Age-related differences in instructed positive reappraisal and mindful attention

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Abstract

Objective: The present study assessed age-related differences in the success of instructed mindful attention and positive reappraisal, as well as trait affect and emotion regulation.

Methods: Young and older adults were instructed to regulate their emotions while viewing frightening and amusing films using three separate instructions (just watch, positive reappraisal, or mindful attention). Participants rated the strength of their experience of the target emotion (fear or amusement) and success in following the instruction to regulate. Electrodermal activity was recorded continuously, and facial electromyography measured positive and negative facial expression. Trait measures of affect and emotion regulation were also administered.

Results: Electrodermal activity provided strong evidence that young adults successfully regulate fear using mindful attention and positive reappraisal relative to a just watch condition. Older adults' electrodermal activity is constant across conditions, and lower than young adults' in the just watch condition, suggesting general hyporeactivity to fear. Subjective data suggest that young, but not older, adults successfully downregulate amusement using mindful attention.

Conclusion: These findings provide some evidence for emotion regulation benefits in young relative to older age. However, these youthful benefits may reflect reduced initial reactivity among older adults.

Keywords: emotion regulation, aging, positive reappraisal, mindful attention, fear

Physical and cognitive decline in older age may be offset by improved emotional health, including strengths in emotion regulation (Charles & Carstensen, 2007). According to Gross' (1989) process model, emotion can be regulated at five sequential stages in the emotion generative process. The regulation strategies employed at each stage include situation selection, situation modification, attentional deployment, cognitive change, and response modulation. Cognitive reappraisal is one form of cognitive change and is the most widely studied regulation strategy among older adults (for a review and meta-analysis see Brady, et al., 2018). It involves "cognitively transforming the situation so as to alter its emotional impact" (Gross, 1998, p. 284).

Positive reappraisal has been defined as "conscious reappraisal of the event to identify positive gain" (Nowlan, et al., 2015, p. 476). Relative to young adults, older adults self-reported using positive reappraisal of negative life events more frequently and benefitting more from this regulation strategy in terms of improved mental health, including higher life satisfaction and reduced depression (for a review see Nowlan et al., 2015). However, it remains unclear whether older adults used and benefitted more from positive reappraisal simply because they experienced more negative life events than young adults. In addition, a recent meta-analysis of instructed emotion regulation indicated that young and older adults may not differ in their successful use of positive reappraisal (Brady et al., 2018). It thus remains important to identify which emotion regulation strategies are most effective for older adults.

Theoretical models propose age-related strengths in yet-to-be-studied strategies, including mindful attention (Prakash et al., 2014). To be mindful is to intentionally pay sustained attention to ongoing sensory, cognitive, and emotional experience, without elaborating upon or judging any part of that experience (Kabat-Zinn, 1994). According to socioemotional selectivity theory, motivational goals change from future-oriented knowledge accumulation in young adulthood to present-focused emotion regulation in older age (Carstensen, et al., 1999). Thus, Prakash et al. (2014) have suggested that older adults may be particularly well suited to capitalise on the benefits of mindfulness.

The extended process model (Gross, 2015) distinguishes three emotion regulation stages; identification (deciding whether to regulate), selection (deciding which strategy to use), and implementation (implementing a strategy). Identification is required before emotion regulation can be enacted and one way to increase emotion identification is via enhanced awareness of bodily processes, which is a core component of mindfulness (Teper, et al., 2013). Mindfulness is thus thought to enhance several emotion regulation strategies, including increased attentional deployment and cognitive change, and reduced expressive suppression (Gross, 2015). Because mindfulness occurs earlier in the emotion generative process, it demands fewer cognitive resources than downstream attentional deployment and cognitive change strategies (Slutsky et al., 2018) and should therefore be particularly effective in older age (Sheppes & Gross, 2011). Surprisingly, no study to date has investigated age-related differences in the effect of a brief lab-based mindfulness instruction on emotion regulation success.

Studies have documented a positive correlation between self-reported mindfulness and age (e.g., Hohaus & Spark, 2013). This increase in trait mindfulness as we grow older may be due to a shift in life circumstances, including less role-related stress (e.g., as parents or workers; Folkman, et al., 1987), increased motivation to focus on the present because of a shorter perceived remaining lifetime, in line with socioemotional selectivity theory (Carstensen et al., 1999), or a “natural” increase in mindfulness skills through aging and development (Rajeski, 2008). Research to date links trait mindfulness in older adults to emotional well-being (Mallya & Fiocco, 2015), protection against stress (de Frias & Whyne, 2015), and reduced negative affect (Raes, et al., 2013). Moreover, mindfulness-based clinical interventions have been shown to be particularly beneficial for older adults' emotional well-being (for a review see Geiger et al., 2015) relative to predominantly young adult samples (e.g., Khoury et al., 2013).

There is also a need to assess age differences in responding to discrete emotions (Kunzman et al., 2014). This is because some evidence suggests that age-related differences in responding are not consistent across various discrete emotions. Despite this, previous research has typically subsumed discrete emotions under the umbrella constructs of negative or positive emotion. It is also important to investigate discrete emotions that are particularly relevant in older age, and no study to date has assessed age-related differences in the regulation of fear despite evidence that experience of this emotion increases with age (Kunzman et al., 2014). Identifying strategies that may help older adults to quickly and successfully self-regulate fear may be of particular importance given the debilitating role of this emotion in numerous health concerns affecting predominantly older community members (e.g., fear of falling). There is also disproportionate experience of certain fears among older adults such as the age-related increase in fear of being a victim of crime despite reduced victimisation with age (Cutler, 2001).

Emotion regulation may involve downregulation, maintenance, or upregulation of positive or negative affect (Gross, 1998). Thus, positive reappraisal may be used to not only downregulate negative affect but also upregulate positive affect (e.g., Pavlov et al., 2014). Successful upregulation of positive emotion has been associated with social gains, including improved interpersonal functioning (Fredrickson, 1998) and increased cooperation (Rand, et al., 2015). The one previous study to examine age-related differences in the ability to amplify positive emotion found no effect of age on increased smiling in response to positive music (Vieillard et al., 2015). More research is required to explore potential age-related differences in the up-regulation of positive emotion in response to other emotional stimuli.

Compared to younger adults, older adults prefer low-intensity positive emotions over high-intensity positive emotions (Isaacowitz, et al., 2017). This may be due in part to the greater demand that high intensity emotions place on limited physiological resources at older ages (Labouvie-Vief, et al., 2009). Assuming that mindfulness-based strategies hinder emotional over-engagement in both positive and negative affect, one would expect mindful attention to be associated with diminished emotional responding to both fear and amusement. A small number of studies involving younger adults have demonstrated this effect in the lab using periods of brief training (e.g., Erisman & Roemer, 2010) or a single instruction (e.g. Lalot, et al., 2014). For example, Lalot et al. (2014) asked participants aged 18-60 years with no prior mindfulness experience to watch positive films and regulate their emotional responding using detached reappraisal (viewing emotional content as a distant observer), mindful attention, expression suppression or no instruction. Both mindful attention and detached reappraisal were associated with reduced positive emotion ratings and reduced facial reactivity (less smiling) compared to expression suppression and the no instruction condition. To our knowledge, only one previous study has investigated age-related differences in instructed regulation of amusement. In this study, older adults were unable to suppress (i.e., downregulate) smiling relative to young adults (Labuschagne et al., 2020). No study has assessed age differences in upregulation of amusement using positive reappraisal, nor downregulation of amusement using mindfulness.

To gain a more complete understanding of emotion regulation response tendencies, it is useful to measure behavioral, experiential (i.e., subjective), and physiological responding. This often involves facial electromyography as the behavioral measure of *corrugator supercilii* (i.e., brow) and *zygomaticus major* (i.e., cheek) muscle activity, while physiological response is often measured via electrodermal activity. Importantly, physiological responding can occur in the absence of overt behavior (Gross, 1998), and both physiological and behavioral responses are not subject to the same social desirability biases as self-reported responses. Each of these response tendencies was assessed in a recent meta-analysis examining age-related differences in the outcomes of attentional deployment, cognitive change, and response modulation (Brady et al., 2018). This meta-analysis provided evidence for maintenance of emotion regulation capacity in older age across all three domains.

Measurement of not only state but also trait emotion regulation also provides a more comprehensive assessment of regulation capacity. Whereas trait emotion regulation is cross-situational and relatively stable, state emotion regulation is situation-specific and goal directed. An open question is whether self-reported trait tendency to use a particular emotion regulation strategy is associated with momentary regulation of state emotion. It is also currently unclear as to whether age moderates this association. However, initial evidence has suggested that high levels of trait reappraisal predict state reappraisal of a negative situation, and that this association is not moderated by age (Hofer & Allemand, 2017).

The current study aimed to assess age-related differences in the success of positive reappraisal and mindful attention in the regulation of fear and amusement. We hypothesized that a) there would be no difference in the success of positive reappraisal among older and younger adults, and b) older adults would be more successful at regulating emotion using mindful attention compared to younger adults. A secondary aim was to assess the association between state and trait emotion regulation among young and older adults. We hypothesized that trait reappraisal would be associated with state positive reappraisal and trait mindfulness would be associated with both state mindfulness and state positive reappraisal.

Method

Participants

Forty-two young and 36 older adults participated in the current study. Young adults were a convenience sample of first year psychology students recruited via a university research participation system in exchange for course credit. Older adults were recruited via a university register, and were reimbursed AUD$20 per hour. They were included if aged 60 years or more, in line with the majority of research with extreme age group designs. Exclusion criteria included a self-reported current psychiatric or neurological impairment, and for older adults only, scores below 82 on the Addenbrooke's Cognitive Examination – III (Hsieh, et al., 2013). Four young adults and three older adults were excluded, leaving 38 young (*M* age = 19.95, *SD* = 3.14; range 17 to 33 years; 68% female) and 33 older (*M* age = 71.52; *SD* = 7.24; range 60 to 89 years; 64% female) adults. See Table 1 for further participant demographics. We aimed for a total of 70 participants in line with previous research that found an effect of instructed emotion regulation in both young and older adults (Pedder et al., 2016). This research was approved by the University Human Research Ethics Committee (approval number H12007).

Procedure

Participants were invited to attend a 60-minute one-on-one testing session at a large Australian University Campus with a trained experimenter. Participation was completed in a light controlled lab, fitted with a desk, a computer, a comfortable chair, physiological recording equipment and a wall-mounted camera. First, participants completed informed consent and survey measures. Participants were then fitted with physiological recording equipment, including facial and finger-tip sensors. Next, the participants were given instructions on how to complete the experimental tasks and the experimenter left the room. At all times the experimenter was able to view the participant via video link from an adjacent room. Participants could not see the experimenter while completing the experimental tasks but were made aware that they could ask for assistance at any time. Participants then completed the experimental tasks after which the physiological recording equipment was removed and the participants were debriefed as to the purpose of the study.

The present study used a repeated measures between-group design whereby young and older adults were asked to complete all six experimental conditions, outlined below. Six films (3 fear, 3 amusement) were selected following a pilot study described in the Supplemental Materials (see Table S1). Participants viewed six trials, each consisting of (a) an emotion regulation instruction displayed for 60 seconds; (b) a fixation cross displayed for 2 seconds; (c) the film clip lasting, on average, 2 minutes; and (d) rating prompts. These prompts consisted of (a) how well they were able to follow the emotion regulation instruction using a 9-point scale from 1 (not at all able to follow instruction) to 9 (extremely successful at following regulation instruction); (b) how generally intense they found the film clip using a 9-point scale from 1 (not at all intense) to 9 (extremely intense); and (c) their experience of nine discrete emotions (i.e., amusement, anger, contentment, compassion, disgust, enthusiasm/excitement, fear, sadness, and surprise; see Table S2 for descriptive statistics) - presented in randomized order across participants - using a 9-point scale from 1 (did not experience the emotion at all) to 9 (strongest experience of the emotion ever felt). This method of assessing subjective emotional reactivity is broadly consistent with previous research on emotion regulation and aging (see Shiota & Levenson, 2009). The order of the films was counterbalanced across the sample.

Just watch trials

For the first two trials, participants were instructed to "*React spontaneously and naturally to the events shown in the film clip. Watch the film clip as you would at home or in* *the cinema.*" based on instructions used in previous research (e.g., Lohani & Isaacowitz, 2009). Fear and amusement films for the first two trials were randomised across participants.

Instructed emotion regulation trials

For the remaining four trials, participants viewed two fear films and two amusing films and were instructed to regulate their emotion while watching using positive reappraisal and mindful attention. The order of the four trials (fear-positive reappraisal, fear-mindful attention, amusement-positive reappraisal, and amusement-mindful attention) was randomised across participants. In positive reappraisal trials, participants received the following instruction: "*While you are watching the film clip, please try to think about positive aspects of what you are seeing. Watch the film clip carefully, but please try to think about what you are seeing in such a way that you feel more positive emotion*." This instruction was based on a similar instructions used by Shiota and Levenson (2009). In mindful attention trials, participants received the following instruction: "*While watching the next film, we ask you to pay attention to any reactions you experience (thoughts, emotions or sensations) that may arise. Observe these reactions as they arise and pass away curiously without trying to label, change, suppress, or avoid them. Simply observe them as they are.*" This instruction was adapted from Lalot, et al. (2014).

Measures

Emotion Regulation Questionnaire (ERQ; Gross & John, 2003)

The development and structure of the 10-item ERQ is discussed in the introduction. An example reappraisal item is "When I want to feel more positive emotion, I change the way I'm thinking about the situation". An example suppression item is "I control my emotions by not expressing them". Respondents are asked to rate their agreement with items using a 7-point Likert-type scale from 1 (strongly disagree) to 7 (strongly agree). Scores are averaged for the items within each scale to provide a single reappraisal score and a single suppression score, ranging from 1 to 7. High scores on each subscale indicate higher trait reappraisal and suppression, respectively. The ERQ has been validated for use with an older adult population (Brady, et al., 2019a).

Positive and Negative Affect Schedule – 10 (PANAS-10; Mackinnon et al., 1999)

The PANAS-10 is a ten-item scale derived from the longer form Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988) designed to measure the experience of positive (inspired, alert, excited, enthusiastic, determined) and negative (afraid, upset, nervous, scared, upset) emotional states. Respondents are asked to indicate how frequently they have experienced the emotions in the last few weeks using a Likert-type scale from 1 (very slightly or not at all) to 5 (Extremely). Item responses are summed for each scale resulting in a single positive affect score and a single negative affect score. Higher scores on each subscale indicate greater experience of affect. In the initial validation study, age was not found to impact the factor structure or factor correlations among a large sample (N = 2651) of adults, including older adults (Mackinnon et al., 1999).

Five Facet Mindfulness Questionnaire – Short Form (FFMQ-SF; Bohlmeijer et al., 2011)

The 24-item FFMQ-SF evaluates five facets of dispositional mindfulness, including observing, describing, acting with awareness, non-judgment of inner experiences, and non-reactivity to inner experiences. Sample items include: “I pay attention to physical experiences, such as the wind in my hair or sun on my face (Observe)”, “I’m good at finding the words to describe my feelings (Describe)”, “I find myself doing things without paying attention (Act Aware)”, “I disapprove of myself when I have illogical ideas (Non-Judgment)”, “I watch my feelings without getting carried away by them (Non-Reactivity)”. Respondents are asked to rate their agreement with items using a five-point Likert-type scale from 1 (never or very rarely true) to 5 (very often or always true). Scores on the Non-

Reactivity, Acting with Awareness, Describing and Non-Judgement subscales range from 5-25, with higher scores indicating greater mindfulness. Scores on the Observing subscale range from 5-20, with higher scores indicating greater mindful observing. The FFMQ has been validated for use with an older adult population (Brady, et al., 2019b).

Behavioral and Physiological Observations

Facial electromyography (EMG) measured *corrugator supercilii* (brow) muscle activity to index positive affect and the *zygomaticus major* (cheek) muscle activity to index negative affect while watching emotive film clips. Facial EMG was averaged across the entire timeframe of each film clip in line with evidence that young and older adults do not differ in rapid facial muscle reactivity (e.g., Bailey & Henry, 2009).

Electrodermal activity (EDA) measured continuous autonomic arousal. EDA data for each film were extracted in four epochs: 2-second pre-film baseline, early film, mid film, late film. The early, mid and late epochs were of equal duration (1/3 total film duration). Prior to analysis, three EDA variables were computed for each film by subtracting average EDA during pre-film baseline from average reactivity during the early, mid and late film periods. The EDA were analyzed in three segments in order to determine whether group differences were influenced by early, middle or later processing of the film content. For instance, some cognitive processes slow down with age, and it was possible that the older group took longer but responded just as strongly to the film clips as younger adults.

Positive EMG and EDA values indicate an increase in activity during the film period compared to baseline. Negative values indicate decreased activity in the film period compared to baseline. A detailed description of the facial EMG and EDA recording and data cleaning procedures are provided in the Supplemental Material.

Data Analyses

Preliminary checks were conducted for subjective and behavioral outcomes using *t*-tests to determine whether responding to fear and amusement differed within the frightening and amusing film conditions. Subjective outcomes were analyzed with 3 (Instruction: just watch, positive reappraisal, mindful attention) × 2 (Age: young, older) mixed-design ANOVAs. In line with Shiota and Leveson (2019), we analyzed only the fear and amusement ratings, and analyses of regulation success (see Supplementary Material) excluded the just watch condition. Intensity ratings were not assessed. Corrugator and zygomaticus reactivity were analyzed with 3 (Instruction: just watch, positive reappraisal, mindful attention) × 2 (Age: young, older) mixed-design ANOVAs. Change in EDA from pre-film baseline was analyzed separately for fear and amusement films using 3 (Instruction: just watch, positive reappraisal, mindful attention) × 3 (Time: early-film, mid-film, late-film) × 2 (Age: young, older) mixed-design ANOVAs. Significant interactions were followed-up with tests of simple effects.

Unstandardized bivariate correlations were used to determine the associations between state affect, and trait emotion regulation capacities among young and older adults. Age group comparisons of state affect and trait emotion regulation capacities were computed using independent-samples t-tests.

Results

Subjective Outcomes

In preliminary checks within the just watch condition, fear films elicited more fear (M = 3.64, SD = 2.35) than amusing films (M = 1.36, SD = 0.97), $t(1, 66) = 12.669$, $p < .001$. Amusing films elicited more amusement (M = 5.88, SD = 2.24) than fear films (M = 3.30, SD = 2.38), $t(1, 66) = 21.428$, $p < .001$.

Table 2 displays descriptive statistics for analyses of subjective outcomes.

Fear films. For fear ratings, there was an age × instruction interaction, $F(2, 138) = 4.391$, $p = .018$, $\eta_p^2 = .06$. Tests of simple effects revealed a simple main effect of instruction for older adults, $F(1, 69) = 15.459$, $p < .05$, $\eta_p^2 = .31$, who reported less fear in the just watch condition compared to positive reappraisal ($p < .001$) and mindful attention ($p < .001$), which did not differ ($p = 1.000$). There was no simple main effect of instruction for young adults, $F(1, 69) = 2.536$, $p = .087$, $\eta_p^2 < .07$. The simple effect of age was not significant within any instruction condition, $ps \geq .091$, $\eta_p^2 \leq .04$.

Amusement films. For amusement ratings, there was an age × instruction interaction, $F(2, 138) = 4.582$, $p = .012$, $\eta_p^2 = .06$. Tests of simple effects revealed a simple main effect of instruction for young adults, $F(1, 69) = 3.177$, $p < .05$, $\eta_p^2 = .09$, who reported more amusement in the just watch condition compared to positive reappraisal ($p = .042$) and mindful attention ($p = .022$), which did not differ ($p = .727$). There was no simple main effect of instruction type for older adults, $F(1, 69) = 1.997$, $p = .144$, $\eta_p^2 < .06$. The simple main effect of age was significant within the just watch condition, $F(1, 69) = 12.129$, $p = .001$, $\eta_p^2 = .15$, where young adults reported greater amusement compared to older adults. The simple effect of age was not significant within the other two instruction conditions, $ps \geq .417$, $\eta_p^2 \leq .01$.

Behavioral and Physiological Outcomes

Data from four young and three older adults were excluded from analyses of physiological outcomes due to technical difficulty or unacceptable participant-induced artefacts.

Emotional Expression as Indexed by EMG

In preliminary checks of the just watch condition, zygomatic reactivity was higher in response to amusing films ($M = 264.43$, $SD = 250.76$) compared to fear films ($M = 145.41$, *SD* = 86.80), $F(1, 63) = 13.812$, $p <.001$, $\eta_p^2 = .18$. However, corrugator reactivity was not significantly different for fear films (*M* = 129.75, *SD* = 76.44) compared to amusing films (*M* = 115.91, *SD* = 59.20), $F(1, 63) = 1.831$, $p = .181$, $\eta_p^2 = .03$.

Table 3 displays descriptive statistics for analyses of behavioral outcomes.

Fear films. As shown in Figure 1a, there was an age × instruction interaction, $F(2, 124) = 3.119$, $p = .048$, $\eta_p^2 = .05$. Tests of simple effects revealed a simple main effect of instruction for older adults, $F(2, 61) = 3.222$, $p < .05$, $\eta_p^2 = .10$, who experienced less corrugator activity in the mindful attention condition compared to both the just watch ($p = .03$) and positive reappraisal conditions ($p = .04$), which did not differ ($p = .63$). There was no simple main effect of instruction among young adults, $F(2, 61) = 0.702$, $p = .499$, $\eta_p^2 = .02$. There was also no simple main effect of age within any instruction condition, $ps \geq .082$, $\eta_p^2 \leq .05$.

Amusement films. As shown in Figure 1b, there was an age group × instruction interaction, $F(2, 124) = 3.119$, $p = .026$, $\eta_p^2 = .06$. Tests of simple effects revealed no reliable simple main effects of instruction within young, $F(2, 61) = 2.675$, $p = .08$, $\eta_p^2 = .10$, or older adults, $F(2, 61) = 2.139$, $p = .13$, $\eta_p^2 = .07$. There was a simple main effect of age within the just watch condition, $F(1, 62) = 9.571$, $p = .003$, $\eta_p^2 = .13$, such that young adults experienced greater increase in zygomaticus activity from pre-film baseline compared to older adults. There were no age differences in the other instruction conditions, $ps \geq .160$, $\eta_p^2 = \leq .03$.

Electrodermal Reactivity

Table 4 displays descriptive statistics for analyses of electrodermal activity in response to frightening and amusing films.

Fear films. There was an instruction × age interaction, $F(2, 118) = 5.783$, $p = .004$, $\eta_p^2 = .09$, as displayed in Figure 2a. Tests of simple effects revealed a simple main effect of instruction for young adults, $F(2, 64) = 16.135$, $p < .001$, $\eta_p^2 = .34$, who experienced greater

EDA in the just watch condition, relative to both the positive reappraisal ($p < .001$) and mindful attention ($p < .001$) conditions, which did not differ ($p = .167$). There was no simple main effect of instruction for older adults, $F(2, 54) = 0.235$, $p = .761$, $\eta_p^2 = .01$. There was no simple effect of age group within the positive reappraisal condition ($t(59) = -0.979$, $p = .332$). However, EDA was lower among older adults in the just watch condition ($t(52.17) = 2.057$, $p = .045$). In the mindful attention condition, young adults experienced lower EDA on average compared to older adults, $t(59) = -2.077$, $p = .042$.

The time × age interaction was also significant, $F(2, 118) = 5.478$, $p = .005$, $\eta_p^2 = .09$, as displayed in Figure 2b. Tests of simple effects revealed a simple main effect of time for young adults, $F(2, 61) = 22.569$, $p < .001$, $\eta_p^2 = .41$. To better understand these effects, we analyzed the data for each age group separately and subjected the time data (early, mid, late) to two specific contrasts: the linear contrast to test the effects of response decrement over time (habituation hypothesis) and the quadratic contrast to examine non-linear effects, including floor effects. The results showed significant response decrement for the young group, linear contrast, $F(1, 32) = 27.284$, $p <.001$, $\eta_p^2 = .46$. The quadratic contrast was not significant ($p = .854$). Neither the linear ($p = .146$) nor the quadratic contrast ($p = .275$) for the older adults was significant. The main effect of time for older adults was not significant, $F(2, 54) = 2.140$, $p = .128$, $\eta_p^2 = .07$. In summary, whilst the younger group showed habituation effects to fear, the older group did not. There were no simple effects of age group within the early ($t(59) = .395$, $p = .695$), mid ($t(59) = -.480$, $p = .633$), or late time periods ($t(59) = -1.541$, $p = .129$).

There was also an instruction × time interaction, $F(4, 236) = 4.294$, $p = .002$, $\eta_p^2 = .07$, which we did not follow up because it did not interact with age. The 3-way interaction of instruction × time × age was not significant, $F(4, 236) = 0.379$, $p = .766$, $\eta_p^2 = .01$.

Amusement films. Only the instruction × time interaction was significant, $F(4, 236) = 8.008$, $p < .001$, $\eta_p^2 = .12$, but we did not follow this up because it did not interact with age.

Association Between State Affect and Trait Emotion Regulation Capacities

Unstandardized bivariate correlations between state positive and negative affect and trait emotion regulation are reported separately for young and older adults in Table 5. Age differences in affect and emotion regulation capacities are reported in Table 6. Older adults reported higher positive affect, cognitive reappraisal and mindful observing than their younger counterparts. Young and older adults did not differ in negative affect, trait expressive suppression, non-reactivity to experiences, acting with attention/awareness, describing inner feelings and experiences, or non-judgement of thoughts and feelings.

Discussion

The current study aimed to assess age-related differences in the success of instructed positive reappraisal and mindful attention strategies for regulating fear and amusement. The main hypothesis was that older adults would be more successful than younger adults at regulating emotion using instructed mindful attention but not positive reappraisal. In response to frightening films, both positive reappraisal and mindful attention increased older (but not younger) adults' ratings of subjective fear relative to the just watch condition. In contrast, older adults' brow reactivity was lower in the mindful attention condition relative to the positive reappraisal and just watch conditions. In addition, both positive reappraisal and mindful attention reduced younger (but not older) adults' EDA to fear relative to the just watch condition. Young adults also showed habituation to fear films over time, averaged across instruction condition, whereas older adults did not. In response to amusing films, young adults (but not older adults) reported reduced subjective amusement in both the positive reappraisal and mindful attention conditions, relative to the just watch condition. This suggests young adults successfully downregulated positive affect using mindfulness.

Young adults also reported more amusement, and smiled more, relative to older adults, in the just watch condition of the amusing films.

There was some support for the hypothesis that trait reappraisal would be associated with state reappraisal. Among older adults, increased trait cognitive reappraisal was correlated with increased self-reported amusement following instructions to use positive reappraisal to upregulate positive affect. There was also some support for the prediction that trait mindfulness would be associated with both state mindfulness and state positive reappraisal. Among young adults, increased trait non-judgement was associated with reduced fear following instructions to regulate using mindfulness. In addition, increased trait non-reactivity was associated with reduced fear following instructions to regulate using positive reappraisal. Among older adults, increased trait non-reactivity was associated with reduced state fear in the mindfulness condition. These findings provide some preliminary support for Gross' (2015) theory that mindfulness enhances several emotion regulation strategies. Exploratory analyses further showed that, among older adults, increased trait non-reactivity, acting aware, and non-judgement, were associated with reduced trait negative affect. Among young adults, increased acting aware and non-judgement were associated with decreased trait negative affect, while increased cognitive reappraisal was associated with increased positive affect.

While the broader emotion regulation literature suggests that emotion regulation capacity is largely maintained (and at times improved) in older age (Charles & Carstensen, 2007), the present study may offer some evidence of a youthful advantage in the regulation of fear using instructed emotion regulation strategies. In line with strategy aims, both positive reappraisal and mindful attention reduced younger (but not older) adults' electrodermal activity during fear films relative to the just watch condition. As an objective measure of affective arousal, the reductions in electrodermal activity constitute good evidence that younger adults were able to effectively regulate fear. Young adults also showed habituation to fear films, averaged across instruction condition (demonstrated by a linear decrease in electrodermal activity over time), whereas older adults did not. However, older adults experienced no difference in electrodermal response across instruction conditions, no habituation to fear across time, and reduced electrodermal reactivity relative to young adults in the just watch condition. Together, this suggests age-related hyporeactivity to fear. It may therefore be that older adults had little physiological fear response to regulate.

In contrast, both positive reappraisal and mindful attention instructions led to increased subjective fear ratings relative to just watch among older (but not younger) adults following frightening films. It may be that the instructions reduced the natural positivity effect in older adults by constraining cognitive processing. Indeed, a meta-analysis revealed that evidence for an age-related positivity effect is limited in studies that constrain information processing by attempting to alter the goals or attention of participants (Reed et al., 2014). However, as noted, a similar age-related increase in negative affect in the instruction conditions was not seen in older adults' electrodermal activity. It is possible that older adults' subjective reports were influenced by social desirability biases. However, young and older adults did not differ in their self-reported success in following mindfulness or positive reappraisal instructions to regulate fear. Thus, the more parsimonious explanation appears to be that emotion regulation instructions may constrain the positivity effect as evidenced in *conscious* self-report but not in more *automatic* processes such as electrodermal activity.

Interestingly, among older (but not younger) adults, brow reactivity to fear films was lower in the mindful attention condition compared to both positive reappraisal and the just watch condition. Reduced brow reactivity could be interpreted as an objective marker of strategy success, as has been predicted in the literature (Prakash et al., 2015), and in line with age-related increases in trait mindfulness (Hohaus & Spark, 2013). However, this interpretation is inconsistent with the increased subjective fear reported by the older adults in the just watch condition relative to the instruction conditions.

Young adults experienced greater self-rated amusement and increased cheek reactivity relative to older adults in response to amusing films in the just watch condition. This was surprising considering the film stimuli were validated as equally amusing for both young and older adults in a pilot study involving an independent sample. Despite this age-related difference in the just watch condition, there was no difference in young and older adults' subjective amusement or smiling in the two instructed regulation conditions, suggesting that the strategies contributed to the two age groups experiencing similar levels of amusement. For young and older adults, subjective and physiological indices did not generally provide evidence for the regulation of positive affect in response to amusing films in either instruction condition relative to the just watch condition. One exception was young adults' reduced ratings of amusement following the mindful attention relative to just watch instructions.

Despite evidence for down-regulation of amusement in young but not older adults, the two age groups did not differ in their self-reported success in following instructions to use mindful attention to *down-regulate* amusement. In contrast, young adults reported greater success than older adults in using positive reappraisal to *upregulate* amusement. However, neither age group reported increased amusement in the positive reappraisal relative to just watch condition. The data suggest that young adults are more successful than older adults in using mindful attention to downregulate amusement, possibly because they experienced more amusement to begin with. However, the finding is consistent with previous research where older adults did not successfully suppress smiling in response to amusing films (Labuschagne et al., 2020), and other research where young adults successfully reduced self-reported positive affect using mindful attention (Lalot et al., 2014). It is also of note that although young adults self-reported a reduction in amusement following mindful attention, their smiling response remained the same. This may be consistent with the idea that mindful attention involves paying attention to ongoing sensory experience without judgement (Kabat-Zin, 1994). Taken together, mindfulness may not be as beneficial for older adults as predicted (Hohaus & Spark, 2013; Prakash et al., 2014; Sheppes & Gross, 2011). However, the benefits may be context specific and further research is required to address this question.

Limitations and Future Research Directions

Although facial EMG data make an important contribution to understanding behavioral responses, this current study is limited by uncertainty regarding interpretation of corrugator EMG data. The manipulation check showed that percentage increase in corrugator activity was similar in response to both fear and amusement. It is possible that brow movement may represent factors other than a change in negative affect, including greater concentration (an increase in corrugator activity) or greater relaxation (a decrease in corrugator activity). This renders interpretation of brow reactivity somewhat more difficult than the other behavioral or physiological measures. Brow activity may also be a less sensitive measure of affect across the longer time period of a film relative to typical studies assessing fast automatic responses to static images. The reduced brow activity to frightening films among older adults in the mindful attention condition could indicate reduced negative affect, reduced concentration, or greater facial relaxation, or a combination of states. Future studies should assess instantaneous brow reactivity in response to static images following a mindfulness instruction. This would help to clarify the mechanism underlying the current finding.

The current study is further limited by the extreme age group design comparing adults under the age of 35 years to those aged over 60 years. While extreme age group designs are informative and common practice in studies of aging, they also cannot possibly capture the complexities of age-related processes across the lifespan. Future studies using lifecourse samples would contribute to a deeper understanding of age-related differences and similarities in emotion regulation processes.

Compliance with Ethical Standards

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the Western Sydney University IRB committee (approval number H11503) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Conflict of Interest

The authors declare that they have no conflict of interest.

Author Contributions

BB: designed and executed the study, completed the data analyses, and wrote the paper. CG: Collaborated with the analysis and interpretation of physiological data. IK: collaborated with the design and writing of the study. EW: Provided coding expertise that was applied to complex physiological data collection, data extraction and artefact correction. PB: collaborated with the design and writing of the study.

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Table 1.
Sample Demographic Characteristics.

Characteristic	Young Adults (*n* = 38)	Older Adults (*n* = 33)
Religion (%)		
Buddhism	7.9	12.1
Christianity	50.0	63.6
Hinduism	7.9	0
Islam	13.2	3.0
No Religion	21.1	18.2
Other Religion	0	3.0
Ethnicity (%)		
Anglo-Australian	34.2	75.8
East and Southeast Asian	13.2	3.0
South Asian	18.4	6.1
Middle Eastern	15.8	3.0
African	2.6	0
Latin, Central and South American	2.6	3.0
Other	10.6	9.1
Marital Status (%)		
Single	60.5	3.0
Dating one person	31.6	3.0
Married	0	72.7
Divorced	0	9.1
Widowed	0	9.1
Engaged	2.6	0
Dating multiple people	2.6	0
Cohabitating	2.6	3.0

Table 2.
Descriptive Statistics for Just Watch, Positive Reappraisal and Mindful Attention Instructions on Subjective Outcomes in Young and Older Adults.

		Just Watch *M* (*SD*)		Positive Reappraisal *M* (*SD*)		Mindful Attention *M* (*SD*)	
Outcome	Emotion	Young	Older	Young	Older	Young	Older
Level of Emotion	Fear	3.83 (2.36)	3.12 (2.36)	4.82 (2.59)	5.82 (2.30)	4.82 (2.57)	5.70 (2.51)
	Amusement	6.66 (1.86)	4.91 (2.36)	5.87 (2.43)	5.73 (2.35)	5.74 (2.13)	5.27 (2.66)
Regulation Success	Fear	-	-	5.16 (2.83)	5.88 (2.62)	7.24 (1.75)	6.64 (1.92)
	Amusement	-	-	7.92 (1.22)	6.00 (2.33)	7.47 (1.48)	6.79 (2.01)

Table 3.
Percentage Change in Brow and Cheek Activity Following Just Watch, Positive Reappraisal and Mindful Attention Instructions in Young and Older Adults.

		Just Watch *M* (*SD*)		Positive Reappraisal *M* (*SD*)		Mindful Attention *M* (*SD*)	
Outcome	Emotion	Young	Older	Young	Older	Young	Older
Brow Reactivity	Fear	119.47 (61.45)	141.39 (90.18)	116.79 (58.00)	133.73 (54.22)	131.13 (67.57)	106.28 (39.34)
Cheek Reactivity	Amusement	349.89 (307.01)	167.57 (105.27)	265.43 (217.10)	200.42 (131.12)	284.32 (259. 87)	258.41 (210.02)

Table 4.

Descriptive Statistics for Just Watch, Positive Reappraisal and Mindful Attention Instructions on Electrodermal Reactivity at Three Time Points in Young and Older Adults.

			Young Adults (*n* = 33)		Older Adults (*n* = 28)	
Film Emotion	Strategy	Time	*M*	*SD*	*M*	*SD*
Fear	Just Watch	Early	0.79	0.90	0.32	0.40
		Mid	0.52	0.88	0.16	0.48
		Late	0.29	0.77	0.13	0.49
	Mindful Attention	Early	-0.13	0.43	0.20	0.91
		Mid	-0.27	0.69	0.10	1.01
		Late	-0.49	0.85	-0.01	0.79
	Positive Reappraisal	Early	0.08	0.47	0.09	0.28
		Mid	-0.04	0.75	0.11	0.62
		Late	-0.10	0.79	0.17	0.72
Amusement	Just Watch	Early	0.31	0.42	0.26	0.72
		Mid	0.00	0.53	0.04	0.41
		Late	0.11	0.88	0.08	0.65
	Mindful Attention	Early	-0.02	0.42	0.03	0.26
		Mid	0.24	0.87	0.35	1.00
		Late	0.12	0.80	0.45	0.99
	Positive Reappraisal	Early	0.10	0.55	0.04	0.34
		Mid	-0.04	0.84	-0.04	0.50
		Late	-0.08	0.99	0.09	0.71

Note. Positive values indicate increased electrodermal activity compared to baseline; negative values indicate decreased electrodermal activity compared to baseline.

Table 5. *Unstandardized Bivariate Correlations Between Trait Affect, Trait Emotion Regulation, Trait Mindfulness, and State Emotion in Young Adults (n = 38; below the diagonal) and Older (n = 33; above the diagonal) Adults*

	1	2	3	4	5	6	7	8	9	10	11	12	13
Trait Affect													
1. Positive	-	-.018	.214	-.222	.005	-.122	-.076	.259	-.343	.336	.340	.420*	.443*
2. Negative	-.262	-	.250	.057	-.397*	.121	-.382*	-.174	-.371*	.455**	.331	.139	-.146
Trait Emotion Regulation													
3. Cognitive Reappraisal	.623**	-.342*	-	.216	-.068	.278	-.008	.102	-.327	.226	.108	.442*	.045
4. Suppression	-.176	.299	-.307	-	.540**	.236	-.075	-.155	-.227	-.129	-.298	.142	.172
Trait Mindfulness													
5. Non-Reactivity	-.139	.167	-.144	.531**	-	.165	.089	.119	.120	-.221	-.360*	.108	.268
6. Observing	.070	-.166	.021	-.224	.134	-	-.088	-.121	-.261	.138	.103	.065	-.108
7. Act Aware	.282	-.331*	-.014	-.285	-.059	.180	-	.348*	.522**	-.214	.152	.196	.005
8. Describing	.225	-.275	.314	-.428**	-.117	.193	.413**	-	.334	-.178	-.025	.188	.163
9. Non-Judgement	-.054	-.433**	-.001	.177	-.106	-.140	-.012	-.092	-	-.225	.019	-.221	-.093
State Fear													
10. Positive Reappraisal	-.005	.030	.180	-.295	-.391*	-.055	-.193	.065	-.108	-	.741**	.191	.033
11. Mindfulness	.070	.252	.040	-.184	-.091	.196	-.188	.139	-.407*	.589**	-	.110	-.048
State Amusement													
12. Positive Reappraisal	.068	.100	.012	-.062	.173	.026	-.099	.121	-.154	.267	.395*	-	.724**
13. Mindfulness	.252	.028	.112	-.112	-.010	.042	.016	.113	-.154	-.004	.253	.370*	-

Note. * correlation is significant at the $p < .05$ (two-tailed) level; ** correlation is significant at the $p < .01$(two-tailed) level.

Table 6.
Age Differences in Trait Affect, Trait Emotion Regulation, and Trait Mindfulness.

	Young Adults (n = 38)		Older Adults (n = 33)				
Factor	*M*	*SD*	*M*	*SD*	*t*	*df*	*p*
Positive Affect	16.47	3.13	18.59	2.86	2.93	68	.005
Negative Affect	8.97	3.28	7.94	4.17	1.16	68	.249
Cognitive Reappraisal	28.11	5.34	31.94	4.90	3.11	68	.003
Expressive Suppression	13.89	5.51	15.03	4.63	0.93	68	.356
Non-Reactivity	15.27	2.87	16.73	3.21	2.00	68	.051
Observing	13.05	2.82	16.55	2.60	5.40	68	.000
Acting with Awareness	17.68	3.14	18.94	3.58	1.58	68	.120
Describing	17.71	2.87	17.88	3.48	0.22	68	.824
Non-Judgement	15.58	3.80	14.85	4.78	0.72	68	.476

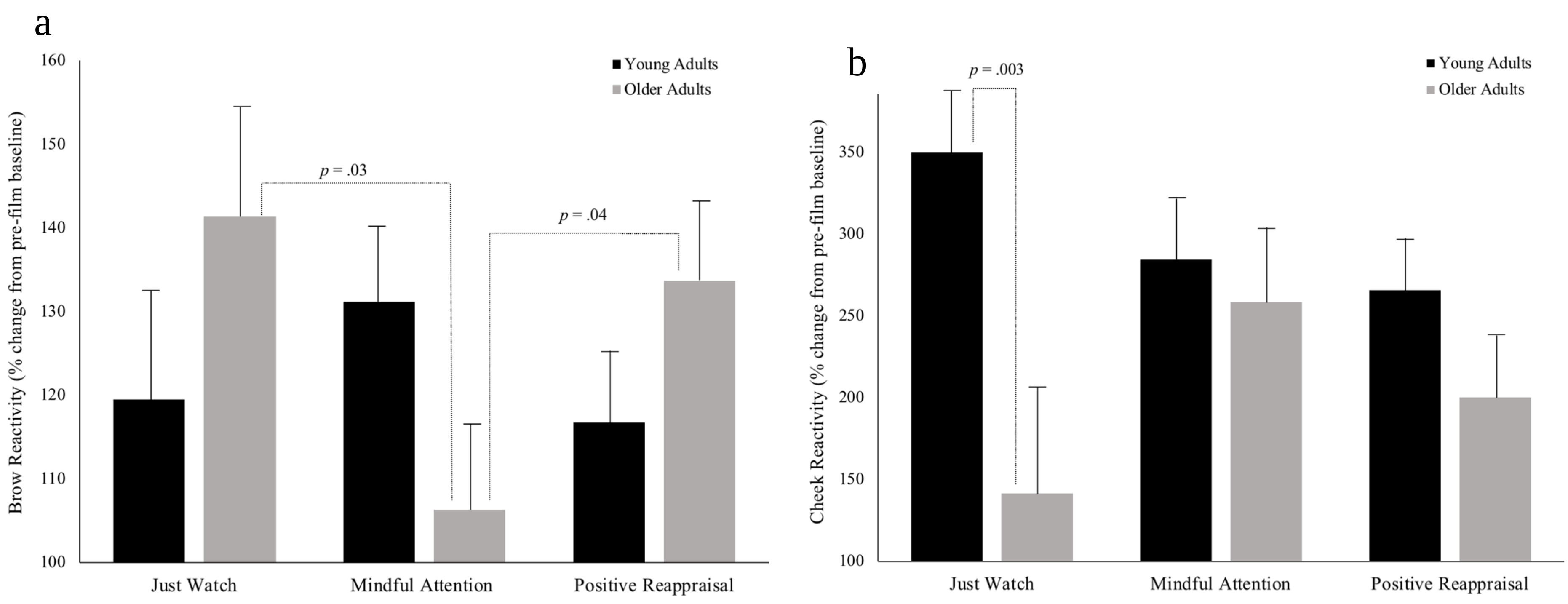

Figure 1. Change in (a) corrugator (brow) muscle activity to fear films and (b) zygomaticus (cheek) muscle activity to amusing films, representing negative and positive facial expression, respectively, as a function of participant age group and instruction type, with standard error bars.

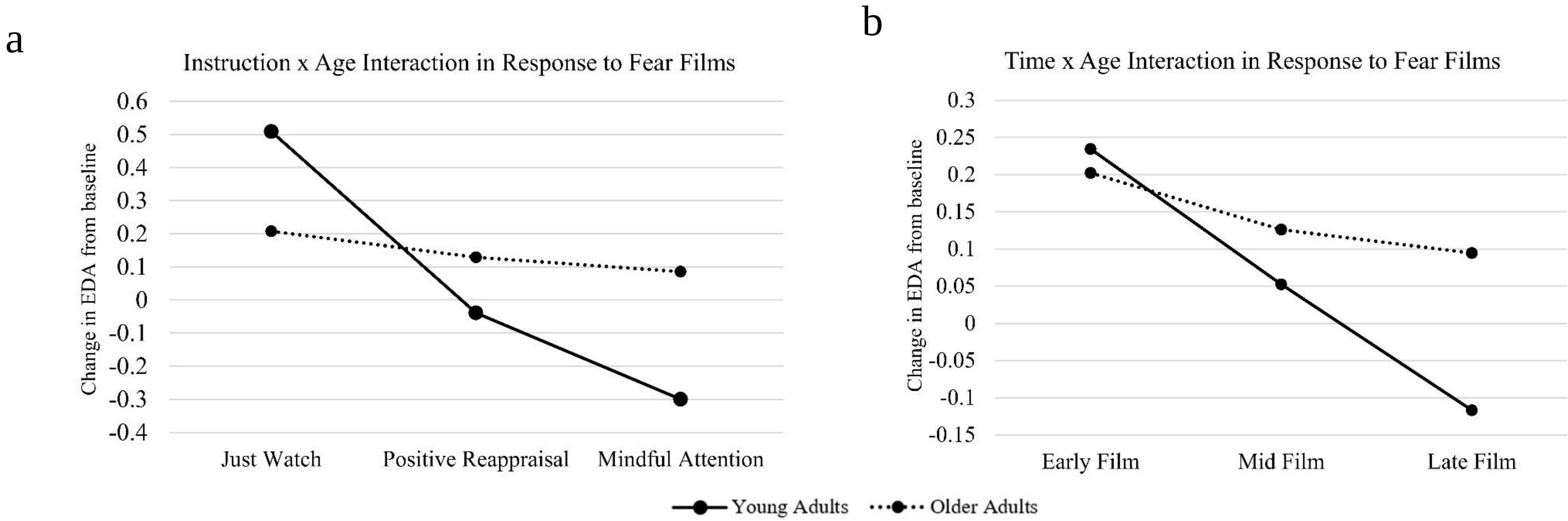

Figure 2. Interactions between age group and (a) instruction, and (b) time for change in electrodermal activity (EDA) in response to fear films.