

**EMOTIONAL DEVELOPMENT ACROSS ADULTHOOD:
DIFFERENTIAL AGE-RELATED EMOTIONAL
REACTIVITY AND EMOTION REGULATION IN
A NEGATIVE MOOD INDUCTION PROCEDURE**

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ABSTRACT

The present study examines the hypothesis that older adults might differentially react to a negative versus neutral mood induction procedure than younger adults. The rationale for this expectation was derived from Socio-emotional Selectivity Theory (SST), which postulates differential salience of emotional information and ability to regulate emotions across adulthood. The present data support a view of differential age-related effects of negative mood inductions with greater and more heterogeneous emotional reactivity among older adults, who showed a substantially greater decrease in self-rated pleasantness, calmness, and wakefulness than younger adults. Moreover, relative to the younger adults, emotion regulation in terms of mood repair was more effective among the older adults. The age-related mood effects are discussed in terms of SST and have practical implications for the study of emotion and cognition across adulthood.

INTRODUCTION

Emotions and emotional states are fundamental motivators across the entire lifespan (Evans & Cruse, 2004; Schmitt & Juchtern, 2001). The present study

addresses *emotional reactivity*, i.e., the tendency to react to positive or negative events (Kunzmann & Gröhn, 2005) and also *emotion regulation*, i.e., the processes by which individuals (consciously or unconsciously) influence the experience and expression of emotions (for a review see Gross, 1998). Clearly, emotion regulation encompasses multiple distinct skills such as the maintenance or restoration of positive affect and the decrease of negative effect (e.g., Carstensen, Pasupathi, Mayr, & Nesselroade, 2000), or the regulation of expressive behavior during emotion-arousing events (e.g., Kunzmann, Kupperbusch, & Levenson, 2005).

EMOTIONS IN OLD AGE

Considering emotions across the *late adult* lifespan, an influential theory that has emerged over the past few years is the Socioemotional Selectivity Theory (SST; e.g., Carstensen, 1993, 1995; see Lawton, 2001, for other theories). The core assumption of SST is that in old age, there is a greater salience of emotional information and an increased emphasis on emotion regulation relative to early adulthood (Carstensen & Turk-Charles, 1994). This rationale is derived from the suggestion that the time left in life is perceived as limited in the older age (or in younger people approaching the end of life; Carstensen & Fredrickson, 1998), which results in older people being highly motivated to monitor and select their environments to optimize their emotions. In contrast, when time is perceived as expansive, as it is in healthy young adults, goal striving centers around acquiring novel information about the world (Carstensen, Isaacowitz, & Charles, 1999). In sum, SST posits that the regulation of emotional states receives greater priority as people age resulting in a greater salience of emotional information and a *decrease* of knowledge-acquisition goals. Consistent with the theory, older age seems to be associated with improved emotion regulation abilities (Gross, Carstensen, Pasupathi, Tsai, Gottestam, & Hsu, 1997; Lawton, Kleban, Rajagopal, & Dean, 1992) and a diminished prevalence of negative emotions in everyday life (Carstensen et al., 2000).

SST thus provides the rationale for anticipating age differences in *emotional reactivity* when younger and older adults are confronted with situations that include emotional information (e.g., Knight, Maines, & Robinson, 2002; Martin & Kliegel, 2005). In an incidental memory paradigm, Carstensen and Turk-Charles (1994) found that older people—relative to younger—remembered a greater proportion of emotional compared to neutral information from narratives. Hence, it can be predicted that older adults should show greater reactivity to events containing emotional information, while younger adults might mainly focus on the acquisition of neutral information (Carstensen, 1995).

However, some recent findings about attention to negative emotional information in the context of SST qualify this general expectation. In particular, Mather and Carstensen (2003) present evidence that where negative and neutral

faces were presented, older adults showed an attentional bias in favor of neutral faces, while younger adults did not exhibit this bias. Similarly, older adults' amygdala was found to show greater activation for positive pictures than for negative pictures, which was not the case for younger adults (Mather et al., 2004). Furthermore, relative to younger, older adults seem to remember negative information less well than positive information although the findings regarding the age-related remembering of negative versus positive information are still somewhat inconsistent (see Charles, Mather, & Carstensen, 2003; Comblain, D'Argembeau, Van der Linden, & Aldenhoff, 2004; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002; Mather & Carstensen, 2003; see Mather, 2004, for a review).

These findings indicate that older adults may tend to selectively inhibit negative information. Thus, especially with regard to situations containing *negative* emotional information, SST seems to provide competing expectations concerning age differences in emotional reactivity. The greater salience of emotional information to older adults might render them more reactive to negative emotional information. On the other hand, selective inhibition of negative information in the old age would suggest a diminished reactivity of the older to negative information.

A number of studies have investigated age differences in emotional reactions to standard emotional stimuli such as the International Affective Picture System (IAPS; Center for the Study of Emotion and Attention, 2001), although the results are not consistent across studies. Two studies did not find age differences in emotional reactivity (Denburg, Buchanan, Tranel, & Adolphs, 2003; Reminger, Kaszniak, & Dalby, 2000). In contrast, Smith, Hillman, and Duley (2005) found greater levels of self-reported valence and arousal in older compared with younger adults, independent of the emotional valence of the pictures. Finally, another study found that older people rated negative pictures from the IAPS as *less* emotionally arousing than the younger, whereas they experienced comparable emotional arousal to positive pictures (Mather et al., 2004).

Another growing body of literature has examined participants' emotional reactivity by using Mood Induction Procedures (MIPs; see Albersnagel, 1988; Chartier & Ranieri, 1989; Clark, 1983; Gerrards-Hesse, Spies, & Hesse, 1994; Goodwin & Williams, 1982; Martin, 1990). MIPs are techniques aimed to induce specific emotional states in participants and are often applied by explicitly telling the participants to try to experience a particular emotion (e.g., Larsen & Ketelaar, 1991). In contrast, MIPs can also be performed *without the explicit instruction* that a particular mood is being induced (e.g., Laird, Wagener, Halal, & Szegda, 1982), in this resembling incidental memory paradigms in which the studies' aim of testing memory is tried to be concealed. Such incidental paradigms more closely mimic everyday situations, and may be *relatively* less susceptible to variations in performance motivation or demand characteristics related to the

experiment per se *than paradigms in which explicit mood induction instructions are provided* (see Carstensen & Turk-Charles, 1994).

With regard to the direction of potential age differences in emotional reactivity to MIPs, the greater salience of emotional information in old age (Carstensen, 1993, 1995) might be expected to result in greater short-term effects of MIPs on emotional states in older adults. This would be consistent with Schulz (1985), who reasoned that although older people seem to be slower to become emotionally aroused in a neurological sense, once aroused their negative affect would be more intense. However, as mentioned above, especially in MIPs inducing negative emotions, the expectations may rather be somewhat unclear, since studies have found a selective inhibition of negative information associated with the old age (e.g., Mather & Carstensen, 2003). These findings would more likely lead to expect the older—relative to the younger—exhibit a diminished emotional reactivity to negative MIPs. In conclusion, SST seems to provide competing expectations also concerning the age-related effects of negative MIPs. Highlighting this somewhat equivocal prediction from the SST, Carstensen et al. (2000, p. 645) state that when comparing younger and older adults “. . . once negative emotions are elicited, the theory makes no claim about the intensity of the experience.” Therefore, empirical data from studies using different types of MIPs might be valuable in further elucidating the effects of aging on reactivity to negative emotions.

However, an overview of the existing literature shows that MIPs have rarely been used to directly compare emotional reactivity in young and old samples (Charles, 2005; Henry, Phillips, Maylor, Hosie, Milne, & Meyer, 2006; Knight et al., 2002; Kunzmann & Grün, 2005; Kunzmann et al., 2005; Labouvie-Vief, Lumley, Jain, & Heinze, 2003; Levenson, Carstensen, Friesen, & Ekman, 1991; Malatesta, Izard, Culver, & Nicolich, 1987; Phillips, Smith, & Gilhooly, 2002; Tsai, Levenson, & Carstensen, 2000), although it has been demonstrated that MIPs are valid in inducing emotional states also in older adults (Fox, Knight, & Zelinski, 1998). Importantly, most studies report no age differences in self-reported emotional reactivity to the MIPs (Knight et al., 2002; Labouvie-Vief et al., 2003; Levenson et al., 1991; Malatesta et al., 1987; Phillips et al., 2002; Tsai et al., 2000).

In contrast to these reports, Kunzmann and Grün (2005) looked at the effects of sad films on emotional reactivity in younger and older adults. The films contained depressing themes that were highly relevant to the older adults (e.g., the loss of loved ones or Alzheimer's Disease) and it was predicted that older participants would experience more intense sadness. This prediction was supported in all of the depressing films across two experiments (Kunzmann & Grün, 2005). Moreover, it was found that some of the depressing films—besides having an influence on sadness—also produced changes in other self-reported emotions, such as anxiety. The greater reactivity of older adults observed in this study was considered as a first, albeit indirect, indication that age differences in emotional

reactivity may be moderated by the age-relevance of the events (Kunzmann & Grühn, 2005; cf. also Charles, 2005). Other recent studies also suggest greater emotional reactivity in older adults to angering films about injustice (Charles, 2005; Henry et al., 2006).

Other evidence indicates that the impact of aging on emotion may well depend on the particular emotion being considered. Kunzmann et al. (2005) found that older adults—relative to the younger—reported *lower* levels of experienced disgust as a response to films containing medical procedures (cf. Labouvie-Vief et al., 2003, for similar findings regarding self-reported anger), whereas no age differences were found in other emotions (e.g., anxiety, sadness, anger).

In sum, empirical evidence regarding potential age differences in the emotional reactivity to MIPs is somewhat mixed with most of the studies showing comparable emotional reactivity across younger and older adults, while some recent studies directly (Henry et al., in press; Kunzmann & Grühn, 2005) or indirectly (Charles, 2005) indicated stronger mood induction effects in the elderly.

Another issue within the realm of aging and emotion concerns age-related *emotion regulation* abilities. So far, there have been only few empirical studies addressing this presumably complex relationship (Kunzmann et al., 2005). Self-report questionnaire studies indicate that older adults rate their emotion regulation abilities more highly than their younger counterparts (Gross et al., 1997; Lawton et al., 1992; Phillips, Henry, Hosie, & Milne, 2006). However, a study by Kunzmann et al. (2005) assessing emotion regulation in terms of the ability to suppress and amplify expressive behavior during emotional arousal found that older and younger adults did not differ in this emotion regulation ability, as assessed by subjective, behavioral, and physiological indicators. Based on their findings, Kunzmann et al. (2005) argued that older people's subjective evaluations of their emotion regulatory abilities (e.g., Gross et al., 1997) may be positively biased compared to their actual ability to regulate emotions. However, it should be acknowledged that expressive behavior as assessed by Kunzmann et al. (2005) only represents one distinct form of emotion regulation. Furthermore, expressed emotional behavior might not directly reflect the inner state of emotion regulation, since it is strongly influenced by social norms or other external pressures.¹ The majority of the literature on age effects on self-reported regulation of emotions relies on retrospective self-report questionnaires based on day-to-day experiences. It would be useful to explore age differences in emotion regulation abilities in performance-based tests that evaluate emotional regulation in a controlled situation, particularly because there exist findings showing that subjective evaluation of competence is not always accurate (see e.g., Heckhausen & Schulz, 1995; Taylor & Brown, 1988).

¹ We thank an anonymous reviewer for raising this issue.

THE PRESENT STUDY

Four issues were addressed in the present study. (A) Age-related emotional reactivity was investigated using a MIP aimed at inducing neutral versus negative mood in younger and older adults. By this means, we sought to test the competing expectations derived from SST regarding age-related emotional reactivity in negative MIPs. To achieve this, we applied a MIP successfully used in previous samples of younger adults (Kliegel, Horn, & Zimmer, 2003; Kliegel et al., 2005). Furthermore, in contrast to most of the previous studies that applied MIPs to young and old populations by explicitly telling the participants to try to feel the emotion (e.g., Knight et al., 2002; Labouvie-Vief et al., 2003; Levenson et al., 1991; Malatesta et al., 1987; Phillips et al., 2002), we attempted to reduce the influence of demand characteristics by not explicitly revealing to participants the purpose of the MIP (cf. Carstensen & Turk-Charles, 1994).

(B) We also aimed to investigate individual differences in emotional reactivity. Criticisms of MIPs have pointed to the low level of intensity of mood that often is produced in MIPs (Marston, Hart, Hileman, & Faunce, 1984) and the relatively low “success rate” of MIPs, i.e., the fact that sizeable percentages of participants do not show any or only very low mood changes (Albersnagel, 1988; Martin, 1990). Some studies have therefore used procedures aimed to select “mood responders”, i.e., participants that did in fact show substantial mood changes (e.g., mood changes that are greater than once or twice the groups’ standard deviations, respectively; cf. Bouhuys, Bloem, & Groothuis, 1995; Gerlsma & Albersnagel, 1987; Klaassen, Riedel, Deutz, & van Praag, 2002; Kliegel et al., 2005). Therefore, we analyzed both mean level group differences in mood changes as well as the number of mood responders.

(C) We aimed to extend previous research by investigating emotional reactivity in different aspects of negative emotion, because most of the MIP studies have used one-dimensional constructs identifying more or less positive and negative feelings, respectively (e.g., Knight et al., 2002; Phillips et al., 2002) and were thus not able to examine different facets of the emotions measured. Importantly, however, it has been argued that the impact of aging on emotion may well depend on the nature of the emotion being considered (Kunzmann et al., 2005). As indicated, age differences in emotional reactivity have been found in sadness and disgust, while there were no or mixed age differences with respect to anxiety, anger, hostility, and contempt (Henry et al., 2006; Kunzmann & Grünh, 2005; Kunzmann et al., 2005; Labouvie-Vief et al., 2003). Additionally, older adults may show a greater heterogeneity in their emotional reactions. In the present context, the term “heterogeneity” refers to the experience of multiple simultaneous emotions at one moment in time (cf. Charles, 2005; see also Carstensen et al., 2000). In other words, people exhibit heterogeneous emotional reactions when they are experiencing several different emotions at the same time rather than one single predominant emotion. A previous study seems to indicate that emotional

reactions of older adults are more heterogeneous relative to their younger counterparts when participants were confronted with depictions of injustice (Charles, 2005). However, it remains an open question whether older people also show a greater heterogeneity in their emotional reactions in other domains besides in their reactions to depictions of injustice. In consequence, we applied a self-rating instrument that provides information on three mood dimensions: pleasantness, calmness, and wakefulness. By this means, we were able to examine whether the prevalence of relatively heterogeneous emotional reactions to the negative MIP (e.g., an experience of simultaneous unpleasantness, restlessness, and sleepiness) and the prevalence of relatively more homogeneous emotional reactions (e.g., an experience of predominantly unpleasantness) differs as a function of age.

(D) The present study aimed to extend the examination of age differences in emotion regulation over time. So far, only the regulation of disgust has been examined in a controlled experimental situation (Kunzmann et al., 2005), and thus, we extend this investigation to another emotion: sadness. Kunzmann et al. (2005) predict that, given that irreversible losses increasingly occur in old age, it would be expected that older people may be especially skilled at regulating sadness. In this context, previous MIP studies have shown that participants induced with negative mood may show processes of emotion regulation during the experimental procedure, since they often regain a better mood after the negative mood induction (e.g., Albersnagel, 1988; Bouhuys et al., 1995; Kliegel et al., 2005; Knight et al., 2002; Phillips et al., 2002). Thus, in the present study, emotion regulation was assessed in terms of mood repair, i.e., the ability to (consciously or unconsciously) restore the equilibrium of more positive mood after a state of strong negative mood has been induced. To evaluate age-related emotion regulation abilities, we assessed self-ratings of emotional states at multiple points during the negative MIP. Importantly, this examination might complement the findings based on self-reports of age-related emotion regulation abilities, particularly in light of the recent argument that questionnaire-based reports of emotion regulation abilities and actual emotion regulation may be discrepant (Kunzmann et al., 2005). Given that SST proposes improved emotion regulation in old age (Carstensen et al., 2000; Charles et al., 2003), we expected older adults' emotion regulation to be faster and more effective relative to the younger adults, resulting in mood end-levels closer to the start levels.

METHODS

Participants and Design

The design of this study was a mixed $2 \times 2 \times 3$ factorial design with age group (younger adults vs. older adults) and mood group (neutral vs. negative) as the between-subjects factors, and time (i.e., repeated mood measurements: pre-induction measurement, post-induction measurement, and measurement at the end

of the experiment) as the within-subjects factor. A total of 60 individuals participated in the study: 30 younger adults ($M = 24.73$ years; $SD = 2.50$; range = 21-32; females = 13) and 30 older adults ($M = 68.43$ years; $SD = 5.48$; range = 60-79; females = 15). The participants were randomly assigned to the mood conditions (younger adults: $n = 15$ in the neutral mood condition [females = 5], $n = 15$ in the negative mood condition [females = 8]; older adults: $n = 15$ in the neutral mood condition [females = 8], $n = 15$ in the negative mood condition [females = 7]; note that gender distribution did not differ significantly between the two age groups neither within the neutral mood condition, $\chi^2(1) = 1.222, p = .269$, nor within the negative mood condition, $\chi^2(1) = .133, p = .715$). Most of the younger adults were undergraduate students, who were recruited from the student populations of the University of Zurich and the Eidgenoessische Technische Hochschule Zurich (none of them were psychology students). The older adults were community-dwelling volunteers. The participants were all paid the equivalent of 8 US dollars for their participation. In order to ensure comparability of age groups with respect to their verbal intelligence, participants were given the widely used German vocabulary test “Mehrfachwahl-Wortschatz-Intelligenztest” (MWT-A; Lehrl, Merz, Burkhard, & Fischer, 1991), which consists of 37 multiple choice items. Comparison of verbal intelligence of the two age groups did not show a significant difference ($t(58) = -.420, p = .676$) (note that based on previous findings (e.g., Lopes, Salovey, Côté, & Beers, 2005; Lopes, Salovey, & Straus, 2003) no significant relationship between verbal intelligence and emotional reactivity or emotion regulation was to be expected, and no event of the experimental procedure required any special verbal intelligence; nevertheless, we wanted to assess and compare the two age groups in terms of their verbal intelligence in order to control for potential cohort differences in formal school education). Older participants scored lower in self-rated health rated on a 5-point Likert-scale ($t(58) = -2.896, p < .010$), and older adults more often reported currently being on medication ($\chi^2(1) = 31.595, p < .001$). The age groups did not differ in years of education ($t(58) = .460, p = .647$) and gender distribution ($\chi^2(1) = .268, p = .605$).

Materials

Mood Measurement

We used the short form (consisting of 12 items) of the “Mehrdimensionaler Befindlichkeitsfragebogen” (MDBF; Steyer, Schwenkmezger, Notz, & Eid, 1994, 1997), a German multidimensional mood questionnaire to assess the effectiveness of the mood induction. The development of the MDBF (see Steyer et al., 1991; 1997) included the selection and rating of appropriate mood-related adjectives from 12 established German mood scales. The selection of the items relied on theoretical and empirical grounds (Steyer et al., 1997). Based on evidence about the factorial structure underlying these items, the following three MDBF dimensions were constructed: *pleasantness* (pleasant-unpleasant; 4 items),

calmness (calm-restless; 4 items), and *wakefulness* (awake-sleepy; 4 items). The short form of the MDBF has been found to have adequate reliabilities in a sample of 503 adults (Cronbach's alpha ranging between .83 and .89 for pleasantness, between .73 and .83 for calmness, and between .84 and .89 for wakefulness—see Steyer et al., 1997). Moreover, there is evidence for the factorial validity of the MDBF as well as convergent and discriminant validity of the MDBF in relation to other self-report measures such as the FPI-R (Fahrenbergh, Hampel, & Selg, 1984) or the German version of the Mood Survey (Steyer et al., 1997; Underwood & Froming, 1980). To fill in the MDBF, participants are required to rate each of the MDBF items on a 5-point Likert scale to indicate the degree to which the particular mood is experienced at that point in time. We assessed mood at three stages of the experiment: (1) before the mood induction, (2) after the mood induction, and (3) at the end of the experiment.

Mood Induction

The present study used a combined film + music MIP, with music continuing to play throughout the experiment after the induction with film segments (cf. Phillips et al., 2002). Six-minute film segments were used for the neutral versus negative mood induction that had been successfully used for this purpose in this lab before (Kliegel et al., 2003, 2005). The film segments were shown on the computer screen. The negative movie showed particularly sad and depressing scenes from the Crakow ghetto. The neutral movie was a segment from a nature documentary (topic: “Flora and Fauna of Meadows”). Mood-congruent music (taken from Gerrards-Hesse et al.'s, 1994, review; see also Fox et al., 1998; Knight et al., 2002) was turned on immediately after the presentation of the film segment (negative music: Albinoni's ‘Adagio G-Minor’; neutral music: Starck & Kevin's ‘In the Fields’) and was played throughout the rest of the session.

Procedure

Participants were tested individually. The study's purposes were described as investigating “films, emotions, and cognitive processes”. On arriving for the experiment, participants were given a brief overview of the tasks that would be completed during the testing session, informed consent was obtained, and participants filled out a short demographic questionnaire. After that, participants completed the MDBF for the first time. Then, the instructions for a cognitive distracter task were given and the participants performed a practice trial. Following this, the mood induction with film segments was carried out. The experimenter—who was always sitting in the background of the testing room—started the film and told the participants to carefully watch it. Importantly, the experimenter gave no comments about the potential emotional information of the films in order to try to reduce the participants' explicit awareness that a particular mood is induced. Immediately after the film, the experimenter started

the mood-congruent music (which was described as serving to equate the background noise for every participant) and participants completed the MDBF for the second time. Next, participants had to work on a word classification distracter task, which lasted 10 minutes (the distracter task was not in the scope of the present study and thus no performance data were obtained). At the end of the experiment, participants completed the MDBF for the third time. Then, the experimenter debriefed the participants and made sure that they were not experiencing a depressed mood before leaving the testing room and invited participants who experienced negative emotions to stay (however, no participant actually followed this invitation, indicating that no participant experienced strong negative emotions at the end of the experiment).

RESULTS

The effects of the MIP on self-rated mood scores at three different stages of the experiment (pre-induction measurement, post-induction measurement, measurement at the end of the experiment) were examined by univariate $2 \times 2 \times 3$ repeated measures analyses of variance (ANOVAs). The rejection level for inferring statistical significance was set at $\alpha = .05$, and the magnitude of the effects in the ANOVAs was indicated by η^2 (the proportion of variance accounted for by a particular effect). For cases in which the sphericity-assumption was violated, an adjusted test of significance using Greenhouse and Geisser's (1959) ϵ was used (cf. Jennings & Wood, 1976; the corrected probabilities are reported together with the uncorrected mean squares and degrees of freedom). When a significant effect was found in the omnibus ANOVA, single comparison t -tests (two-tailed) were performed to evaluate the differences between the means of the mood groups, for each age group separately. To preserve the overall significance level at $\alpha = .05$, the Bonferroni correction (i.e., $\alpha' = \alpha/k$; k = number of comparisons) was used to lower the significance level of the single comparisons to $\alpha' = .008$ with $k = 6$ (i.e., there were six single comparisons for every mood dimension). The magnitudes of the differences between the means of the mood groups were expressed in terms of the effect size d (Cohen, 1988).

Reliability of the MDBF

To examine the reliability of the MDBF (cf. Steyer et al., 1994, 1997) in the present sample, we calculated Cronbach's alpha for every MDBF dimension, for each mood measurement separately. For the pre-induction measurement, the post-induction measurement, and the measurement at the end of the experiment, Cronbach's alphas were .63, .88, and .76 for pleasantness, .80, .88, and .80 for calmness, and .82, .81, and .79 for wakefulness. In conclusion, the MDBF dimensions had acceptable reliabilities in the present sample although each dimension only consisted of 4 items and despite the moderate sample size.

MDBF Dimension Pleasantness

Self-rated MDBF mean scores concerning pleasantness and their course over the experimental session are illustrated separately for younger and older adults in Figure 1. The ANOVA results corrected with $\epsilon = .903$ revealed no significant main effect of age, $F(1, 56) = .072$, $MSE = 11.044$, $p = .789$, $\eta^2 = .001$, but a significant main effect of mood group, $F(1, 56) = 28.974$, $MSE = 11.044$, $p < .001$, $\eta^2 = .341$ resulting from lower self-rated pleasantness of the negative mood groups relative to the neutral mood groups. The main effect of time was significant, $F(2, 112) = 32.646$, $MSE = 4.468$, $p < .001$, $\eta^2 = .368$ showing that mood changed across time irrespective of age and mood group. There was no significant Age \times Mood Group interaction, $F(1, 56) = 2.326$, $MSE = 11.044$, $p = .133$, $\eta^2 = .040$, but a significant Age \times Time interaction, $F(2, 112) = 6.628$, $MSE = 4.468$, $p < .010$, $\eta^2 = .106$, such that older adults showed more fluctuations in self-rated mood across time than their younger counterparts, irrespective of mood group. The critical interaction for determining the overall success of the mood induction was the Mood Group \times Time interaction. This interaction was significant, $F(2, 112) = 33.395$, $MSE = 4.468$, $p < .001$, $\eta^2 = .374$ showing that mood actually changed in the negative mood groups across time whereas there was no change in the neutral mood groups. Moreover, the Age \times Mood Group \times Time interaction was significant, $F(2, 112) = 5.387$, $MSE = 4.468$, $p < .010$, $\eta^2 = .088$. This three-way interaction indicates that the age groups differed in the effects of the mood induction, such that older adults showed a greater emotional reactivity to the negative mood induction than the younger adults (see Figure 1).

Single comparisons were first performed for the younger age group and revealed that there was no significant difference in self-rated pleasantness between the neutral and the negative mood group before the mood induction ($d = .14$), but that there was a significant difference after the mood induction in the predicted direction ($d = 1.45$). By the end of the experiment, there was still a trend of lowered pleasantness experienced by the negative mood group that did not reach statistical significance ($d = .77$). The single comparisons in the older age group revealed similar results, i.e., no significant difference between the two mood groups before the mood induction ($d = .12$), a significant difference after the mood induction in the predicted direction that turned out to be extraordinarily large since it was greater than twice the pooled standard deviation of this mood measurement ($d = 2.42$), and a non-significant trend of a difference at the end of the experiment with the negative mood group scoring lower in self-rated pleasantness ($d = .66$).

MDBF Dimension Calmness

Self-rated MDBF mean scores concerning calmness and their course over the experimental session are illustrated separately for younger and older adults in Figure 2. The ANOVA results corrected with $\epsilon = .815$ revealed no significant

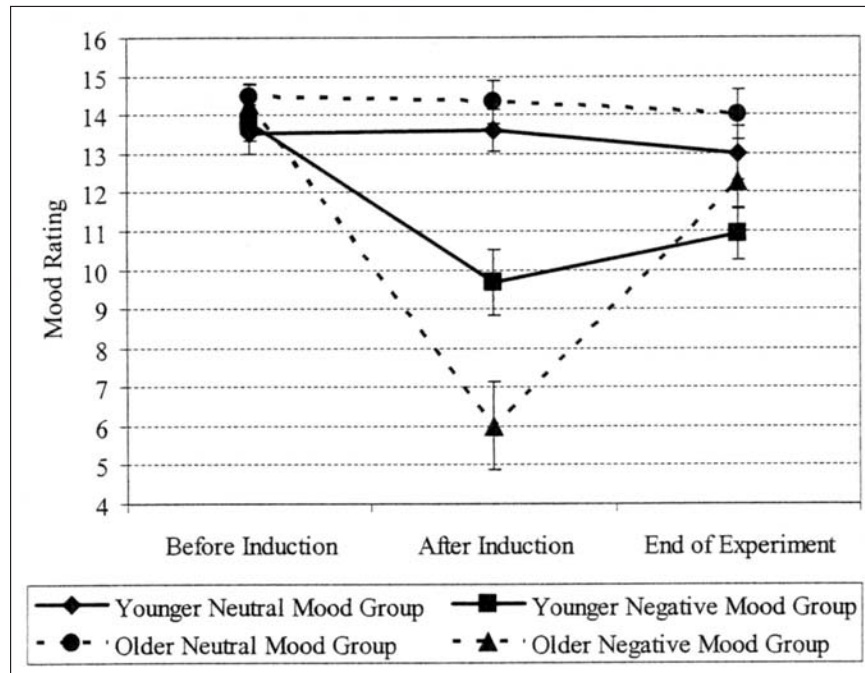


Figure 1. Mood ratings before the mood induction, after the mood induction, and at the end of the experiment in the MDBF dimension pleasantness.

Note: MDBF = Multi-dimensional mood questionnaire. Higher values indicate higher degrees of pleasantness. Bars represent the standard errors of the means.

main effect of age, $F(1, 56) = .557$, $MSE = 18.437$, $p = .459$, $\eta^2 = .010$, but a significant main effect of mood group, $F(1, 56) = 14.717$, $MSE = 18.437$, $p < .001$, $\eta^2 = .208$, and a significant main effect of time, $F(2, 112) = 14.666$, $MSE = 4.073$, $p < .001$, $\eta^2 = .208$. The Age \times Mood Group interaction was not significant, $F(1, 56) = .290$, $MSE = 18.437$, $p = .593$, $\eta^2 = .005$. There was a significant Age \times Time interaction, $F(2, 112) = 7.333$, $MSE = 4.073$, $p < .010$, $\eta^2 = .116$, and a significant Mood Group \times Time interaction, $F(2, 112) = 24.027$, $MSE = 4.073$, $p < .001$, $\eta^2 = .300$ showing that the mood induction also successfully influenced self-rated calmness. Moreover, the three-way Age \times Mood Group \times Time interaction was significant, $F(2, 112) = 8.119$, $MSE = 4.073$, $p < .010$, $\eta^2 = .127$, indicating that the age groups differed in the effects of the mood induction, such that older adults showed a greater emotional reactivity to the negative mood induction than the younger adults (see Figure 2).

Single comparisons in the younger age group revealed no significant difference between the two mood groups before the mood induction ($d = .66$), a significant

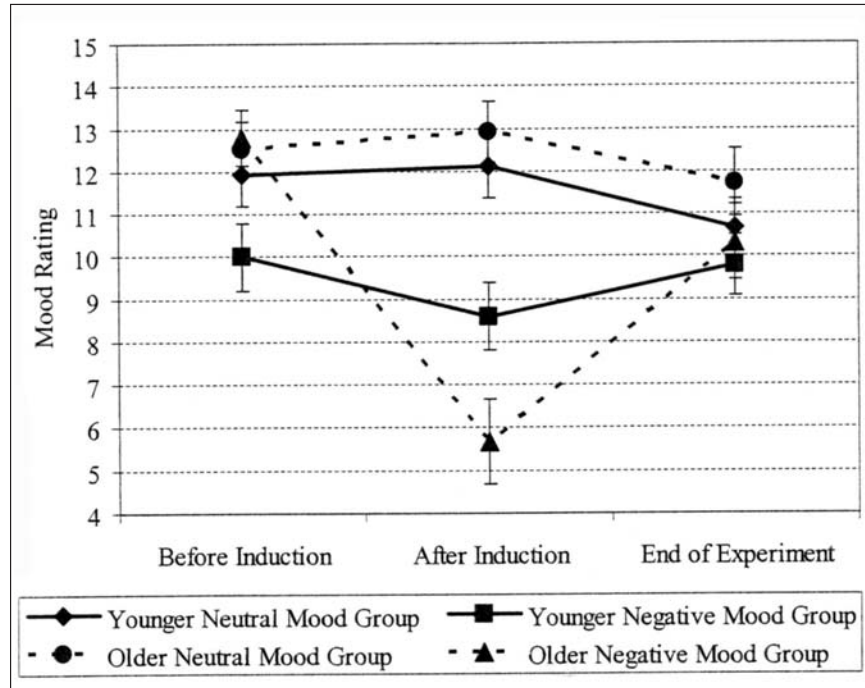


Figure 2. Mood ratings before the mood induction, after the mood induction, and at the end of the experiment in the MDBF dimension calmness.

Note: MDBF = Multi-dimensional mood questionnaire. Higher values indicate higher degrees of calmness. Bars represent the standard errors of the means.

difference after the mood induction ($d = 1.19$), and no significant difference at the end of the experiment ($d = .32$). In the older age group, the single comparisons revealed no significant difference before the mood induction ($d = .11$), a significant difference after the mood induction that was more than twice as large as the pooled standard deviation of this mood measurement ($d = 2.16$), and a non-significant difference at the end of the experiment ($d = .43$).

MDBF Dimension Wakefulness

Self-rated MDBF mean scores concerning wakefulness and their course over the experimental session are illustrated separately for younger and older adults in Figure 3. In this dimension, the ANOVA results corrected with $\epsilon = .936$ revealed that there was a significant main effect of age, $F(1, 56) = 10.868$, $MSE = 19.238$, $p < .010$, $\eta^2 = .163$, such that older adults reported being more alert than their

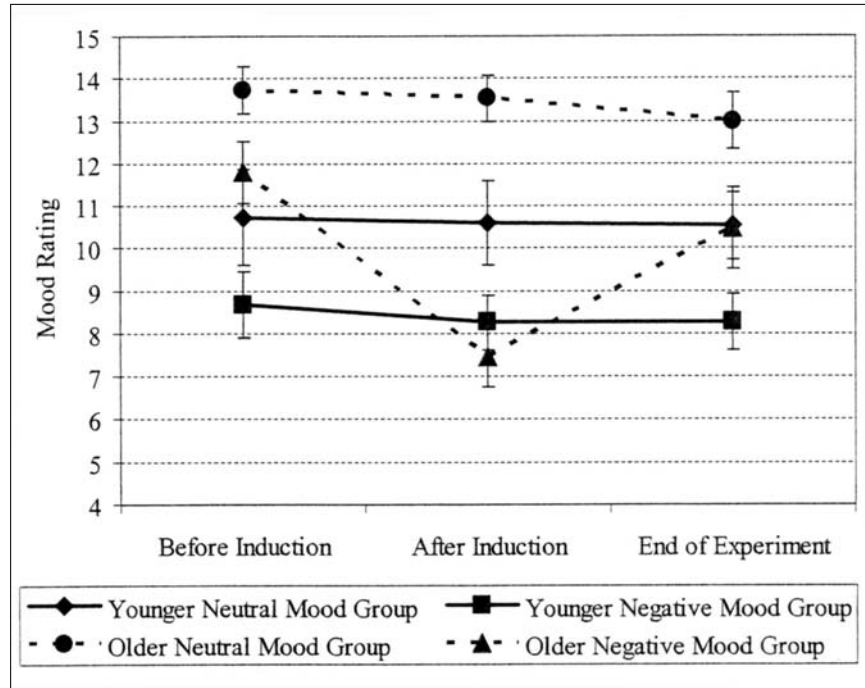


Figure 3. Mood ratings before the mood induction, after the mood induction, and at the end of the experiment in the MDBF dimension wakefulness.

Note: MDBF = Multi-dimensional mood questionnaire. Higher values indicate higher degrees of wakefulness. Bars represent the standard errors of the means.

younger counterparts, irrespective of mood group and time.² The main effect of mood group was significant, $F(1, 56) = 19.222$, $MSE = 19.238$, $p < .001$, $\eta^2 = .256$ resulting from lower self-rated wakefulness of the negative mood groups relative to the neutral mood groups. The main effect of time was significant, $F(2, 112) = 5.908$, $MSE = 4.077$, $p < .010$, $\eta^2 = .095$ showing that wakefulness changed across time, irrespective of age and mood group. There was no significant Age \times Mood Group interaction, $F(1, 56) = .971$, $MSE = 19.238$, $p = .329$, $\eta^2 = .017$, but a significant Age \times Time interaction, $F(2, 112) = 3.766$, $MSE = 4.077$, $p < .050$,

² The generally higher wakefulness of the older adults relative to the younger adults likely cannot be explained by differences in time of day at which the younger and older adults were tested (we thank an anonymous reviewer for raising this possibility), since 8 and 22 younger adults were tested before and after midday, respectively, and 9 and 21 older adults were tested before and after midday, respectively ($\chi^2(1) = .082$, $p = .774$). Thus, the reason for these age differences in wakefulness remains unclear.

$\eta^2 = .063$, such that older adults showed fluctuations in self-rated wakefulness across time whereas their younger counterparts did not. The Mood Group \times Time interaction was significant, $F(2, 112) = 5.052$, $MSE = 4.077$, $p < .010$, $\eta^2 = .083$ showing that the negative mood induction induced a decrease in self-rated wakefulness. Furthermore, the Age \times Mood Group \times Time interaction was significant, $F(2, 112) = 4.158$, $MSE = 4.077$, $p < .050$, $\eta^2 = .069$. This three-way interaction indicates that the age groups differed in the effects of the mood induction with regard to their wakefulness, such that the older adults showed a fluctuation in wakefulness as a response to the mood induction whereas the younger adults did not (see Figure 3).

The single comparisons in this mood dimension did not reveal any significant differences between the means of the two mood groups in the younger adults, although there were non-significant trends of differences especially in the post-induction measurement and in the measurement at the end of the experiment (d s = .55, .72, and .80, for the three mood measurements). The single comparisons in the older adults revealed that the two mood groups tended to differ from each other before the mood induction with the negative mood group reporting lower wakefulness ($d = .78$),³ but this difference was not statistically significant. Furthermore, there was a significant difference between the two mood groups after the mood induction with largely reduced self-rated wakefulness in the negative mood group ($d = 2.48$). At the end of the experiment, there was still a non-significant trend of lowered wakefulness in the negative mood group ($d = .79$).

Age-Related Correlations between MDBF Dimensions

The preceding ANOVAs have shown that whereas the negative mood condition had an effect only on self-rated pleasantness and calmness among the younger adults, this manipulation had a somewhat more widespread effect on the older participants because the MIP also influenced their wakefulness. However, to determine whether this differential age-related effect of the MIP on self-reported wakefulness was due to the fact that the three MDBF dimensions might be more strongly related among the older than among the younger negative mood group (see footnote 1), we investigated the relationship between the three MDBF dimensions for each mood measurement, for each age group, and for each mood group, separately. The main critical comparison is the pre-induction

³ The non-equivalence in self-reported wakefulness between the mood groups of each age group does not seem to be due to differences in time of day at which the two mood groups were tested, since neither in younger adults ($\chi^2(1) < .001$, $p > .999$) nor in older adults ($\chi^2(1) = .159$, $p = .690$) the two mood groups differed in time of day at which they were tested (i.e., before vs. after midday). Therefore, the reason for why the two mood groups of each age group tended to differ in self-reported wakefulness in the pre-induction measurement remains unclear.

measurement, because this mood measurement might reveal whether the three MDBF dimensions were more strongly correlated among the older than among the younger adults. As can be seen from Table 1, the three MDBF dimensions were not entirely independent from each other, as there were significant correlations between them. More central for the present purposes, although the correlations in the pre-induction measurement were slightly greater for the older adults of the negative mood group than for the younger adults of the negative mood group, these differences did not approach significance ($z_s < .66$, $ps > .509$), indicating that the relationship between pleasantness, calmness, and wakefulness was comparable for both negative mood groups across age. Also in the post-induction measurement and in the mood measurement at the end of the experiment, the correlations did not differ significantly between the younger and the older negative mood group (post-induction measurement: $z_s < 1.29$, $ps > .197$; measurement at the end of the experiment: $z_s < .74$, $ps > .459$), which provides further evidence that the general relationship between pleasantness, calmness, and wakefulness did not differ substantially between the younger and the older negative mood group.

Table 1. Correlations between the Three MDBF Scales for Each Mood Measurement

Age group	Mood group	MDBF dimension	Before induction		After induction		End of experiment	
			1.	2.	1.	2.	1.	2.
Younger adults	Negative	1. Pleasantness	—	—	—	—	—	—
		2. Calmness	.48 [†]	—	.69**	—	.85***	—
		3. Wakefulness	.50 [‡]	.24	.60*	.66**	.54*	.58*
	Neutral	1. Pleasantness	—	—	—	—	—	—
		2. Calmness	.32	—	-.05	—	.19	—
		3. Wakefulness	.29	.25	.52*	.47	.65**	.39
Older adults	Negative	1. Pleasantness	—	—	—	—	—	—
		2. Calmness	.66**	—	.88***	—	.79***	—
		3. Wakefulness	.55*	.33	.68**	.44	.72**	.61*
	Neutral	1. Pleasantness	—	—	—	—	—	—
		2. Calmness	.22	—	.60*	—	.26	—
		3. Wakefulness	.69**	.31	.73**	.29	.79***	.20

Note: MDBF = Multi-dimensional mood questionnaire.

[†] $p < .07$. [‡] $p < .06$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Age-Related Variability in Self-Reported Mood

In all previous repeated measurements ANOVAs, the results had to be corrected using Greenhouse and Geisser's (1959) ϵ . This indicates that variances were not homogenous across the mood measurements. Moreover, the variances of the mood measurements might also vary as a function of age. In consequence, to be able to accurately interpret the effect sizes in terms of Cohen's (1988) d for the mean differences in self-reported mood (see the analyses of mean level differences above), it might be valuable to examine the age-related and mood group-related *variability* in self-rated mood across the three mood measurements. To make this point clearer, for instance, the older adults of the negative mood group showed an extraordinarily large effect size for the post-induction measurement of pleasantness ($d = 2.42$), whereas the same effect was substantially smaller for the younger adults ($d = 1.45$). Based on this result, one might infer that the MIP had a much greater effect on the older adults' than on the younger adults' self-rated pleasantness. However, the greater effect size for the older adults might also have partly resulted from a smaller variability of the older adults in self-reported pleasantness relative to the younger adults, which would lead to a smaller Cohen's d denominator for the older adults and thus a greater effect size (see footnote 1). To investigate this possibility, we report the standard deviations for each age group and for each MDBF dimension in Table 2, separated by mood group and

Table 2. Standard Deviations for Each MDBF Dimension and for Each Mood Measurement

Age group	Mood group	MDBF dimension	Before induction	After induction	End of experiment
Younger adults	Negative	Pleasantness	1.78	3.24	2.67
		Calmness	3.07	3.07	2.76
		Wakefulness	2.97	2.49	2.55
	Neutral	Pleasantness	2.10	2.06	2.73
		Calmness	2.82	2.88	2.64
		Wakefulness	4.38	3.81	3.07
Older adults	Negative	Pleasantness	1.98	4.36	2.71
		Calmness	2.54	3.87	3.46
		Wakefulness	2.81	2.75	3.70
	Neutral	Pleasantness	1.36	2.16	2.51
		Calmness	2.50	2.77	3.08
		Wakefulness	2.12	2.10	2.62

Note: MDBF = Multi-dimensional mood questionnaire.

mood measurement. Several Mauchly's tests of sphericity with $\alpha = .20$ revealed that for the age-separated neutral mood groups, the variances were not homogenous across the three mood measurements, except for the younger adults' self-rated pleasantness. For the age-separated negative mood groups the variances were not homogenous neither, except for the younger adults' self-rated calmness. Inspection of the standard deviations revealed that—among the negative mood groups—from the pre-induction measurement to the post-induction measurement there was a pronounced increase in the variability of self-rated calmness among both the younger and the older adults, and an increase in the variability of self-rated pleasantness among the older adults. More important for the present purposes is the fact that the older adults of the negative mood groups showed a numerically *greater* variability in self-rated pleasantness and calmness than their younger counterparts in the post-induction measurement (although these differences in variability were not significant, $F_s < 1.094$, $p_s > .304$), whereas for the other mood measurements, particularly those before the mood induction and at the end of the experiment, there were generally no apparent age differences in the variability of self-rated mood. This result indicates that the greater effect size of the older adults regarding the effects of the MIP as assessed in the post-induction measurement were not boosted by a smaller variability among the self-reports of the older; in fact, the variability tended to be *greater* among the older relative to the younger adults in the post-induction measurement.

Analysis of Substantial Mood Changes

We used two (less versus more conservative) criteria to decide which individual participants showed substantial mood changes as a response to the negative mood induction (see Bouhuys et al., 1995; Gerlsma & Albersnagel, 1987; Klaassen et al., 2002, Kliegel et al., 2005, for similar procedures): We calculated the proportion of participants who showed decreases from the pre-mood induction measurement to the post-mood induction measurement that were greater than once or twice the groups' standard deviations of self-reported mood. The critical standard deviations were obtained by averaging the standard deviations of the negative mood group of the target age group across the three mood measurements. Table 3 shows the critical standard deviations and the exact number and percentage of participants within the younger and the older negative mood group that fulfilled the less conservative or the more conservative criterion, respectively, for each MDBF-dimension separately. Overall, across all dimensions and criteria applied, there were many more mood responders amongst the older adults compared to the younger adults.

DISCUSSION

The present study was aimed at investigating age-related emotional reactivity to a Mood Induction Procedure (MIP) inducing younger and older adults into

Table 3. Analysis of Substantial Mood Changes Within the Negative Mood Groups

MDBF-dimension	Age group	<i>SD</i>	# _{1SD}	% _{1SD}	# _{2SD}	% _{2SD}
Pleasant-Unpleasant	Younger adults (<i>n</i> = 15)	2.56	10	67%	5	33%
	Older adults (<i>n</i> = 15)	3.02	13	87%	10	67%
Calm-Restless	Younger adults	2.96	7	47%	0	0%
	Older adults	3.29	11	73%	8	53%
Awake-Sleepy	Younger adults	2.67	3	20%	1	7%
	Older adults	3.09	10	67%	5	33%

Note: *SD* = Critical standard deviation obtained by averaging the standard deviations of the negative mood group within the target age group across the three mood measurements; #_{1SD} or #_{2SD} = Number of participants of the negative mood condition that fulfilled the less conservative or the more conservative criterion for substantial mood changes, respectively; %_{1SD} or %_{2SD} = Percentage of participants of the negative mood condition that fulfilled the less conservative or the more conservative criterion for substantial mood changes, respectively.

neutral versus negative mood. Overall, the present film + music mood induction was revealed to be mostly effective in inducing relatively strong mood changes both in younger (cf. Kliegel et al., 2005) and—especially so—in older adults, by this providing further evidence for the utility of MIPs in older adults (cf. Fox et al., 1998). Importantly, in the pre-induction measurement there were no significant differences in self-rated mood between the two mood groups, which provides evidence that the significant differences in the post-induction measurement were due to the MIP rather than to baseline differences in self-rated mood. However, note that some of the effect sizes indicating the mean group differences in self-rated mood in the pre-induction measurement reflected a medium or large effect (especially for wakefulness), which indicates that insufficient statistical power may partially account for these non-significant differences. Nevertheless, the group-related changes of self-rated mood *across time* strongly confirm that the present MIP was effective in inducing neutral versus negative mood.

Our first research question concerned age differences in the emotional reactivity to a negative MIP. According to Socioemotional Selectivity Theory (SST; Carstensen, 1993, 1995), which postulates differential susceptibility to emotional information across the lifespan, we hypothesized that a MIP might have differential effects in younger and older adults. In the present study, reliable Age × Mood Group × Time interactions found in all of the three MDBF dimensions indicated that there were indeed age differences in emotional reactivity to the MIP. Note that for each MDBF dimension, the complex interplay between age, mood

group, and time explained a proportion of variance that corresponded to a medium or large effect, as indicated by the effect sizes η^2 (cf. Cohen, 1988). The central finding of this study is that older people reacted *more strongly* to the negative mood induction than younger adults. The direction of this age-effect seems consistent with an expectation derived from SST that older adults show substantial mood changes to a highly salient negative MIP (Carstensen, 1993, 1995; Carstensen & Turk-Charles, 1994). The competing hypothesis that older adults might inhibit the negative information in a negative MIP was clearly rejected by the present data. From the pre-induction measurement to the post-induction measurement, the effect sizes comparing neutral with negative mood groups increased by factors of 20.2, 19.6, and 3.2 (for pleasantness, calmness, and wakefulness, respectively) among the older adults, while they increased by substantially smaller factors of 10.4, 1.8, and 1.3 among the younger adults. In line with the age-related effect sizes, the analysis of how many individuals showed substantial mood changes (tapping our second research question) further supported stronger mood induction effects in the older participants. Importantly, the analysis of age-related *variability* in self-reported mood across time seemed to rule out the possibility that the effect sizes for the older adults might have been artificially boosted by a smaller variability among the older relative to the younger adults, because the older adults in fact showed a numerically *greater* variability in self-rated pleasantness and calmness in the post-induction measurement. This result even strengthens the conclusion that the MIP had stronger effects on the older adults relative to the younger adults, because the greater variability among the older even tends to diminish the effect sizes indicating the mean level differences between the two mood groups of the older adults.

The higher emotional reactivity of the older participants in response to the present MIP contrasts with many previous studies indicating equivalent emotional response across age groups to MIPs (Knight et al., 2002; Labouvie-Vief et al., 2003; Levenson et al., 1991; Malatesta et al., 1987; Phillips et al., 2002; Tsai et al., 2000), while only some recent findings demonstrated a greater emotional reactivity of the older (e.g., Henry et al., 2006; Kunzmann & Grühn, 2005). Greater reactivity of older adults to some negative MIPs might be moderated by the age-relevance of the events (Kunzmann & Grühn, 2005; cf. also Charles, 2005). The film material in the current study was likely to have had higher relevance to the older sample because it showed a scene that was linked to World War II. However, contrasting evidence to this suggestion comes from studies that have found greater emotional reactivity of the older to stimuli or film clips which do not seem to have a particularly high relevance to older adults (Henry et al., 2006; Smith et al., 2005; see also Charles, 2005). Alternatively, we argue that some of the previous studies might not have used MIPs that were strong enough to lead to age differences in emotional reactivity (e.g., Phillips et al., 2002), given that age differences in emotional reactivity might most probably emerge in strong mood inductions rather than in MIPs inducing weak mood changes.

Still another explanation of the discrepant findings is that most of the previous MIP studies explicitly told the participants to try to feel and induce the emotion (e.g., Knight et al., 2002; Labouvie-Vief et al., 2003; Levenson et al., 1991; Malatesta et al., 1987; Phillips et al., 2002). However, paradigms in which the aim of the study to induce particular emotional states is not explicitly explained to the participants may be better suited for testing age differences in the salience of emotional information, because the processing of such situations is presumably less susceptible to demand characteristics than the processing of situations where the participants are explicitly instructed to focus on emotional information (see Carstensen & Turk-Charles, 1994).⁴ For instance, when younger adults are instructed that they should focus on the emotional aspects of the information, this might reduce their tendency to predominantly engage in other, more neutral aspects of cognitive processing such as knowledge-acquisition. In contrast, where there is no specific emotion instructions younger adults might engage in cognitive processing to a relatively higher degree, which would diminish their resources that are potentially allocated to the emotional information. In the present study, participants were not explicitly told to focus on the emotional information. In consequence, the greater emotional reactivity of the older could have emerged because the younger adults might have engaged in neutral cognitive processing (e.g., in trying to memorize the details of the film segments) to a relatively high degree while their processing of emotional information was reduced. By contrast, the older adults might have put relatively more emphasis on the processing of emotional information in comparison to the younger adults, while their processing of neutral information might have been reduced. These age differences in the relative emphasis on neutral cognitive processing versus processing of emotional information might have contributed to the older adults' greater emotional reactivity, an explanation that would be consistent with the proposal of SST that emotional information has a higher salience in old age (see e.g., Carstensen & Turk-Charles, 1994). To disentangle the different explanations of age differences

⁴ Importantly, note that our assumption is *not* that that in MIPs where the processing of emotional information is not explicitly instructed, the participants are entirely unaware of the study's purposes. Especially since the participants were confronted with repeated mood measurements and the emotionally valenced stimulus material, it is likely that some of them inferred the study's purposes. Instead, we only claim that in MIPs such as the present the participants are less likely to focus on the emotional information than in MIPs where they are explicitly instructed to do so. Moreover, we do *not* wish to claim that MIPs such as the present are totally free from demand characteristics, it is only assumed that in the present MIP demand characteristics might play a smaller role than in MIPs where the focus on emotional information is explicitly addressed by the instructions. Unfortunately, we did not estimate the involvement of demand characteristics in post-experiment interviews. Therefore, the possibility remains that potential demand characteristics might have influenced the older adults more strongly than the younger adults, which could partly explain our findings of age differences in emotional reactivity (we thank an anonymous reviewer for raising this possibility). Future studies applying MIPs to participants of different age groups should thus assess the relative contribution of demand characteristics to the observed pattern of age-related findings.

in emotional reactivity considered so far, an avenue for further studies may be to systematically vary the degree of the age-relevance of the stimulus material, the strength of the MIP, and the participants' focus on neutral versus emotional information.

Our third research question addressed the different aspects of emotions that might be influenced by negative emotion-arousing events. In the present study, the negative MIP produced changes in self-rated pleasantness, calmness, and wakefulness. Note that the correlational findings presented in Table 1 revealed that the three mood dimensions were not entirely independent from each other, which is not very surprising (see Steyer et al., 1994, 1997; Watson & Tellegen, 1985, for similar findings). In consequence, the present MIP must be considered as having yielded a combined effect on correlated mood dimensions rather than influencing independent domains of emotions. More central for the present purposes, differential age-effects regarding the three mood dimensions emerged because the mood induction largely decreased self-rated pleasantness in younger adults, with a relatively small effect on calmness; in contrast, amongst older adults, pleasantness and calmness were both strongly affected, and there was also a significant decline in self-rated wakefulness. In other words, the older adults showed a greater heterogeneity in their emotional reactions to the MIP as their younger counterparts. The age-related correlations between the three MDBF dimensions (see Table 1) indicated that the relatively selective influence of the MIP on the older adult's wakefulness did not seem to be merely an artifact produced by a potentially higher relationship between the three mood dimensions for the older relative to the younger adults induced into negative mood. In more detail, there was no significant age difference in the relationship between self-rated pleasantness, calmness, and wakefulness among the negative mood groups neither in the pre-induction measurement nor in the other mood measurements (however, note that insufficient power might have masked the numerical age differences in the relationship between the three mood dimensions). Taken together, the correlational findings indicate that the negative mood induction had differential age-related effects across the three mood dimensions that does not seem to be an artifact of a substantially stronger relationship between the mood dimensions for the older adults. The present findings extend previous work, which indicated that the impact of aging on emotion may well depend on the particular emotion being considered (Kunzmann & Grühn, 2005; Kunzmann et al., 2005; Labouvie-Vief et al., 2003). Our findings suggest that younger adults' feeling of wakefulness may be relatively resistant to strong negative emotion-arousing events, while older adults might react with a reduction in subjective wakefulness to this kind of situations. However, the reason for this decrease in wakefulness as a response to the negative MIP remains mostly unclear. One possibility might be that the older adults of the negative mood group might have set themselves into a state of sleepiness as a defence against the overwhelming negative affects resulting from the depressing film clip. The present findings across the three

MDBF-dimensions are consistent with the recent finding that older adults—relative to the younger—demonstrated greater heterogeneity in their emotional reactions to scenes of injustice (Charles, 2005). Thus, the present study provides evidence that the older adults' greater emotional heterogeneity seems to generalize to other situations as those containing scenes of injustice, although the possibility cannot be ruled out that the present MIP contained depictions of injustice as well (see footnote 1). In consequence, future studies should further examine under which circumstances age differences in emotion heterogeneity might or might not emerge.

The fourth research question aimed at extending the examination of age differences in emotion regulation (see Kunzmann et al., 2005). In the present study, emotion regulation was assessed in terms of mood repair, i.e., the ability to (consciously or unconsciously) restore the equilibrium of more positive mood after a state of strong negative mood has been induced. Similarly to previous studies (e.g., Albersnagel, 1988; Bouhuys et al., 1995; Knight et al., 2002), participants induced with negative mood showed processes of mood repair during the experimental procedure, since in general, their self-rated mood did not differ significantly from the neutral mood groups at the end of the experiment (however, there were some non-significant trends of differences between the mood groups, which would likely become significant when increasing power by using larger sample sizes; nevertheless, the effect sizes were largely diminished in the last mood measurement). Interestingly, although mood-congruent music was played throughout the experimental procedure, the participants were successful in (consciously or unconsciously) restoring the equilibrium of more positive mood. The changes of the effect sizes clearly highlight the more effective mood repair among the older adults. From the post-induction measurement to the measurement at the end of the experiment, the effect sizes (indicating the differences between the mood groups) decreased by the factors of 3.7, 5.0, and 3.1 (for pleasantness, calmness, and wakefulness, respectively) among the older adults, while they decreased by smaller factors of 1.9, 3.7, and 0.9 among the younger adults. Thus, the present study adds to the evidence for an increase of emotion regulation abilities across adulthood as indicated by self-reports (Gross et al., 1997; Lawton et al., 1992) and is in accordance to findings showing that among older people, periods of highly negative emotional experience seem to be less stable than among younger adults (Carstensen et al., 2000). In consequence, the present findings qualify the suggestion that older people's subjective evaluations of their emotion regulatory abilities may be positively biased (cf. Kunzmann et al., 2005).

In terms of conclusion, the present study demonstrated that—at least under some circumstances (cf. Kunzmann & Grühn, 2005)—older people exhibit greater emotional reactivity than younger adults and thus clearly show no impoverished ability to emotionally react to negative events. Furthermore, older adults also showed a greater heterogeneity in the mood dimensions that were influenced by the emotion-arousing event (cf. Charles, 2005). Finally, the present study has

provided further evidence for the older adults' self-reports of improved emotion regulation abilities relative to the young (Gross et al., 1997). However, in common with all research on this topic, the present study examined age-effects in a cross-sectional design. Therefore it remains unclear whether differences between younger and older adults were truly age-related or were partially due to cohort differences. Further studies should thus examine intraindividual changes in domains such as emotional reactivity and emotion regulation in longitudinal designs to accurately delineate emotional development across the lifespan. Moreover, a discussion of internal versus external validity seems warranted regarding the interpretation of our findings. The presumably high internal validity of the present experimental manipulation might have been purchased at the price of external validity. In other words, a second limitation of the present study is that we cannot determine whether our findings within the well-controlled laboratory situation generalize to real life. For instance, age differences in emotional reactivity and emotion regulation might not necessarily occur in real-life. Moreover, it remains an open question whether the changes in self-rated mood that was produced by the MIP would have practical relevance when they occurred in real-life situations.

In sum, from a theoretical perspective, the present data are consistent with some of the expectations derived from Socioemotional Selectivity Theory and have practical and theoretical implications for future research examining the relationship between emotion and cognition across the lifespan.

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