td>
<td>.89</td>
</tr>
<tr>
<td>Behavioral Control</td>
<td>Controlling speech and gestures in order to appear less anxious on the outside.</td>
<td>29.46%</td>
<td>.80</td>
</tr>
<tr>
<td>Internal Control</td>
<td>Controlling body in order to feel less anxiety, such as taking deep breaths and/or directing eye contact away from judges (avoidance) or toward judges with sense of disdain (aggressive).</td>
<td>24.03%</td>
<td>.94</td>
</tr>
<tr>
<td>Confidence</td>
<td>Feeling confident that one was performing well while presenting the speech.</td>
<td>17.83%</td>
<td>.81</td>
</tr>
<tr>
<td>Feelings of nervousness</td>
<td>Admitted failure in controlling anxiety and nervousness.</td>
<td>10.85%</td>
<td>.89</td>
</tr>
</tbody>
</table>

Notes.
Two raters coded emotion regulation strategies reported by participants, indicating the presence or absence of a given strategy with a 1 or 0, respectively.

±Frequency represents the percentage of all participants who indicated using a given strategy.
Some participants reported using multiple strategies.

K Cohen’s kappa represents inter-rater agreement for each scale while taking into account agreement that could occur by chance.