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Age Group Differences in Affect Responses to a Stressor

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A Thesis Presented

by

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ABSTRACT

AGE GROUP DIFFERENCES IN AFFECT RESPONSES TO A STRESSOR

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Older adults may be better able to modulate their emotional experiences than younger adults, and thus may recover more quickly from negative stressors. Additionally, older adults may be more likely to experience co-occurrence of negative and positive emotions in the setting of negative stressors, which may facilitate emotion recovery. To date, few studies have investigated the nature of age group differences in spontaneous emotional responses to a standardized stressor. The current study utilizes a laboratory mood manipulation to determine age group differences in emotion recovery in negative and positive affects, as well as age group differences in the co-occurrence of negative and positive affect. Older adults reported greater reactivity in one and greater recovery in two negative affect scales than younger adults; however, these differences did not remain significant when controlling for overall arousal ratings of the mood induction. There were no age group differences in reactivity or recovery of positive affects. Both younger and older adults returned to baseline in negative affects by the end of the recovery period despite age group differences in affect responses and arousal ratings. Older adults reported greater co-occurrence of negative and positive emotions in response to the mood induction as compared to younger adults. Overall, these results provide support for age group similarities in reactivity and recovery in discrete affects, and age group differences

in mixed emotion states. Greater co-occurrence appears to reflect greater baseline endorsement of positive affect in older as compared to younger adults. Thus, higher baseline positive affect may create greater opportunities for older adults to experience mixed emotion states, which may in turn serve as an adaptive resource for older adults.

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CHAPTER 1

INTRODUCTION

Older adults report better emotional well-being than young and midlife adults (e.g. Carstensen et al., 2011). Older age is associated with increased subjective happiness (Cacioppo et al., 2008), as well as lower rates of psychopathology and higher life satisfaction than at younger ages (Mikels, Reed, Hardy, & Lockenhoff, 2014). Further, older adults endorse less negative affect (e.g., Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Charles, Reynolds, & Gatz, 2001; Ready et al., 2011) and a higher ratio of positive to negative emotion (Carstensen et al., 2011) in comparison to midlife adults. Per socioemotional selectivity theory (SST), improvement in emotional well-being in old age may be the result of a greater prioritization of emotional goals that arise in response to an awareness of limited time left in life (Carstensen, Fung, & Charles, 2003). Thus, older adults may place greater emphasis on emotional well-being (e.g., Carstensen et al., 2003; Mikels et al., 2014). Indeed, older adults report greater recovery from negative stressors in daily life than younger adults (e.g., Hay & Diehl, 2011), and indicate more frequent experiences of mixed emotional states, often referred to as poignancy (e.g., Carstensen et al., 2011; Schneider & Stone, 2015).

Though many studies focus on age group differences in emotional well-being, fewer studies determine how affect changes in the minutes immediately following a stressor in younger and older adults. Much of what we know about age group differences in affect responses to stressors is based on studies that collected repeated measures of general emotional experience. Thus, there is a well-established literature indicating greater emotional well-being in older compared to younger adults over the span of days or weeks (e.g., Carstensen et al., 2011; Charles et al., 2001; Magai, Consedine,

Krivoshekova, Kudadjie-Gyamfi, & McPherson, 2006). Other studies focused on whether older and younger adults are differentially able to modify their emotions following a stressor using instructed techniques (e.g., Lohani & Isaacowitz, 2014; Phillips, Henry, Hosie, & Milne, 2008; Shiota & Levenson, 2009); these studies establish that older adults are better able to regulate negative emotions in the minutes following a stressor when using specific instructed emotion regulation techniques (e.g., thinking about the situation in a more positive way). These past approaches to emotion differences in older and younger adults do not allow for determination of the ways that older and younger adults spontaneously respond to and recover from stressors in the short-term. As such, it is not yet established whether older and younger adults respond differently when they are exposed to a laboratory stressor and allowed to respond without instruction. The present study seeks to address this gap in the literature with regard to age-related differences in spontaneous affect responses immediately following a negative laboratory stressor.

1.1 Age and Emotion Reactivity and Recovery

Age-related advantages in emotional well-being are not simply the result of older adults experiencing emotions less intensely or being generally less reactive to negative stimuli or situations. A substantial body of research indicates that older adults experience similar subjective reactivity to emotion stimuli as younger adults. Older adults report comparable levels of negative emotion in response to criticism (Charles & Carstensen, 2008), negative pictures (Streubel & Kunzmann, 2011), and daily stressors (Röcke, Li, & Smith, 2009; Stawski, Sliwinski, Almeida, & Smyth, 2008). Similarly, older adults evidence comparable affect change as younger adults in response to film clips about interpersonal loss (Ready & Santorelli, 2016). Some studies have found that older adults

even endorse *greater* ratings of unpleasantness than younger persons in response to sadness-eliciting pictures (Streubel & Kunzmann, 2011), as well as greater sadness ratings in response to film clips focusing on age-relevant losses (e.g., death of a spouse; Kunzmann & Grühn, 2005).

However, older adults may experience better emotion recovery than younger persons following negative emotional experiences. Indeed, older adults recover more quickly from high arousal emotional stressors in daily life and may spend more time in low arousal negative affective states than in high arousal negative states relative to younger adults (Hay & Diehl, 2011). Similarly, older adults are more likely to sustain the absence of negative emotions and to move from high negative to low negative emotional states over time than younger adults (Carstensen et al., 2000). Of note, Carstensen et al. (2000) and Hay and Diehl (2011) assessed affect recovery over one or more days; it is not yet established whether older adults recover more quickly than younger persons in the moments following a stressor. However, preliminary data from our laboratory suggest there may be age group differences in short-term affect recovery after a laboratory mood induction. Ready and Santorelli (2016) assessed affect recovery in younger and older adults after film clips focusing on interpersonal loss; midlife and older adults recovered more quickly with regard to a positive affect scale (i.e., Assurance) than younger persons. Additionally, in another project, when induced into a negative mood using music, older adults were more likely than younger adults to be classified as "rapid regulators" (i.e., defined as having returned to a neutral or positive mood just a few minutes after a negative mood induction; Larcom & Isaacowitz, 2009). These studies indicate the

importance of measuring both positive and negative affect because positive and negative affect may recover at different rates.

1.2 Co-occurrence of Positive and Negative Affect

In addition to investigating independent change in positive and negative affects, it is important to examine the interactions among emotions to accurately assess age group differences in affect recovery. Many studies of age and emotion responses focus on singular discrete emotions (e.g., Gross & Levenson, 1995; Hofer, Burkhard, & Allemand, 2015; Shiota & Levenson, 2009; Streubel & Kunzmann, 2011), or place negative and positive emotion on a single bipolar scale (e.g., Larcom & Isaacowitz, 2009; Lohani & Isaacowitz, 2014; Streubel & Kunzmann, 2011). Such approaches to studying emotion responses are fruitful, but do not allow for an investigation of the co-occurrence of different affective states. During negative mood induction procedures, for example, participants do not just report increases in sadness, but they also evidence increases in other negative emotions (e.g., hostility), and decreases in positive emotions (Ready & Santorelli, 2016). Thus, emotion responses to stressors are characterized by simultaneously occurring emotions, both within-valence and between-valence. Because the emotions experienced in response to stressors are multi-faceted, age group differences in affect responses are not fully understood when only investigating independent change in discrete emotions.

Emotion co-occurrence refers to the simultaneous experience of emotions of different valence (e.g., feeling sad and happy during a momentous event)[1]. Though

[1] Cross-valence co-occurrence is conceptualized as a distinct phenomenon from within-valence co-occurrence (i.e., differentiation; Carstensen et al., 2000). Whereas greater within-valence differentiation—and thus lesser within-valence co-occurrence—has been

emotion co-occurrence can occur in the setting of positive or negative events, we are primarily concerned with the experience of both positive and negative affect during a negative situation. Such situations create opportunities for people to modulate their emotions and thus are highly relevant to understanding age group differences in emotional well-being. There is theoretical support for increased co-occurrence of negative with positive emotions in older as compared to younger adults. SST (e.g., Carstensen et al., 2003) suggests that greater salience of emotional stimuli, and thus greater emphasis on both positive and negative emotional cues, may result in increased affect complexity in older adults (Charles, 2005). Additionally, some have suggested that increased life experiences that accumulate throughout adulthood allow for increased associations between present and past experiences (Charles 2005). Increased associations between varied life experiences may strengthen associative networks between emotions, and may generate more heterogeneous responses to emotional experiences.

Studies focused on daily emotional experiences of younger and older adults yield mixed results with regard to simultaneous experience of positive and negative affect. Though the majority of studies find no age group differences in co-occurrence (Brose, de Roover, Ceulemans, & Kuppens, 2015; Hay & Diehl, 2011; Scott, Sliwinski, Mogle, & Almeida, 2014), several studies have found increased co-occurrence in older adults (Carstensen et al., 2000; Carstensen et al., 2011; Lockenhoff, Costa, & Lane, 2008), and one study found greater co-occurrence in younger than older adults (Scott, et al., 2014).

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associated with a variety of positive outcomes in younger adult samples (e.g., Erbas, Ceulemans, Lee Pe, Koval, & Kuppens, 2014; Kashdan, Ferssizidis, Collins, & Muraven, 2010; Pond et al., 2012; Zaki, Coifman, Rafaeli, Berenson, & Downey, 2013), the opposite pattern is found for cross-valence co-occurrence. Thus, within-valence differentiation and cross-valence co-occurrence do not appear to represent bipolar ends of the same construct.

Of note, such studies measure variation in affect over multiple days, and do not address whether co-occurrence of positive and negative emotion is more or less common for older than younger adults immediately following emotional stressors. To date, only one study has examined age group differences in emotion co-occurrence in the setting of a negative mood induction. Magai et al. (2006) found that, in response to a mood induction using personal narratives of sadness, older and younger adults did not evidence different levels of positive and negative emotion co-occurrence. The failure to find differences in co-occurrence between younger and older adults may reflect insufficient potency of the mood induction used in this study, rather than a lack of age group differences. As such, it is not yet clear whether older adults endorse greater co-occurrence of negative and positive emotion than younger persons during the immediate reaction to negative stressors.

If such age group differences do exist, differential levels of emotion co-occurrence may reflect a mechanism by which older adults recover emotion equilibrium more quickly than younger adults. For example, among older adults, positive emotion in the presence of a stressor has been identified as a factor that protects against the persistence of negative emotion (e.g., Ong, Bergeman, Bisconti, & Wallace, 2006). Increased experiences of mixed emotion have been linked to positive outcomes for older adults, including improved psychological and physical health (Hershfield, Scheibe, Sims & Carstensen, 2013). Additionally, positive emotions in the presence of a stressor speed recovery from heightened cardiovascular arousal (Fredrickson & Levenson, 1998). In the setting of negative stressors, the experience of positive emotions in the face of negative

stimuli appears to function as a positive adaptive response; this specific facet of resilience may be more common in older than younger adults (Ong, Bergemen, & Boker, 2009).

1.3 The Present Study

Little is known about the nature of older adults' short-term emotion recovery from stressors and the co-occurrence of different emotions in reaction to such stressors. To address this gap in the literature, the current study tracks emotion reactivity to and short-term recovery from a laboratory stressor in younger and older adults. Specifically, we utilize multi-item scales of several negative and positive affects, collected at multiple time points (i.e., baseline, immediately after a mood induction involving sad film clips, and during a recovery period from the mood induction), to gain a comprehensive and reliable assessment of age group differences in emotion reactivity and recovery. This approach aims to delineate the affect responses of older and younger adults not just by looking at change in discrete emotions, but also by exploring the associations between positive affect (PA) and negative affect (NA) in response to the mood induction.

Prior findings indicate that older adults evidence equal or greater reactivity to sad stimuli (e.g., Kunzmann & Grühn, 2005; Streubel & Kunzmann, 2011), so we expect age group differences in affect to be reflected not by lessened reactivity to negative stimuli but by greater emotion recovery among older than younger adults. Thus, the first aim of the current research is to determine age group differences in recovery from a negative mood induction. We predict that older adults will evidence greater decreases in negative and increases in positive affects than younger adults following the negative mood induction. Though the primary focus is on emotion recovery, we will also examine

emotion reactivity to help characterize the trajectory of emotion responses to stressors in older and younger adults.

Further, there is evidence that the complexity of emotion responses differs between younger and older adults, such that older adults experience more mixed emotions in response to stressors (Carstensen et al., 2000; Carstensen et al., 2011; Lockenhoff et al., 2008). As a secondary aim, we will determine age group differences in the co-occurrence of PA and NA after the stressor. Based on previous work noting the importance of positive emotion in older adults' emotional function (e.g., Ong & Bergeman, 2004; Ong et al., 2006), we expect that older adults will evidence greater co-occurrence of NA and PA immediately following the negative mood induction.

Prior studies have pointed to the importance of positive emotion in allowing for modulation of negative emotion (Fredrickson, Mancuso, Branigan, & Tugade, 2000; Tugade & Fredrickson, 2004). Based on these results, we expect that the presence of PA immediately following the film clips will be associated with faster recovery in negative emotions in both younger and older adults. Additionally, based on evidence of the increased importance of positive emotions in older adults (e.g., Ong et al., 2006; Ong, 2010), we expect that age will moderate this relationship such that the relationship between PA immediately following the mood induction and NA recovery will be stronger for older than younger adults.

CHAPTER 2

METHOD

2.1 Participants

Participants were 71 younger and 44 older adults residing in western Massachusetts (Table 1). Young adults (YA) were undergraduate students recruited through the SONA research participation system at the University of Massachusetts Amherst. Students received one experimental credit per half hour for their participation. Older adults were community members recruited through newspaper ads. Older adults were compensated $5 per half hour. Participants were primarily White and female.

2.2 Procedure

Data for this project were derived from a study approved by the University of Massachusetts Amherst Institutional Review Board. After consent was obtained, older adults were administered the Memory Orientation Screening Test (MOST; Clionsky & Clionsky, 2010) to screen for cognitive impairment. All participants were administered several neuropsychological tasks, followed by a series of self-report questionnaires, including a baseline measure of momentary affect. After viewing a neutral nature film, participants completed another measure of momentary affect. Then, participants viewed a 12 min video montage of film clips about interpersonal loss from the movies *Up*, *Steel Magnolias*, *Sophie's Choice*, and *Pay It Forward*. Film clips were presented in the same order for all participants. At the conclusion of the film clips, participants again reported momentary affect. Momentary affect was recorded two more times after 5 min intervals to track emotion recovery. Participants were then asked to separately rate how negative and how arousing they found the film clips to be on a 5-point Likert scale, and indicated

whether they were familiar with any of the film clips. At the conclusion of the session, participants were shown a brief positive video for mood correction.

2.2.1 Film stimuli

All four film clips used in the negative mood induction depict scenes related to interpersonal loss (e.g., death of a family member). Interpersonal loss is effective in inducing negative mood (Gross & Levenson, 1995) in younger and older adults (Kunzmann & Grühn, 2005; Streubel & Kunzmann, 2011). The clips were chosen based on successful use in previous studies (Feinstein, Duff, & Tranel, 2010; Ready & Santorelli, 2016). In addition, *Up* was selected because the clip includes an older adult protagonist and thus may be particularly salient for the older adult sample.

2.3 Measures

2.3.1 Cognitive screening. The MOST is a brief 29-point clinician-administered screening test that measures word recall, orientation, sequence memory, and clock drawing (Clionsky & Clionsky, 2010). Total scores on the MOST are calculated by summing points from each of the four subtests; scores below 18 indicate cognitive impairment. The MOST has adequate internal consistency ($\alpha = .79$), with high test-retest reliability ($r = .91$). MOST scores are highly correlated with scores on other common measures of cognitive impairment. In initial validation studies, the MOST accurately classified older adults into normal and cognitively impaired groups with 83% accuracy, outperforming the Folstein Mini Mental Status exam (73%; Folstein, Folstein, & McHugh, 1975) and the Mini-Cog (72%; Borson, Scanlan, Brush, Vitaliano, & Dokmak, 2000). The current study utilizes the computerized iPad version of the MOST, which has

been shown to have equivalent psychometric properties to the original paper version (Clionsky & Clionsky, 2014).

2.3.2 Verbal IQ. Verbal IQ (VIQ) was estimated using the American National Adult Reading Test (ANART; Nelson, 1982). The ANART requires respondents to orally read 50 phonetically irregular words of increasing rarity, each of which is marked correct or incorrect based on pronunciation (Bright, Jaldow, & Kopelman, 2002). The ANART is highly reliable, as evidenced by good internal consistency ($\alpha = 0.93$; Nelson, 1982), test-retest reliability ($r = 0.98$; Crawford, Parker, Stewart, Besson, & De Lacey, 1989), and inter-rater reliability ($r = 0.96$-0.98; O'Carroll, 1987). ANART scores are highly predictive of full-scale IQ scores in cognitively healthy individuals, and account for 50-66% of the variance in estimated IQ (Bright et al., 2002; Crawford et al., 1989a). Additionally, scores on the ANART are highly correlated with general IQ scores (Crawford et al., 1989a), and load strongly onto the general intelligence factor of the Wechsler IQ tests (Crawford, Stewart, Cochrane, Parker, & Besson, 1989). In the current study, verbal IQ T scores were estimated using the following equation: Verbal IQ T Score = 60.101 – 3.298 (square root of errors on the ANART) (Gladsjo, Heaton, Palmer, Taylor, & Jeste, 1999).

2.3.3 Beck Depression Inventory-II. Depressive symptoms were assessed using the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996). The BDI-II is a 21-item scale that measures severity of depressive symptoms. Respondents rate items on a Likert scale ranging from 0 to 3, with higher scores indicating more severe depression. The BDI-II has adequate factorial and convergent validity (Beck et al., 1996; Dozois, Dobson, & Ahnberg, 1998), and high internal consistency ($\alpha = .91$; Dozois et al., 1998).

2.3.4 Momentary affect. Momentary affect was measured using the Positive and Negative Affect Schedule - Expanded Form (PANAS-X; Watson & Clark, 1994). The PANAS-X is a 60-item self-report scale that measures Positive Affect (PA) and Negative Affect (NA), as well as three distinct positive affects (i.e., Joviality, Self-assurance, Attentiveness) and four distinct negative affects (i.e., Fear, Sadness, Guilt, Hostility). Participants are instructed to rate the extent to which they feel a certain emotion "at this moment" on a scale from 1 (*very slightly or not at all*) to 5 (*extremely*). The PA and NA scales are quasi-independent (*r*s = -.05 to -.35). Internal consistency is adequate for the PA (α = .87) and NA scales (α = .85), for the three positive affects (αs = .72 to .93), and for the four negative affects (αs = .80 to .88). The Fear, Hostility, Sadness, and Fatigue subscales of the PANAS-X are highly correlated (*r*s = .85 to .91) with conceptually similar scales of the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971).

2.4 Data Analytic Plan

Descriptive statistics were examined to characterize the sample and to evaluate the data for normality and outliers. To test our first aim, we examined self-reported affect reactivity and recovery utilizing scores on the PANAS-X subscales at five time points: baseline, immediately following the neutral video, immediately following the negative mood induction, and 5 and 10 minutes post induction. We examined change in affect over the course of the procedure using piecewise multilevel modeling in HLM 7 (Raudenbush, Bryk, & Congdon, 2004). We utilized a piecewise approach because these models allow the slope from baseline to post-film (i.e., reactivity) and from post-film to recovery to differ in line with the expected response to the negative mood induction procedure. First,

unconditional models were run with each of the nine affect scales as the outcome (i.e., PA, NA, Fear, Hostility, Guilt, Sadness, Joviality, Assurance, Attentiveness) to determine which affect scales showed significant change in response to the mood induction. For scales with significant change in reactivity and recovery during the mood induction, we then entered age group as a Level 2 predictor to determine whether older adults evidence a steeper slope of affect recovery post mood induction. BDI-II and VIQ scores and ratings of arousal for the film clips were entered as covariates because preliminary analyses indicated that these measures significantly differed between age groups.

To determine age group differences in NA and PA co-occurrence in response to the mood induction (Aim 2), we operationalized affect co-occurrence in two ways. First, we calculated the occurrence of Mixed Emotion (ME), using a minimum value equation (e.g., Ersner-Hershfield, Mikels, Sullivan, & Carstensen, 2008). Using this formula, ME is defined as the minimum value of PA or NA endorsed by a participant at a specific time point. For example, if PA = 4 and NA = 6 at a given time point, the ME value for that time point would be 4. This approach allows for calculation of time point-specific measures of emotion co-occurrence for each participant, rather than a correlation based on repeated sampling. ME values reflect the intensity of mixed emotions, so that the co-occurrence of low levels of both NA and PA is differentiated from the co-occurrence of high levels of both NA and PA. We then utilized repeated measures ANCOVA to determine age group differences in ME values, with a planned follow up comparison to examine differences at Time 3 (i.e., immediately following the mood induction). Next, we utilized multivariate multilevel models in HLM to simultaneously model PA and NA over time, as per Scott et al. (2014). This model yields estimates of the variance of PA,

the variance of NA, and the covariance of PA and NA. A correlation between PA and NA can be calculated from this covariance score, allowing for a more traditional estimation of the co-occurrence between PA and NA (e.g., Hay & Diehl, 2011; Scott et al., 2014). In order to estimate covariances for each age group, separate models were fit for younger and older adults.

To determine whether PA at Time 3 was associated with greater recovery of NA (Aim 3), we utilized a univariate multilevel model to predict NA recovery from PA at Time 3 (Ong & Bergeman, 2004). Change in NA over time was entered as a piecewise within-subject variable at Level 1, while PA at Time 3 and age group were entered as between-subjects variables at Level 2. An interaction term between age and Time 3 PA was entered at Level 2 to investigate whether the relationship between PA at Time 3 and NA recovery is stronger for older than younger adults. We also examined the covariance estimates from the multivariate model used in Aim 2 to determine whether there was a significant association between PA at Time 3 and recovery in NA.

Traditional power analyses are not feasible when using multilevel models. However, based on previous simulation studies (e.g., Maas & Hox, 2005), a Level 2 sample size greater than 50 is adequate to produce accurate parameter and standard error estimates. In order to address the potential for Type I error from multiple analyses, we decreased the alpha level from .05 to .01 for HLM parameter estimates, and did not note trend results. However, analyses involving covariance estimates in HLM are particularly low-powered (Saville, Herring, & Kaufman, 2011). These analyses represent a novel approach to establishing covariance; to correct for the high potential for Type II error in these analyses, we considered $p < .05$ to be significant and discuss trend results.

CHAPTER 3

RESULTS

3.1 Preliminary Analyses

Older adults reported significantly lower BDI-II scores and evidenced significantly higher VIQ scores than younger adults (Table 1); thus, these variables were included as between-person covariates in subsequent analyses. Older adults rated the film clips as more arousing than younger adults, but not more negative. Log-transformed scores for the negative PANAS-X scales (i.e., NA, Sadness, Fear, Guilt, Hostility) were used in HLM analyses because of significant positive skew in the raw scores. Raw scores for affects scales at each time point are provided in Table 2.

3.2 Unconditional HLM Models

Unconditional piecewise HLM models were run to determine whether each affect scale changed significantly in response to (i.e., Piece 1) and during recovery from (i.e., Piece 2) the negative mood induction (Table 3). Time was centered at Time 3 and thus model intercepts reflect the average affect score immediately following the negative mood induction. The following model equations were used for each affect scale, with NA presented as an example below:

$$\text{Level 1: } NA_{ij} = \beta_{0j} + \beta_{1j}*(\text{Piece } 1_{ij}) + \beta_{2j}*(\text{Piece } 2_{ij}) + r_{ij}.$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + u_{2j}$$

Unconditional models yield an estimate of the average affect score at Time 3 (γ_{00}), and the average slope of reactivity (γ_{10}) and recovery (γ_{20}).

Affect changed significantly in Piece 1 and Piece 2 for seven of the nine PANAS-X scales: NA, Sadness, Hostility, PA, Joviality, and Assurance. Fear and Guilt did not increase significantly in response the mood induction, so these scales were not included in subsequent analyses. Though Attentiveness changed significantly in Piece 1 and Piece 2, the direction of this change was not consistent with that expected of a positive emotion in response to a negative stressor. Specifically, Attentiveness decreased between Time 1 and Time 3 as expected, but did not increase during the recovery period; instead, Attentiveness continued to decrease between Times 3 and 5. Thus, Fear, Guilt, and Attentiveness were excluded from primary analyses.

3.3 Emotion Reactivity and Recovery

To address Aim 1—whether older and younger adults differed in emotion responses to the mood induction—we ran a series of HLM models that entered age group, BDI-II scores, and estimated VIQ as predictors at Level 2. Time was centered at Time 3, and age was entered as a dummy variable (i.e., Younger adult = 0, Older adult = 1); thus, intercept values represent the average values for younger adults. BDI-II and estimated VIQ were grand-mean centered in all models. The following model equations were used for each affect scale, with NA provided as an example:

$$\text{Level 1: } NA_{ij} = \beta_{0j} + \beta_{1j}*(\text{Piece } 1_{ij}) + \beta_{2j}*(\text{Piece } 2_{ij}) + r_{ij}.$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + \gamma_{01}*(BDI_j) + \gamma_{02}*(VIQ_j) + \gamma_{03}*(\text{Age Group}_j) + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}*(BDI_j) + \gamma_{12}*(VIQ_j) + \gamma_{13}*(\text{Age Group}_j) + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}*(BDI_j) + \gamma_{22}*(VIQ_j) + \gamma_{23}*(\text{Age Group}_j) + u_{2j}$$

Parameter estimates and random effects of models for each affect scale are provided in Table 4 and 5, respectively.

3.3.1 Main effects of age. Older adults (γ = 0.06, *SE* = 0.013, p < .001) evidenced greater reactivity in Hostility as compared to younger adults (γ = 0.014, *SE* = 0.018, p < .001). There were main effects of age group for recovery in NA (Figure 1) and Hostility (Figure 2). Younger (γ = -0.039, *SE* = 0.0064, *p* < .001) and older adults (γ = -0.082, *SE* = 0.012, *p* < .001) evidenced significant recovery in NA, but the slope of recovery in NA for older adults was significantly steeper than for younger persons. Similarly, younger (γ = -0.054, *SE* = 0.011, *p* < .001) and older adults (γ = -0.12, *SE* = 0.015, *p* < .001) reported significant recovery in Hostility, but the slope of recovery for older adults was significantly steeper than for younger persons.

3.3.2 Main effects of depressive symptoms. Greater depressive symptoms were associated with a lesser slope of reactivity in NA and Sadness, such that participants that endorsed greater depressive symptoms experienced lesser increases in these affect scales in response to the mood induction (see Table 4). BDI-II scores were not significantly associated with recovery in any affect scales.

3.3.3 Main effects of estimated VIQ. Greater estimated VIQ was associated with lesser reactivity to the mood induction in Sadness, Hostility, and Assurance (see Table 4), and lesser reported NA and Hostility at Time 3. Greater VIQ was also associated with a lesser decreases in NA and Hostility after the mood induction, indicating lesser recovery.

3.3.4 Controlling for arousal ratings. Due to age group differences in ratings of arousal of the film stimuli, we included arousal ratings as a Level 2 predictor. When controlling for arousal, there were no significant age group differences in reactivity and recovery, *p*s > .01. Thus, age group differences in reactivity to and recovery from the films may have

been driven—at least in part—by age group differences arousal ratings of the mood induction.

3.3.5 Return to baseline. Whether or not age group differences in affect responses were directly accounted for by arousal, it is interesting to consider whether older and younger adults returned to baseline levels of affect by the end of the recovery period. To answer this question, mixed measures ANOVAs were run for each affect scale, with time point as a within-subject variable (i.e. Times 1 and 5) and age group as a between-subject variable (Table 6). Time 1 and Time 5 ratings were not different for Sadness and Hostility. However, participants endorsed lower NA at Time 5 than Time 1; this effect was not moderated by age. For the three positive affects (i.e., PA, Joviality, Assurance), there were main effects of time and age, but no interaction; Time 1 ratings were greater than Time 5 ratings, and older adults endorsed greater positive affect than younger adults. Thus, whereas negative affects returned to baseline in the ten minutes following the mood induction, positive affects did not.

3.4 Emotion Co-occurrence

3.4.1 Mixed emotions. The second aim was to determine age group differences in the co-occurrence of positive and negative emotion in response to the mood induction (i.e., Time 3). First**,** mixed emotion (ME) scores were derived from the raw scores for PA and NA at each time point (Table 7). Controlling for depressive symptoms, estimated VIQ, and overall arousal ratings, a mixed measures ANCOVA revealed that there was not a main effect of age for ME scores, F (1, 95) = 1.18, p = .278, partial η^2 = 0.012. However, age group did interact with time point, F (3.01, 309.04) = 2.71, p = .041, partial η^2 = 0.028. We ran post-hoc one-way ANCOVAs with age group as a between-subjects factor for

each time point, controlling for depressive symptoms, VIQ, and arousal ratings. As hypothesized, older adults evidenced greater ME scores at Time 3 than younger adults, F (1, 100) = 6.73, p = .011, partial η^2 = 0.063 (Figure 3). Age groups did not differ in ME scores for any other time points, ps > .05.

3.4.2 Multivariate HLM models. To further probe Aim 2 and investigate covariance between PA and NA, we ran multivariate HLM models that estimated change in PA and NA simultaneously. In these models, intercept and time variables were entered separately for PA and NA at Level 1. PA and NA were coded such that when NA = 1, then PA = 0, and vice versa; thus, β_{1j} represented the intercept for PA, and β_{2j} represented the intercept for NA. Subsequently, Piece 1 and Piece 2 variables were entered separately for PA and NA to generate separate estimates for the slope of reaction to and recovery from the mood induction. In the equation below, the outcome variable (i.e., Affect) represents either PA or NA, depending on the coding of the remaining variables. Entering PA and NA simultaneously as predictors allows the model to estimate the covariance between parameters in the model (e.g., whether higher PA at Time 3 is associated with higher NA at Time 3).

$$\text{Level 1: } \text{Affect}_{ij} = \beta_{1j}*(\text{PA}_{ij}) + \beta_{2j}*(\text{NA}_{ij}) + \beta_{3j}*(\text{PA Piece 1}_{ij}) + \beta_{4j}*(\text{PA Piece 2}_{ij}) + \beta_{5j}*(\text{NA Piece 1}_{ij}) + \beta_{6j}*(\text{NA Piece 2}_{ij}) + r_{ij}$$

$$\text{Level 2: } \beta_{1j} = \gamma_{10} + \gamma_{11}*(\text{BDI}_j) + \gamma_{12}*(\text{VIQ}_j) + \gamma_{13}*(\text{Age Group}_j) + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}*(\text{BDI}_j) + \gamma_{22}*(\text{VIQ}_j) + \gamma_{23}*(\text{Age Group}_j) + u_{2j}$$

$$\beta_{3j} = \gamma_{30} + \gamma_{31}*(\text{BDI}_j) + \gamma_{32}*(\text{VIQ}_j) + \gamma_{33}*(\text{Age Group}_j) + u_{3j}$$

$$\beta_{4j} = \gamma_{40} + \gamma_{41}*(\text{BDI}_j) + \gamma_{42}*(\text{VIQ}_j) + \gamma_{43}*(\text{Age Group}_j) + u_{4j}$$

$$\beta_{5j} = \gamma_{50} + \gamma_{51}*(\text{BDI}_j) + \gamma_{52}*(\text{VIQ}_j) + \gamma_{53}*(\text{Age Group}_j) + u_{5j}$$

$$\beta_{6j} = \gamma_{60} + \gamma_{61}*(\text{BDI}_j) + \gamma_{62}*(\text{VIQ}_j) + \gamma_{63}*(\text{Age Group}_j) + u_{6j}$$

The primary outcome of interest in determining co-occurrence of PA and NA in response to the mood induction was the covariance between PA and NA at Time 3 (Table 8). There was a trend for significant covariance of NA and PA at Time 3 for younger adults, $\tau = 0.0031$, $SE = 0.0017$, r = .28, $t(66) = 1.82$, $p = 0.073$, and older adults, $\tau = 0.0033$, $SE = 0.0017$, r = .48, $t(39) = 1.94$, $p = 0.060$. Though there is not a means to make a direct comparison between these values, the magnitude of the correlations (Table 9) indicates that older adults experience a medium to large association between NA and PA immediately following the negative mood induction, whereas young adults evidence a small to medium association between NA and PA. It is worth noting that significance tests for covariance estimates in HLM models are low-powered (Saville et al., 2011), so interpretation of trend results may be useful in exploring relationships between variables.

3.5 PA and Emotion Recovery

3.5.1 Univariate HLM models. In order to address Aim 3—whether PA at Time 3 is associated with recovery in NA—we ran a piecewise univariate HLM model with NA as the outcome variable. The Level 1 model was identical to that used in Aim 1. At Level 2, PA at Time 3 was entered as a predictor, yielding a parameter estimate for the association between PA at Time 3 (PA3) and the slope of recovery in NA (i.e., Piece 2). We also entered an interaction term for age group and PA at Time 3 to assess whether the association between PA at Time 3 and NA recovery is different for younger and older adults. The Level 1 and 2 equations were as follows:

Level 1: $\text{NA}_{ij} = \beta_{0j} + \beta_{1j}*(\text{Piece 1}_{ij}) + \beta_{2j}*(\text{Piece 2}_{ij}) + r_{ij}$.

Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01}$*(PA at Time 3_j) + γ_{02}*(BDI$_j$) + γ_{03}*(VIQ$_j$)

+ γ_{04}*(Age Group$_j$) + γ_{05}*(PA at Time 3 X Age Group$_j$) + u_{0j}

$\beta_{1j} = \gamma_{10} + \gamma_{11}$*(PA at Time 3_j) + γ_{12}*(BDI$_j$) + γ_{13}*(VIQ$_j$)

+ γ_{14}*(Age Group$_j$) + γ_{15}*(PA at Time 3 X Age Group$_j$) + u_{1j}

$\beta_{2j} = \gamma_{20} + \gamma_{21}$*(PA at Time 3_j) + γ_{22}*(BDI$_j$) + γ_{23}*(VIQ$_j$)

+ γ_{24}*(Age Group$_j$) + γ_{25}*(PA at Time 3 X Age Group$_j$) + u_{2j}

Contrary to predictions, PA at Time 3 was not associated with the slope of recovery in NA, $\gamma = 0.000084$, $SE = 0.0015$, $p = 0.955$. Additionally, age did not moderate this relationship, $\gamma = -0.0016$, $SE = 0.0021$, $p = 0.457$.

3.5.2 Multivariate HLM models. To assess the association between PA at Time 3 and recovery in NA via an additional methodology, we return to the multivariate HLM model described in Aim 2. Covariance estimates from the multivariate models run in Aim 2 yield an estimate of the association between PA at Time 3 and recovery in NA (Tables 8 and 9). We first ran a model that included younger and older adults. In this model, PA at Time 3 was not significantly associated with recovery in NA, $\tau = -0.00092$, $SE = 0.00058$, r = -.45, $t(107) = 1.59$, $p = 0.115$. Because the estimates of covariance are based on the entire sample, we then ran separate multivariate models for younger and older adults. Though this analysis does not allow for a direct comparison between the age groups, it served as a means of characterizing the age groups descriptively. PA at Time 3 was not significantly associated with recovery in NA for younger adults, $\tau = -0.00074$, $SE = 0.00075$, r = -.28, $t(66) = 0.99$, $p = 0.326$, or older adults, $\tau = -0.00077$, $SE = 0.00089$, r = -.42, $t(39) = 0.87$, $p = 0.390$ (Tables 8 and 9).

CHAPTER 4

DISCUSSION

Older adults endorsed greater recovery in NA and Hostility and reported greater co-occurrence of PA and NA than younger adults in the minutes immediately following a negative mood induction. Despite these differences in reaction, both younger and older adults returned to baseline levels of negative affects within 10 minutes following the mood induction. Thus, age group differences in emotional responses appear to be prominent in the immediate minutes following a stressor, but may diminish shortly after the stressor is removed.

4.1 Emotion Reactivity and Recovery

Consistent with prior research (e.g., Kunzmann & Grühn, 2005; Streubel & Kunzmann, 2011), older and younger adults reacted similarly in negative affects to the mood induction, aside from older adults reacting more strongly in Hostility. As hypothesized, older adults reported greater decreases in both NA and Hostility than younger adults during a recovery period following the mood induction. Whereas prior studies have suggested that older adults recover more quickly than younger adults from negative emotions over the span of hours or days (Carstensen et al., 2000; Hay & Diehl, 2011), the current results indicate effective recovery in older adults in a matter of minutes. However, it is important to note that age group differences in NA and Hostility did not remain significant when controlling for overall arousal ratings of the mood induction. Thus, it appears that older adults responded similarly to younger adults when ratings of the arousal of the film stimuli were held equivalent. This is consistent with prior findings that age group differences in responses to stressors tend to recede when controlling for contextual factors, like the frequency of stressors (Charles, Mogle, Urban,

& Almeida, 2016) or the ability to avoid stressors (Charles, Piazza, Luong, & Almeida, 2009).

There were age group differences in positive affects, both at baseline and in response to the negative mood induction, but there were no age group differences in the slope of reactivity and recovery in positive affects. Older adults reported higher PA and Assurance than younger adults at baseline, replicating past findings of greater self-reported PA in older adults (e.g., Carstensen et al., 2011; Mikels et al., 2014). PA decreased in response to the negative mood induction and increased during recovery at a similar rate in older and younger adults; thus, there is not support for differential modulation of PA in older and younger adults after a stressor. However, higher overall PA may serve as resource for older adults because higher baseline PA in older adults may have contributed to correspondingly higher PA during the immediate moments following a stressor.

Contrary to predictions of differential affective recovery in younger and older adults, results for discrete negative affects may in fact provide support for age group similarities rather than age group differences. Older adults reported greater recovery in negative affects, but this was at least partially accounted for by older adults finding the mood induction to be more arousing than younger adults. Thus, it is unclear whether the few age group differences in discrete affective responses (e.g., NA and Hostility) simply reflect differential impact of the mood induction. Older adults rated the film clip as more arousing; however, older adults still returned to baseline negative affect during the recovery period. Thus, there is some evidence that, consistent with prior research (Carstensen, et al., 2000; Hay & Diehl, 2011), older adults may modulate responses to

negative stressors more effectively than younger adults. These results are consistent with SST (Charles, 2005), in that older adults may be more motivated to engage with emotional experiences; older adults may also be more motivated than younger adults to return to baseline following engagement with negative stressors.

4.2 Co-occurrence of Positive and Negative Affect

Older adults evidenced greater co-occurrence of positive and negative emotions in response to the mood manipulation, both when comparing ME scores and when comparing the covariance between PA and NA after the mood induction. Greater co-occurrence across valences reflects a more mixed affective state; older adults simultaneously experienced higher NA and PA than younger persons in the moments following a stressor.

Greater co-occurrence of negative and positive emotions in older than younger adults in response to a negative stressor is consistent with theoretical models of adult development that posit more complex associative networks (Charles, 2005; Magai et al., 2006) and greater emphasis on emotional experiences across valence in old age (Carstensen et al., 2003). Though past research is mixed with regard to age group differences in emotion co-occurrence, the current results provide support for greater emotion co-occurrence in older than younger adults in the immediate moments following a stressor. Similar results of increased emotion co-occurrence in older adults have been found for self-reported emotions in daily life (Carstensen et al., 2000; Carstensen et al., 2011) and in narrative descriptions of stressful experiences (Lockenhoff et al., 2008).

There was not an age group difference in the slope of reactivity in PA and thus it is possible that greater co-occurrence between PA and NA in response to the mood

induction reflects mean differences in PA in older and younger adults, rather than differential modulation of PA (Figure 4). That is, older and younger adults were similarly reactive in PA (i.e., reported equivalent decreases in PA in response to the mood induction), but older adults reported higher PA initially and subsequently stayed at a higher level of PA after the mood induction. Greater PA immediately following the mood induction in older than younger adults may reflect age group differences in general emotional experience and well-being, rather than in direct modulation of emotion. Perhaps greater baseline PA serves as a resource for older adults; our results indicate that this resource is maintained in the face of negative stressors. Importantly, higher baseline PA may create more frequent opportunities for older adults to experience mixed emotions (Brose et al., 2015; Carstensen et al., 2000) because PA is thus more likely to remain higher in negative situations for older as compared to younger adults, even in the face of significant decline in PA in response to a stressor.

A propensity to experience both positive and negative emotions at once or to report some degree of positive emotion in the face of negative stressors may be well suited to techniques inherent in certain psychotherapeutic approaches. In particular, acceptance-based approaches instruct persons to act in ways that reflect one's greater values, instead of reacting directly to negative emotions in the moment (e.g., Hayes, 2004). If older adults tend to experience concurrent positive and negative emotions more readily than younger persons, they may be inherently more able to sustain positive emotions in the presence of negative emotions or resist acting in direct response to negative emotions. This framework may help explain why co-occurrence of negative and positive emotions is related to better emotional well-being (Hay & Diehl, 2011) and

physical health in older adults (Hershfield et al., 2013). Perhaps mixed emotional experiences serve as a protective resource for older adults, allowing them to more easily find meaning in negative situations (Tugade & Fredrickson, 2004) or to cope more effectively after engaging with stressors (Ong et al., 2006).

4.3 Positive Affect as a Resource for Negative Affect Recovery

Contrary to predictions, higher PA immediately following the mood induction did not predict greater recovery in NA. Previous findings have pointed to the role of positive affect in regulating sympathetic physiological arousal in the immediate moments following a stressor (Fredrickson et al., 2000), which may not closely correspond with subjective NA, especially for older adults (Tsai, Levenson, & Carstensen, 2000). Thus, it is possible that PA serves more directly as a resource for regulating immediate physiological arousal than for the subjective experience of NA. Alternatively, it is possible that an undoing effect of PA on subjective ratings of NA occurs over a longer period of time than the short-term recovery included in our paradigm, or is reflected in less direct measures of emotion well-being (e.g., resilience; Fredrickson, 2004). Although the current sample is adequately powered, it is also possible that the current methodological approach did not truly assess the association between PA and recovery in NA. Piecewise HLM models do not provide simultaneous parameter estimates for change in PA and NA, which may limit our ability to examine interactive associations between affects.

4.4 Study Limitations

The study samples were demographically homogeneous, and included relatively few male-identified participants. The lack of racial, ethnic, and socioeconomic diversity,

especially among the older adult sample, limits the generalizability of findings. Additionally, the film clips used in the negative mood induction may have been differentially relevant to older and younger adults due to their focus on interpersonal loss. Indeed, older adults rated the film clips as more activating than younger adults. However, younger and older adults did not differ in whether they were familiar with one or more of the film clips, and did not differ in how negatively they judged the film clips. Finally, we did not collect a measure of arousal at each time point. Instead, we collected an overall rating of arousal after the completion of the study procedures, which does not allow for consideration of how arousal changed over the course of the mood induction.

4.5 Future Directions

This study identified age group differences in emotion responses to film clips focusing on interpersonal loss. We purposefully did not define patterns of emotional response as adaptive or maladaptive; however, we did expect patterns of emotional response to reflect prioritization of hedonic well-being (i.e., greater PA and lesser NA). An important next step involves determining the short- and long-term impact of more mixed reactions to negative stressors. Perhaps the ability to engage with a negative experience in a nuanced way in the moment is associated with a greater likelihood of finding meaning in that experience (Tugade & Fredrickson, 2004), allowing for a more complex understanding of or appreciation for these events later on. Additionally, it is possible that more mixed emotional reactions in the setting of a stressor are associated with differences in the way that stressor is remembered later on. The presence of PA in the setting of a negative stressor may allow for easier reappraisal of the situation because this approach involves reinterpreting events or stimuli in a more positive way.

Additionally, further research is needed to determine the mechanisms that give rise to greater co-occurrence of positive and negative affect among older adults, and to identify specific ways that co-occurrence may be related to psychological outcomes and emotional well-being. Studies should also investigate individual difference factors that may be associated with emotion co-occurrence, including life experiences (e.g., Charles, 2005), personality traits (e.g., Ong & Bergeman, 2004), and propensity for affect asynchrony (i.e., independent fluctuation of PA and NA), which may function as a temperament-like trait (Rafaeli, Rogers, & Revelle, 2007)

The present study focused on cognitively healthy, high-functioning older adults. An important continuation of this research includes expanding this work to include older adults with mild cognitive impairment (MCI) and/or dementia. Healthy aging is associated with higher endorsement of emotional well-being (e.g., Carstensen et al., 2011). However, high rates of psychiatric symptoms and emotional difficulties are reported in MCI and dementia (e.g., Di Iulio et al., 2010; Monastero, Mangialasche, Camarda, Ercolani, & Camarda, 2009). Determining the ways in which emotion function in MCI and dementia differ from emotion function in healthy older adults may identify areas for intervention.

Table 1. Sample Characteristics and Descriptive Statistics

Variable	Younger Adults n = 71 *M* (*SD*) or %	Older Adults n = 44 *M* (*SD*) or %	Test Statistic
Age	19.84 (1.27)	66.36 (4.80)	$t(46.81) = -62.94$***
Female	74.6%	80%	$\chi^2(1) = 0.36$
Race			$\chi^2(4) = 6.49$
White	74.6%	93.2%	
Black	8.5%	2.3%	
Hispanic	2.8%	--	
Asian American	8.5%	2.3%	
Native American	--	2.3%	
Multiracial	5.6%	--	
Income			$\chi^2(5) = 4.98$
Less than $10,000	2.8%	2.3%	
$20,001-$30,000	8.5%	6.8%	
$30,001-$40,000	5.6%	11.4%	
$40,001-$50,000	15.5%	20.5%	
$50,001 or greater	67.6%	56.8%	
BDI-II	9.76 (8.72)	6.21 (5.79)	$t(109.45) = 2.60$*
Verbal IQ T Score[a]	46.53 (2.56)	52.61 (3.15)	$t(112) = -11.29$***
Arousal of film clips	3.64 (0.98)	4.36 (0.75)	$t(106) = -4.13$***
Valence of film clips	4.36 (0.92)	4.30 (0.95)	$t(106) = 0.35$
Familiar with film clips			$\chi^2(1) = 0.17$
Yes	85.9%	88.6%	
No	14.1%	11.4%	

Note. BDI-II = Beck Depression Inventory II.
[a]Verbal IQ estimated from scores on the American National Adult Reading Test (ANART).
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

Table 2. PANAS-X Scores for Younger and Older Adults

	Time1		Time 2		Time 3		Time 4		Time 5	
	YA	OA	YA	OA	YA	OA	YA	OA	YA	OA
Affect Scale	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
NA	12.88 (3.60)	12.83 (3.44)	11.55 (2.60)	10.64 (1.14)	16.38 (6.12)	17.59 (5.42)	12.64 (3.72)	12.32 (2.65)	11.93 (2.99)	11.34 (1.74)
Sadness	6.59 (2.50)	6.7 (2.70)	5.58 (1.35)	5.16 (0.48)	10.44 (3.19)	10.95 (3.23)	6.94 (2.19)	7.27 (2.05)	6.29 (1.84)	6.32 (1.68)
Hostility	6.69 (1.25)	6.82 (2.09)	6.39 (1.03)	6.07 (0.25)	10.96 (4.60)	12.20 (5.57)	7.26 (2.49)	7.30 (2.30)	6.85 (1.99)	6.75 (1.77)
Fear	8.13 (2.82)	7.83 (2.06)	7.24 (1.91)	6.70 (1.39)	8.75 (4.02)	8.61 (3.56)	7.27 (2.24)	7.05 (1.82)	6.84 (1.48)	6.68 (1.25)
Guilt	7.07 (2.07)	7.45 (2.92)	6.30 (1.03)	6.11 (0.62)	7.44 (2.36)	6.66 (1.40)	6.57 (1.50)	6.20 (0.67)	6.46 (1.69)	6.05 (0.21)
PA	26.13 (7.95)	31.36 (6.22)	21.03 (7.47)	26.84 (6.76)	17.08 (4.69)	22.98 (5.60)	18.11 (5.99)	24.30 (5.90)	18.01 (6.97)	25.18 (6.35)
Joviality	20.26 (6.82)	22.07 (5.43)	17.70 (7.36)	18.70 (6.16)	10.11 (3.27)	10.89 (3.13)	13.56 (4.76)	14.95 (4.62)	13.99 (6.00)	16.18 (4.96)
Assurance	13.29 (5.21)	15.74 (3.84)	10.83 (5.35)	12.70 (3.76)	8.37 (3.20)	11.07 (3.71)	9.27 (3.29)	12.25 (3.65)	9.57 (4.16)	12.50 (3.81)
Attentiveness	12.63 (3.19)	14.98 (2.46)	10.32 (3.19)	13.98 (2.58)	9.69 (3.11)	13.07 (2.97)	9.19 (3.15)	12.84 (2.84)	8.84 (3.52)	12.68 (2.79)

Note. YA = younger adults; OA = older adults; NA = negative affect; PA = positive affect.

Table 3. Parameter Estimates for Unconditional HLM Models

	Fixed Effects		
Affect Scale	Intercept γ (SE)	Piece 1 γ (SE)	Piece 2 γ (SE)
NA	1.16 (0.011)**	0.050 (0.0060)**	-0.055 (0.0055)**
Sadness	0.94 (0.011)**	0.10 (0.0080)**	-0.083 (0.0076)**
Hostility	0.96 (0.014)**	0.091 (0.0086)**	-0.080 (0.0074)**
Fear	0.88 (0.013)**	0.0096 (0.0062)	-0.032 (0.0054)**
Guilt	0.82 (0.0078)**	-0.00052 (0.0054)	-0.016 (0.0041)**
PA	19.33 (0.57)**	-4.30 (0.32)**	0.76 (0.23)*
Joviality	11.45 (0.37)**	-5.13 (0.32)**	1.82 (0.25)**
Assurance	9.47 (0.35)**	-2.31 (0.19)**	0.69 (0.15)**
Attentiveness	10.87 (0.32)**	-1.25 (0.15)**	-0.28 (0.11)*

*$p < .01$. **$p < .001$.

Table 4. Parameter Estimates for Multilevel Models Predicting Affect from Age, Estimated Verbal IQ, and Depressive Symptoms

		Final Models	
Fixed Effects	Intercept	Piece 1	Piece 2
	γ (SE)	γ (SE)	γ (SE)
NA			
Intercept	1.13 (0.017)**	0.036 (0.0089)**	-0.039 (0.0083)**
Age	0.080 (0.033)	0.035 (0.018)	-0.044 (0.016)*
BDI	0.0016 (0.0014)	-00.20 (0.00075)*	0.00067 (0.00070)
Est. VIQ	-0.0076 (0.0039)	-0.0034 (0.0022)	0.0043 (0.0019)
Sadness			
Intercept	0.92 (0.017)**	0.084 (0.012)**	-0.077 (0.011)**
Age	0.050 (0.034)	0.043 (0.024)	-0.016 (0.022)
BDI	0.00036 (0.0015)	-0.0042 (0.00098)**	0.0014 (0.00094)
Est. VIQ	-0.0046 (0.0041)	-0.0067 (0.0028)	0.0031 (0.0026)
Hostility			
Intercept	0.91 (0.020)**	0.063 (0.013)**	-0.054 (0.011)**
Age	0.14 (0.039)**	0.075 (0.026)*	-0.067 (0.021)*
BDI	0.0024 (0.0017)	-0.00053 (0.0011)	0.00029 (0.00092)
Est. VIQ	-0.017 (0.0047)**	-0.0088 (0.0031)*	0.0081 (0.0025)*
PA			
Intercept	17.61 (0.74)**	-3.98 (0.49)**	0.37 (0.35)
Age	4.52 (1.47)*	-0.88 (1.00)	1.04 (0.68)
BDI	-0.060 (0.062)	0.034 (0.041)	0.0057 (0.029)
Est. VIQ	0.24 (0.17)	0.21 (0.12)	-0.074 (0.081)
Joviality			
Intercept	11.67 (0.55)**	-4.52 (0.47)**	1.34 (0.37)**
Age	-0.60 (1.10)	-1.65 (0.97)	1.27 (0.74)
BDI	-0.0073 (0.047)	0.075 (0.040)	-0.0097 (0.031)
Est. VIQ	0.23 (0.13)	0.21 (0.12)	-0.090 (0.087)
Assurance			
Intercept	8.83 (0.49)**	-2.06 (0.29)**	0.54 (0.22)
Age	1.69 (0.98)	-0.69 (0.59)	0.38 (0.45)
BDI	-0.047 (0.042)	0.026 (0.024)	0.0017 (0.019)
Est. VIQ	0.15 (0.12)	0.16 (0.070)	-0.034 (0.053)

Note. NA = negative affect. PA = positive affect. Intercept values correspond to reported affect at Time 3 (i.e., immediately following the negative film clips). Parameter estimates for the Intercept reflect younger adults.
*$p < 0.01$. **$p < .001$.

Table 5. Random Effects for Multilevel Models Predicting Affect from Age, Estimated Verbal IQ, and Depressive Symptoms

	Random Effects			
Affect Scale	Residual Variance σ	Variance in Intercept τ (SE)	Variance in Piece 1 slope τ (SE)	Variance in Piece 2 slope τ (SE)
NA	0.0061	0.0088 (0.0018)**	0.00096 (0.00057)*	0.00044 (0.00051)
Sadness	0.013	0.0053 (0.0021)**	0.00060 (0.0010)	0.00001 (0.00095)
Hostility	0.0093	0.012 (0.0026)**	0.0034 (0.0011)**	0.0013 (0.00085)
PA	9.88	18.87 (3.55)**	6.43 (1.54)**	1.01 (0.87)*
Joviality	11.76	6.16 (2.12)**	4.99 (1.50)**	1.08 (1.02)
Assurance	3.70	9.02 (1.59)	2.12 (0.54)	0.66 (0.36)

*$p < 0.01$. **$p < 0.001$.

Table 6. Results of Mixed Measures ANOVAs Comparing Time 1 and Time 5 Affect Ratings

Affect Scale	Time point *F*	Age group *F*	Age X time point *F*
NA	16.68**	0.39	0.54
Sadness	1.04	0.06	0.00
Hostility	0.09	0.01	0.05
PA	139.76**	24.65**	3.10
Joviality	102.73**	3.58	0.09
Assurance	99.60**	10.78*	0.34

* $p < .01$. ** $p < .001$.

Table 7. Descriptive Statistics for Mixed Emotion Scores for NA and PA

	Mixed Emotion Score	
	M (*SD*)	Min - Max
Time 1		
Younger adults	12.59 (2.93)	10 - 24
Older adults	12.83 (3.44)	10 - 24
Time 2		
Younger adults	11.34 (1.93)	10 - 18
Older adults	10.64 (1.14)	10 - 14
Time 3		
Younger adults	13.80 (3.14)	10 - 25
Older adults	17.00 (4.45)	10 - 28
Time 4		
Younger adults	12.07 (2.88)	10 - 22
Older adults	12.32 (2.65)	10 - 20
Time 5		
Younger adults	11.43 (2.13)	10 - 20
Older adults	11.34 (1.74)	10 - 17

Table 8. Covariance Estimates from Multivariate Models for Younger and Older Adults

	PA	PA Piece 1	PA Piece 2	NA	NA Piece 1	NA Piece 2	Variance
	τ (*SE*)	τ (*SE*)	τ (*SE*)	τ (*SE*)	τ (*SE*)	τ (*SE*)	τ (*SE*)
PA	--	0.00015 (0.00091)	0.0018* (0.00082)	0.0031 (0.0017)	0.00073 (0.00081)	-0.00074 (0.00075)	0.010** (0.0023)
PA Piece 1	0.0014 (0.0011)	--	-0.00026 (0.00047)	-0.0013 (0.00092)	-0.00080 (0.00044)	0.00055 (0.00040)	0.0017* (0.00067)
PA Piece 2	-0.00005 (0.00096)	0.00006 (0.00049)	--	0.00088 (0.00085)	0.00033 (0.00040)	-0.00050 (0.00037)	0.0011 (0.00059)
NA	0.0033 (0.0017)	0.00027 (0.00080)	-0.0010 (0.00080)	--	0.0035* (0.0011)	-0.0026* (0.00098)	0.012** (0.0026)
NA Piece 1	0.0013 (0.0011)	0.00006 (0.00052)	-0.00043 (0.00052)	0.0029* (0.0013)	--	-0.00087 (0.00046)	0.0012 (0.00059)
NA Piece 2	-0.00077 (0.00089)	-0.00005 (0.00043)	0.00025 (0.00042)	-0.0015 (0.0010)	-0.00081 (0.00064)	--	0.00072 (0.00052)
Variance	0.0079* (0.0026)	0.00028 (0.00065)	0.00025 (0.00064)	0.0059 (0.0022)	0.0017 (0.00094)	0.00042 (0.00067)	--

Note. Younger adult values are above the diagonal; older adult values are below the diagonal.
*p < 0.05. **p < .001.

Table 9. Covariance Estimates from Multivariate Models for Younger and Older Adults Presented as Correlations

	PA	PA Piece 1	PA Piece 2	NA	NA Piece 1	NA Piece 2
	r	*r*	*R*	*r*	*r*	*r*
PA	--	.04	.53	.28	.21	-.28
PA Piece 1	.95	--	-.19	-.19	-.57	.51
PA Piece 2	-.04	.21	--	.25	.29	-.57
NA	.48	.21	-.85	--	.95	-.90
NA Piece 1	.36	.09	-.66	.91	--	-.94
NA Piece 2	-.42	-.14	.78	-.98	-.97	--

Note. Younger adult values are above the diagonal; older adult values are below the diagonal.

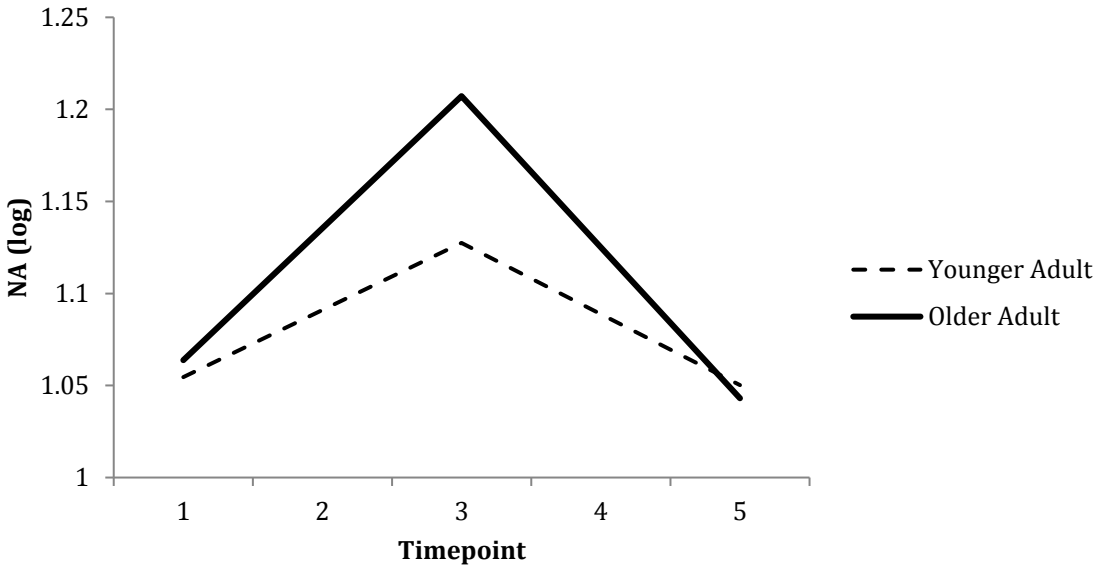

Figure 1. Older adults reported greater recovery in NA than younger adults.

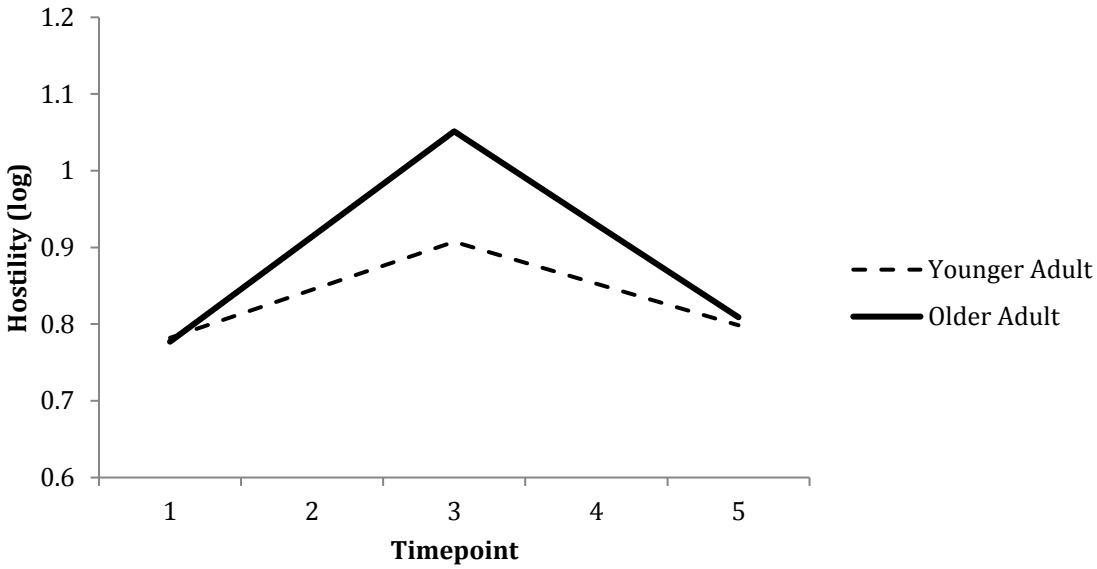

Figure 2. Older adults reported greater reactivity and recovery in Hostility than younger adults.

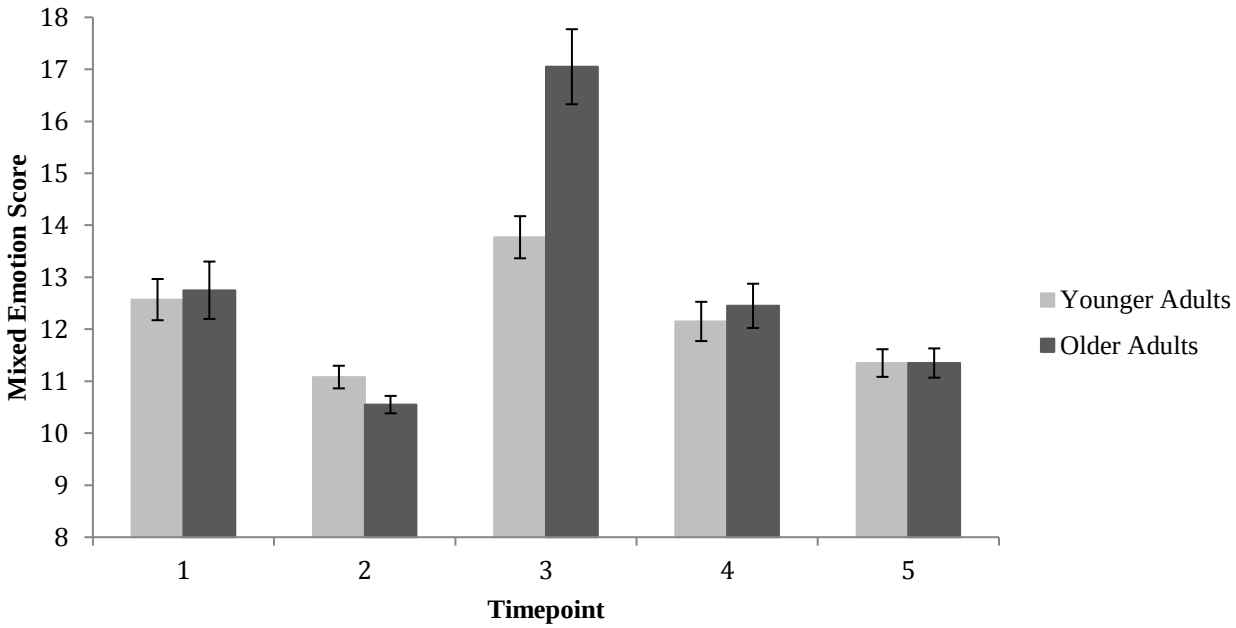

Figure 3. Older adults endorsed higher co-occurrence of NA and PA, as measured by a Mixed Emotion Score, than younger adults at Time 3 (i.e., in reaction to the negative mood induction), and at Time 1 (i.e., baseline), controlling for depressive symptoms, estimated VIQ, and arousal ratings.

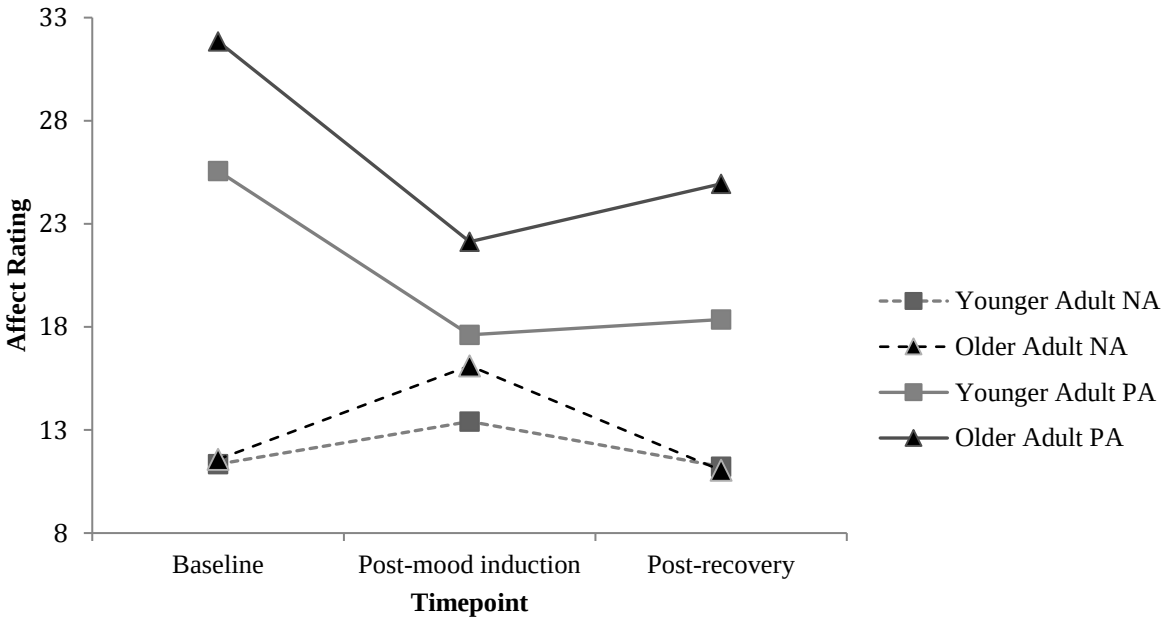

Figure 4. Trajectories of change in positive affect (PA) and negative affect (NA) in response to a negative mood induction in older and younger adults. Older adults reported greater NA and PA than younger adults immediately following the mood induction, resulting in greater mixed emotions.

APPENDIX

PANAS-X (Watson & Clark, 1994)

This scale consists of a number of words and phrases that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate <u>to what extent you have felt this way right now, at this MOMENT</u>. Use the following scale to record your answers:

1 very slightly or not at all	2 a little	3 moderately	4 quite a bit	5 extremely
_____ cheerful	_____ sad	_____ active		_____ angry at self
_____ disgusted	_____ calm	_____ guilty		_____ enthusiastic
_____ attentive	_____ afraid	_____ joyful		_____ downhearted
_____ bashful	_____ tired	_____ nervous		_____ sheepish
_____ sluggish	_____ amazed	_____ lonely		_____ distressed
_____ daring	_____ shaky	_____ sleepy		_____ blameworthy
_____ surprised	_____ happy	_____ excited		_____ determined
_____ strong	_____ timid	_____ hostile		_____ frightened
_____ scornful	_____ alone	_____ proud		_____ astonished
_____ relaxed	_____ alert	_____ jittery		_____ interested
_____ irritable	_____ upset	_____ lively		_____ loathing
_____ delighted	_____ angry	_____ ashamed		_____ confident
_____ inspired	_____ bold	_____ at ease		_____ energetic
_____ fearless	_____ blue	_____ scared		_____ concentrating
_____ disgusted with self	_____ shy	_____ drowsy		_____ dissatisfied with self

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