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Effects of Aging on Experimentally Instructed Detached Reappraisal, Positive Reappraisal, and Emotional Behavior Suppression

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Emotion regulation includes multiple strategies that rely on different underlying abilities and that may be affected differently by aging. We assessed young, middle-aged, and older adults' ability to implement 3 emotion regulation strategies (detached reappraisal, positive reappraisal, and behavior suppression) in a laboratory setting, using standardized emotional stimuli and a multimethod approach to assessing regulation success. Results revealed age-related decline in ability to implement detached reappraisal, enhancement of ability to implement positive reappraisal, and maintenance of ability to implement behavior suppression. We discuss these findings in terms of their implications for emotion theory and for promoting successful aging.

Keywords: aging, emotion, emotion regulation, psychophysiology, reappraisal

Emotion regulation has been defined as "the processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (Gross, 1998a, p. 275). Whereas studies of cognitive and physical aging often emphasize decline (e.g., Salthouse, 2004), laboratory studies (e.g., Kunzmann, Kupperbusch, & Levenson, 2005), survey studies (e.g., Gross et al., 1997), and common wisdom all suggest that the ability to manage emotions is maintained, perhaps even enhanced, throughout adulthood. These findings are augmented by studies of older adults' use of a few particular regulation strategies, such as avoiding unpleasant social situations (e.g., Birditt & Fingerman, 2005; Coats & Blanchard-Fields, 2008) and problem solving when facing a nonsocial stressor (e.g., Blanchard-Fields, 2007; Coats & Blanchard-Fields, 2008).

Emotion regulation is not a single process, but rather a family of processes that rely on different skills and produce different outcomes. As a result, various emotion regulation strategies may be affected differently by aging. Only a few strategies have been studied in this regard, and little research has addressed the effects of normal aging on several strategies studied extensively in young adults, including cognitive reappraisal and behavior suppression (e.g., Gross, 1998b; Gross, 2002; Gross & Levenson, 1993; Hageman, Levenson, & Gross, 2006; Jackson, Malmstadt, Larson, & Davidson, 2000). The aim of the present study was to assess young, middle-aged, and older adults' ability to implement three emotion regulation strategies (detached reappraisal, positive reappraisal, and behavior suppression) in a laboratory setting. We used standardized emotional stimuli and a multimethod approach (subjective experience, physiological response, and facial expression) to assess regulation success.

Aging and Emotion Regulation: The Current Picture

The theoretical and empirical literatures offer strong support for the argument that emotion regulation skill is maintained or enhanced throughout adulthood. According to socioemotional selectivity theory (Carstensen, Isaacowitz, & Charles, 1999), emotion regulation goals become more salient as people age, and older adults invest more effort in enjoying the present rather than building resources for the future. A number of studies with diverse samples have found that self-reported emotional control increases throughout adulthood (e.g., Gross et al., 1997; Lawton, Kleban, Rajagopal, & Dean, 1992). Emotion regulation is typically geared toward reducing negative emotion, and evidence that overall levels of negative emotion decrease throughout adulthood is provided by studies that have used global self-reports (Gross et al., 1997), experience sampling data (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000), longitudinal designs (Charles, Reynolds, & Gatz, 2001), and laboratory methods (Levenson, Carstensen, & Gottman, 1994; Tsai, Levenson, & Carstensen, 2000). Older adults report less distress than their juniors in particular stressful situations, including daily hassles (Charles & Almeida, 2007), property loss (Phifer, 1990), and interpersonal conflict (Birditt, Fingerman, & Almeida, 2005). Although these studies do not test emotion regulation directly, they support the proposal that older adults are globally better at regulation and are more sophisticated at tailoring regulation strategies to fit the stressor (Blanchard-Fields, 2007).

Knowing that older adults manage their emotions well does not indicate how they accomplish this, nor does it reveal whether older adults use particular regulation strategies more often or more effectively than young adults. Recently, researchers have begun to examine age effects on the use of specific strategies. For example, several studies have suggested that older adults are more likely

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than young adults to avoid unpleasant social situations, either by withdrawing from them or by sidestepping areas of conflict (Birditt & Fingerman, 2005; Blanchard-Fields, 2007; Coats & Blanchard-Fields, 2008; Hess & Pullen, 1994). When facing a nonsocial stressor, older adults are just as likely as young adults to say they would focus on problem solving (Blanchard-Fields, 2007; Blanchard-Fields, Chen, & Norris, 1997). Despite these advances, major lacunae in the understanding of aging and emotion regulation still exist. First, most studies rely on self-report measures—questionnaires about global dispositions, distal retrospective accounts, or responses to hypothetical scenarios. Although self-report data provide insight into emotion regulation intentions and schemas, these accounts are not always consistent with more immediate and/or objective measures (Todd, Tennen, Carney, Armeli, & Affleck, 2004). Laboratory-based studies of emotion regulation, in which standardized emotion stimuli and multimethod measures of regulation success are used, are needed to confirm and extend findings based on self-reports. Second, studies of aging and emotion regulation often compare young adults with an older sample, typically ages 60–85 years. Inclusion of a middle-aged sample is less common; without this third group, nonlinear age effects cannot be explored. Third, laboratory studies of emotion regulation and aging have rarely examined the two broad approaches to regulation studied most extensively in young adults: cognitive reappraisal and behavior suppression.

Detached Reappraisal, Positive Reappraisal, and Behavior Suppression

Gross (1998a) distinguishes among emotion regulation strategies in terms of their temporal positions within the emotion process. According to this model, strategies enacted at different stages of the emotion process rely on different skills and have different consequences for emotional experience, physiology, and behavior. For example, a strong program of research has explored differences between *cognitive reappraisal*—altering one's thoughts about a target event to control the initial emotional response—and *behavior suppression*—attempting to conceal one's emotions after the initial response has occurred. The differences between these strategies may have important implications for the effects of aging on each.

Among emotion regulation strategies, cognitive reappraisal offers many benefits, appearing effective in the short-term and psychologically healthy in the long-term (Gross, 2002; Gross & John, 2003). Unlike avoidance, cognitive reappraisal allows one to remain involved in stressful situations while still reducing negative emotion. Experimental studies of instructed reappraisal reveal that it alleviates both the experience of negative emotion and the sympathetic nervous system arousal that typically accompanies it (e.g., Gross, 1998a; Gross, 2002; Jackson et al., 2000). High self-reported dispositional use of reappraisal is associated with high positive affect, low negative affect, high life satisfaction, greater sharing of emotion with others, peer-rated likeability, closer relationships, lower risk of depression, and higher psychological well-being (Gross & John, 2003).

How might cognitive reappraisal be affected by aging? Although self-report data suggest that reappraisal increases throughout adulthood (John & Gross, 2004), evidence regarding the neural mechanisms supporting reappraisal raises the possibility of decline. Successful reappraisal relies on a set of deliberate, controlled cognitive processes—working memory, cognitive monitoring, dominant response inhibition, and response generation—collectively known as *executive function* (Raz, Gunning-Dixon, Head, Dupuis, & Acker, 1998). These skills appear to be mediated by activation in the prefrontal cortex, which is highly engaged during reappraisal (Ochsner, Bunge, Gross, & Gabrieli, 2002; Ochsner & Gross, 2005). Normal aging is accompanied by gray matter losses in this region and by corresponding declines in executive function as measured with neuropsychological tests (Alexander et al., 2006; Raz et al., 1998; Tisserand et al., 2004). Thus, declining executive function associated with normal aging may impair ability to enact emotion regulation strategies that draw heavily on these processes.

Cognitive reappraisal encompasses a number of more specific strategies, all of which rely on executive functioning to a somewhat different degree and which rely on other cognitive resources as well. Most studies of cognitive reappraisal have utilized a strategy that we call *detached reappraisal*. In detached reappraisal, one deliberately focuses one's attention on nonemotional aspects of the situation to reduce the emotional reaction. This redirection of attention away from the most compelling aspects of the situation draws heavily on executive functioning, making detached reappraisal increasingly difficult with age.

In the present study, we contrast detached reappraisal with a second strategy, *positive reappraisal.* In positive reappraisal, the individual attends to the negative event but also recognizes its positive aspects and outcomes (Folkman & Moskowitz, 2000). Like detached reappraisal, positive reappraisal appears to be psychologically healthy, predicting higher well-being (Folkman, 1997; Shiota, 2006) and resilience to stress (Tugade & Fredrickson, 2004). Unlike detached reappraisal, however, positive reappraisal keeps one's focus on the emotional aspects of the situation, reinterpreting these aspects' meaning rather than ignoring them. As a result, positive reappraisal requires less redirecting of attention than does detached reappraisal and may rely to a lesser degree on executive functioning. Instead, the positive reinterpretation of negative situations draws heavily on life experience, particularly the knowledge that painful and challenging experiences may lead to valued gains. There is growing evidence that these kinds of processes play an important role in the lives of older adults. The elderly are thought to have a *positivity bias,* which allows them to allocate a greater proportion of their attention to positive stimuli than do young adults (Carstensen & Mikels, 2005; Charles, Mather, & Carstensen, 2003; Mather & Carstensen, 2003, 2005) and to make greater use of positive emotion in the service of emotion regulation and coping (Charles & Carstensen, 2007; Folkman, Lazarus, Pimley, & Novacek, 1987; Isaacowitz, Toner, Goren, & Wilson, 2008). Because positive reappraisal makes fewer demands on executive functioning than detached reappraisal, draws more on life experience, and makes use of an attentional bias characterizing older individuals, it may become easier with age.

Both detached and positive reappraisal can be contrasted with behavior suppression, or attempting to conceal one's emotions. Studies with young adults have suggested that this strategy effectively reduces behavioral signs of emotion but with significant drawbacks, having minimal impact on the experience of negative emotion and exacerbating the cardiovascular costs (Gross, 1998a;

Gross & Levenson, 1993, 1997). Self-report data suggest that older adults use behavior suppression less often than young adults (John & Gross, 2004); thus, this strategy may not be well rehearsed by the elderly. Behavior suppression is thought to rely heavily on executive functions, requiring self-monitoring and dominant response inhibition (Richards & Gross, 1999, 2006). However, the role of executive functioning in behavior suppression may be somewhat less pronounced than is the case for detached reappraisal. The focus in behavior suppression is on inhibiting motor behavior, whereas the focus of detached reappraisal is on inhibiting and redirecting thoughts—a subtler and more complex process. In a recent study, our laboratory found that neuropsychological tests of working memory, response inhibition, and set shifting did not predict individual differences in behavior suppression, although other tests (e.g., verbal fluency) did predict this skill (Gyurak et al., 2009). This underscores the likelihood that different emotion regulation strategies draw on different aspects of executive functioning in ways not yet understood. For these reasons, age-related declines in executive functioning may not lead to declines in behavior suppression until the former become extreme.

A prior study from our research group offered a first look at aging and emotion regulation under laboratory conditions. In this study, adults ages 18–28 and 60–85 years were comparably successful in suppressing and amplifying disgust behavior. Moreover, the physiological consequences of suppression and amplification were similar for both cohorts (Kunzmann et al., 2005). This study supports a hypothesis of age-related stability in behavior suppression. However, the stimulus films used in the study (which showed surgical procedures) appeared more potent for the younger cohort than for the older cohort; thus, the suppression task may have been easier for the older cohort. Also, this previous study did not include a middle-aged cohort.

The Present Study

The present study extends existing research on aging and emotion regulation in several ways. We examine age differences in three strategies: detached reappraisal, positive reappraisal, and behavior suppression. To examine these strategies in a laboratory setting, we used standardized emotion stimuli, multiple target negative emotions, experimental manipulation of emotion regulation, a within-subjects design comparing emotional responding during instructed regulation conditions with responding during a *just watch* condition (thereby distinguishing regulation success from initial reactivity), and comprehensive, multimethod assessment of emotional responding (subjective experience, peripheral physiology, and emotional facial expression). Finally, we included a middle-aged cohort as well as young and older adult cohorts.

We hypothesized that age effects would differ for the three kinds of regulation. Consistent with evidence regarding age-related declines in executive function, we predicted that increasing age would be associated with less successful detached reappraisal. For positive reappraisal, we predicted that the combined effects of declining executive function, greater life experience, and a well-rehearsed positivity bias would lead to maintained or enhanced success with increasing age. Consistent with our prior research (Kunzmann et al., 2005), we did not expect to observe age differences in the ability to use behavior suppression or in the experiential or physiological consequences of enacting this strategy.

Methods

Sample

Participants were 144 adults residing in the Northern California Bay Area. The sample was equally divided among participants ages 20–29 years, 40–49 years, and 60–69 years, with $n = 48$ (approximately 50% female and 50% male) in each cohort. All 144 participants completed three just watch trials with no emotion regulation instruction, two trials with cognitive reappraisal instruction, and one trial with behavior suppression instruction; in the cognitive reappraisal trials, 68 participants received detached reappraisal instructions (22 in their 20s, 22 in their 40s, and 24 in their 60s), and 76 received positive reappraisal instructions (26 in their 20s, 26 in their 40s, and 24 in their 60s).[1] Four additional participants completed the study protocol, but their data were unusable because of computer or physiological signal quality problems.

A professional survey research firm was used to recruit a sample representative of the Bay Area in terms of ethnicity and socioeconomic status (Table 1). Initial recruitment was conducted with flyers, newspaper advertisements, online postings (e.g., Craigslist), and presentations to local community-based organizations (e.g., religious organizations, senior centers), describing the study and including contact information for the recruitment firm. The recruitment firm conducted telephone-based screening interviews for all respondents and scheduled eligible participants for a laboratory session at the Berkeley Psychophysiology Laboratory at the University of California, Berkeley. The screening excluded respondents who (a) had participated in any other research study in the past 6 months, (b) did not use English as their primary language at home or work, (c) had Michigan Alcoholism Screening Test (Selzer, 1971) scores greater than 6, (d) were wheelchair bound, (e) had diagnosed diabetes or any other medical condition that would prevent sitting comfortably in the laboratory chair for 2 hr, (f) were currently using psychoactive medication to treat an affective or anxiety disorder, or (g) were allergic to the adhesive used to attach the physiological sensors.

Procedures

When participants arrived at the laboratory, they reviewed and signed a consent form. A research assistant then attached the devices used to measure physiological responses. Participants were assigned to an experimental condition, systematically crossing age, sex, ethnicity, reappraisal type, and stimulus tape (which determined film clip sequence). Next, participants received the basic instructions for six film-viewing trials from an experimenter. Within each trial, participants viewed (a) a large *X* on a television monitor for 60 s, during which they were asked to clear their minds of thoughts, feelings, and memories; (b) a 5-s image repeating the instructions; (c) the film clip, which lasted roughly 3 min; and (d) a blank screen for a final 60 s (data from this physiological recovery period are not used in the present analyses). After delivering the instructions, the experimenter left the room for the

[1] A third subsample also participated, receiving nonspecific regulation instructions prior to the fourth and fifth trials; these individuals are not included in the present analyses.

Table 1
Demographic Characteristics of Detached Reappraisal and Positive Reappraisal Subsamples

Demographic characteristic	Detached reappraisal subsample			Positive reappraisal subsample		
	20s (n = 22)	40s (n = 22)	60s (n = 24)	20s (n = 26)	40s (n = 26)	60s (n = 24)
Gender						
Female	52	57	54	50	50	58
Male	48	43	46	50	50	42
Ethnicity						
European American	39	44	63	54	46	67
Asian American	22	22	13	23	19	13
Latino/Latina	17	17	4	15	19	4
African American	22	17	21	8	15	17
Income						
<$25K	55	35	22	57	32	38
$25–$40K	32	35	30	22	32	17
$40–$60K	14	22	22	13	8	38
$60–$75K	0	4	17	9	16	4
>$75K	0	4	9	0	12	4

Note. Values are percentages. For the detached reappraisal subsample, mean age (*SD*) was 25.5 (2.3) for the 20s, 44.7 (2.7) for the 40s, and 64.8 (2.8) for the 60s. For the positive reappraisal subsample, mean age (*SD*) was 25.3 (2.4) for the 20s, 43.2 (2.9) for the 40s, and 64.5 (3.5) for the 60s.

duration of the trial. At the end of the trial, the experimenter re-entered the room, administered the emotional experience questionnaire (see *Measures* section next), and delivered instructions for the next trial.

For the first three trials (the just watch trials), participants were instructed to "just watch the film clip as though you were watching television at home, or a movie in a movie theater." The first trial showed an emotionally neutral film and was used to help participants adjust to the experimental procedures; data from this trial are not used in the present analyses. In the second and third trials, participants saw one sad and one disgusting clip (see later descriptions), with order counterbalanced across the sample. For the fourth and fifth trials (the reappraisal trials), participants received the reappraisal instructions for their assigned condition. The detached reappraisal instruction was,

> This time, while you are watching the film clip, please try to adopt a detached and unemotional attitude. As you watch the film clip, please try to think about what you are seeing objectively. Watch the film clip carefully, but please try to think about what you are seeing in such a way that you feel less negative emotion.

The positive reappraisal instruction was,

> This time, 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 less negative emotion.

In the two reappraisal trials, participants viewed one sad and one disgusting film clip, with order counterbalanced across the sample.

For the sixth trial (the suppression trial), all participants watched a disgusting film clip, and all were instructed,

> This time, if you have any feelings as you watch the film clip, please try your best not to let those feelings show. Watch the film clip carefully, but try to behave so that someone watching you would not know that you are feeling anything at all.

The disgusting film clips were taken from the television show *Fear Factor* and depicted a person engaged in an unpleasant eating activity—a prototypical elicitor of disgust. One clip showed a woman eating horse rectum, another showed a man sucking fluid from cow intestine, and the third showed a woman eating coagulated blood balls from a plate of live worms without using her hands. The order of the horse rectum and cow intestine clips was counterbalanced across the sample, with one used in a just watch trial and the other in a reappraisal trial. The blood balls clip was always used in the suppression trial.

The two sad film clips were taken from feature films and depicted a person learning of and mourning a close other's death—a prototypical elicitor of sadness. One clip, from the film *21 Grams*, showed a mother learning of her two daughters' deaths in a car accident. The other clip, from *The Champ*, showed a boy watching his mentor's death after a boxing match. The order of these clips was counterbalanced across the sample, with one used in a just watch trial and the other used in a reappraisal trial.

After the final trial, an experimenter removed the physiological measurement sensors. Participants completed an interview about a recent emotion regulation experience (not used in the present analyses) and were debriefed. Participants received $50 for participating in the 2.5-hr study.

Measures

Subjective emotional experience. After each trial, participants were asked to report their emotional experience while viewing the film clip. Specifically, participants rated how strongly they had experienced each of nine emotions (amusement/humor, anger, contentment, compassion, disgust, enthusiasm/excitement, fear, sadness, and surprise) on a scale from 0 (*did not experience the emotion at all*) to 8 (*strongest experience of the emotion ever felt*). The present analyses examine only ratings for the target emotion for each film clip. After the instructed reappraisal and suppression trials, participants were also asked to rate how successful they thought they were at complying with the “instructions for dealing with your emotions during the film clip” on a scale from 0 (*not at all successful*) to 4 (*very successful*).

Physiology. The physiological measures were selected to sample broadly from major organ systems (cardiac, vascular, respiratory, and electrodermal), to allow for continuous measurement, to be as unobtrusive as possible, and to include measures used in our previous studies of emotion. To obtain continuous recordings of nine measures of peripheral physiological activity, we used a system consisting of a Grass Model 7 polygraph (Grass Technologies, West Warwick, RI), a Finapres blood pressure monitor (Finapres Medical Systems, Amsterdam, The Netherlands), and a microcomputer with analog and digital input–output capabilities: To measure cardiac interbeat interval, electrodes with abrasive paste were placed in a bipolar configuration on opposite sides of the participant’s chest, and the interval between successive R-waves of the electrocardiogram was measured in milliseconds. To measure skin conductance level, a constant voltage device passed a small voltage between electrodes attached to the palmar surface of the intermediate phalanges of the first and third fingers of the nondominant hand, with sodium chloride in Unibase as the electrolyte. To measure finger pulse amplitude, a UFI photoplethysmograph (UFI Instruments, Morro Bay, CA) attached to the distal phalanx of the third finger of the nondominant hand recorded the volume of blood in the finger. The trough-to-peak amplitude of the finger pulse was measured, providing an index of the amount of blood in the periphery. To measure pulse transmission time to the finger, the time interval was measured between the R-wave of the electrocardiogram and the upstroke of the peripheral pulse at the finger. To measure pulse transmission time to the ear, a UFI photoplethysmograph attached to the left earlobe recorded the volume of blood in the ear. The time interval was measured between the R-wave of the electrocardiogram and the upstroke of the peripheral pulse at the ear. To measure finger temperature, a thermistor (Yellow Springs Instruments, Yellow Springs, OH) was attached to the palmar surface of the distal phalanx of the fourth finger of the nondominant hand. To measure mean arterial blood pressure, an inflating cuff was placed on the intermediate phalanx of the second finger of the nondominant hand and was adjusted continuously by the Finapres monitor to provide an estimate of blood pressure on each heartbeat. To measure respiration period and respiration depth, a cloth belt wrapped around the participant’s thorax compressed an inflated bladder to provide a measure of chest wall movement. The time interval between inspirations was used to measure respiration period, and the difference in signal amplitude between peak inspiration and peak expiration was used to measure respiratory depth. A computer program written by Robert W. Levenson calculated second-by-second averages for each physiological measure.

Prior to additional analysis, all data were examined by research assistants unaware of participants’ age, sex, and experimental condition to remove artifacts and outliers. Data for each measure were then averaged into key epochs by calculating means for the 60-s baseline preceding each stimulus film clip and the duration of the clip.

To reduce the number of physiological dependent variables and control Type I error, we computed a composite averaging the response across eight of the nine measures: cardiac interbeat interval, skin conductance level, finger pulse amplitude, pulse transmission time to the finger, pulse transmission time to the ear, finger temperature, respiration depth, and mean arterial blood pressure.[2] This composite was formed for each trial by subtracting the mean of the baseline epoch from the mean of the film epoch for each channel; normalizing the resulting difference scores across the entire sample; multiplying the normalized scores for cardiac interbeat interval, finger pulse amplitude, finger temperature, and ear pulse transmission time by -1 so that more positive values indicated increasing levels of autonomic cardiovascular activation (i.e., faster heart rate, greater peripheral vasoconstriction, and more rapid ventricular contraction); and averaging the resulting eight z scores for the trial.

Facial expression. We videotaped participants throughout the laboratory session, with their knowledge and consent, using a remotely controlled camera partially concealed behind darkened glass. For each trial, emotional behavior was coded during the stimulus film clip and the first 10 s after the clip (because a burst of expression often followed the clip’s end). Coding of target emotion expressions was based on criteria derived from the Facial Affect Coding System and the Emotional Facial Action Coding System (Ekman & Friesen, 1978; Friesen & Ekman, 1983) and included required and optional/enhancing action units. For disgust, required action units were 9 (nose wrinkle) and/or 10 (upper lip raise), and optional action units included 23 (lip tighten) and 24 (lip press). For sadness, required action units were 1 (inner brow raise) or 1 + 4 (inner brow raise plus brow lower), and optional action units were 6 (cheek raise), 15 (lip corners down), 17 (chin raise), and 24 (lip press). Coding was segmented into 5-s bins, each of which was rated for both sadness and disgust (other emotions were also coded but were not used in the present analyses) on a scale from 0 (*not present*) to 3 (*strongly present*), reflecting both intensity and duration of the expression. Coders were unaware of which film clip the participant was watching in each trial, as well as the participant’s reappraisal type condition. The present analyses examine the average ratings for target emotion expression (i.e., sadness facial expressions during sad films and disgust facial expressions during disgust films) across all bins of each film clip. Coding was completed by three individuals. Data from 14 participants (10% of the sample) were coded by all three individuals to assess reliability; single-coder intraclass correlations were .69 for disgust and .76 for sadness.

Analyses

To assess age equivalence in initial reactivity to the film clips (before the regulation instruction), just watch trials were analyzed with mixed-model analyses of variance (ANOVAs) predicting three dependent measures: target emotion experience, physiolog-

[2] Principal components analyses of the nine physiology variables were conducted for each of the five trials used in the present analyses, to assess appropriateness of including each variable in the composite. Factor loadings from the first unrotated vector for each trial were examined. Respiration period was not included in the composite because it showed a strong (>.30) positive loading on this vector in two trials, a strong negative loading in one trial, and near-zero loadings in the remaining two trials. The remaining variables showed a more consistent pattern across the five trials and also confirmed which variables were to be reversed (multiplied by -1) after normalization and prior to averaging.

ical reactivity, and target emotion facial expression. The structure of these ANOVAS was 3 × 2 × 2 × 8 × 2 (Age Group × Sex × Reappraisal Type [detached vs. positive] × Stimulus Tape [order of specific film clips] × Film Type [disgusting vs. sad]. All variables were treated as between-subjects except film type, which was treated as a within-subject variable. Interactions involving age group were further decomposed with one-way ANOVAs to examine the effect of age within each level of any other variable or variables in the interaction.

To isolate the effects of the reappraisal instructions, just watch and reappraisal trials were then analyzed with mixed-model ANOVAs to examine regulation success in four dependent variables: self-reported regulation success, target emotion experience, physiological reactivity, and target emotion facial expression. The structure of these ANOVAS was 3 × 2 × 2 × 8 × 2 × 2 (Age Group × Sex × Reappraisal Type × Stimulus Tape × Film Type × Instruction [just watch vs. reappraise]). All variables were treated as between subjects except film type and instruction, which were treated as within-subject variables. In these analyses, regulation success was operationalized as the reduction in emotional responding from just watch trials to reappraisal trials. Thus, the effects of primary interest for examining age differences in regulation success were the Age Group × Instruction interaction and any further interactions with additional variables. When these interactions were significant, we decomposed them, using paired-samples *t* tests to contrast reactivity during the just watch and reappraisal trials for each age group (within each level of any other variables in the interaction). Self-reported regulation success was not assessed for the just watch trials; thus, this dependent variable was analyzed without the instruction variable.

Finally, to isolate the effects of behavior suppression instruction, just watch (disgust only) and behavior suppression trials were analyzed with mixed-model ANOVAs to examine regulation success in four dependent variables: self-reported regulation success, target emotion experience, physiological reactivity, and target emotion facial expression. The structure of these ANOVAS was 3 × 2 × 8 × 2 (Age Group × Sex × Stimulus Tape × Instruction [just watch vs. behavior suppression]). All variables were treated as between subjects except instruction, which was treated as a within-subject variable. As with the reappraisal analysis, the focus was on the Age Group × Instruction interaction, and any further interaction of these variables with additional variables. Self-reported regulation success was not assessed for the just watch trial; thus, this dependent variable was analyzed without the instruction variable.

Results

Reactivity to Just Watch Film Clips

Subjective experience. The main effect of age group was not significant, $F(2, 60) = 2.13$, $p = .271$. However, the Age Group × Film Type interaction was significant, $F(2, 60) = 3.43$, $p = .039$. Follow-up analyses indicated that subjective experience of sadness to the sad films increased with age: 20s = 4.00, 40s = 4.78, 60s = 5.88; $F(2, 143) = 6.54$, $p = .002$. However, this was not the case for subjective experience of disgust to the disgust films. This interaction was further moderated by sex, with more pronounced age-related increases in sadness to the sad films among women than among men, $F(2, 60) = 7.93$, $p = .001$. In addition, age group interacted significantly with stimulus tape, $F(14, 60) = 1.92$, $p = .041$, suggesting age effects on responses to particular film clips. Follow-up analyses revealed that target emotion experience while viewing the *21 Grams* clip increased significantly with age: 20s = 4.12, 40s = 4.96, 60s = 6.30; $F(2, 72) = 4.70$, $p = .012$. However, this was not the case for the other three films. There were no other significant interactions involving age group.

Physiological reactivity. The main effect of age group was not significant, $F(2, 61) = 0.56$, $p = .558$, and the interactions of age group with film type and/or reappraisal type also were not significant. The Age Group × Stimulus Tape interaction was significant, $F(14, 61) = 2.34$, $p = .012$, and was further moderated by reappraisal type, $F(12, 61) = 2.02$, $p = .038$. Follow-up analyses indicated that physiological reactivity while viewing the *21 Grams* film clip increased significantly with age among those who would later receive positive reappraisal instructions: 20s = −0.06, 40s = −0.14, 60s = 0.53; $F(2, 36) = 4.84$, $p = .014$. However, physiological reactivity did not increase among those who would later receive detached reappraisal instructions. Age differences in physiological reactivity were not present for any of the other three clips. No other interactions involving age group were significant.

Facial expression. The main effect of age group was not significant, $F(2, 44) = 0.30$, $p = .744$. A four-way Age Group × Reappraisal Type × Film Type × and Stimulus Tape interaction was significant, $F(11, 44) = 2.39$, $p = .020$, but the effect of age group was not significant for any film clip in either the detached reappraisal group or the positive reappraisal group; thus, the pattern of results was not readily interpretable. No other interactions involving age group were significant.

Summary. Analyses of reactivity to the film clips in the just watch condition were used to assess age differences in responses to film stimuli prior to receiving the reappraisal instruction. The cohorts were largely similar in their emotional responding to these clips, with the exception of the *21 Grams* film clip, where self-reported sadness increased with age, and physiological reactivity increased with age among participants who would later receive the positive reappraisal instructions. Implications of these findings will be addressed in the *Discussion* section.

Main Effects of Emotion Regulation Instruction

Main effects of cognitive reappraisal instruction. A main effect of instruction (just watch vs. reappraise) was observed in the analysis predicting target emotion experience: just watch = 5.08, reappraise = 4.59; $F(1, 60) = 8.90$, $p = .004$. The main effect of instruction on physiological reactivity was not significant. This was expected, because the *z* scoring process used to form the physiological composite was performed separately for each trial; channel-by-channel effects supported the expected effects of reappraisal, suggesting reduced physiological reactivity during reappraisal trials relative to just watch trials. A main effect of instruction was observed in the analysis predicting facial expression of the target emotion: just watch = 0.30, reappraise = 0.23; $F(1, 44) = 16.19$, $p < .001$. In summary, across the entire sample, reappraisal instruction appeared to reduce target emotional responding relative to the just watch trials.

Main effects of behavior suppression instruction. As expected, a significant main effect of instruction (just watch vs. behavior suppression) was observed in the analysis predicting facial expression: just watch = 0.50, suppress = 0.15; $F(1, 87) = 44.24$, $p = .001$. A significant main effect of instruction on emotion experience was also observed, with participants reporting less disgust in the suppression condition than in the just watch condition: just watch = 5.24, suppress = 4.57; $F(1, 100) = 10.64$, $p = .002$.[3] The main effect of instruction on physiological reactivity was not significant. In summary, across the entire sample, participants successfully reduced their facial expressions of emotion in response to behavior suppression instructions.

Age Differences in Effects of Detached and Positive Reappraisal Instruction

Self-reported reappraisal success. The main effect of age was significant, with self-reported reappraisal success increasing in the older cohorts: 20s = 2.15, 40s = 2.54, 60s = 2.69; $F(2, 130) = 3.81$, $p = .025$. No interactions involving age were significant.

Subjective emotional experience. The Age Group × Instruction interaction was not significant. However, the three-way Age Group × Instruction × Reappraisal Type interaction was significant, $F(2, 60) = 5.37$, $p = .007$; see Table 2. Decomposing this interaction revealed significant differences in target emotion experience between just watch and detached reappraisal trials for the 20s age group, $t(21) = 2.52$, $p = .020$, a weaker and marginally significant effect for the 40s age group, $t(23) = 1.88$, $p = .073$, and no significant effect for the 60s age group, $t(23) = 0.37$, *ns*. In contrast, there were no significant differences in target emotion experience between just watch and positive reappraisal trials for the 20s, $t(25) = -0.16$, *ns,* or 40s, $t(25) = 0.19$, *ns,* age groups, but in the 60s age group, this effect was significant, $t(23) = 2.35$, $p = .028$.

The three-way Age Group × Instruction × Reappraisal Type interaction was not further moderated by film type (the pattern was observed in response to both sad and disgusting stimuli) and/or sex, but was further moderated by stimulus tape, $F(12, 60) = 2.27$, $p = .019$. Although this four-way interaction indicates that the three-way interaction described earlier varied with the order in which specific film clips were presented, no clear, interpretable pattern emerged.

In summary, there were clear age differences in the effects of detached and positive reappraisal on subjective emotional experience, and age effects varied with type of reappraisal. Whereas younger participants showed the greatest benefits of detached reappraisal instruction, older adults showed the greatest benefits of positive reappraisal instruction.

Physiological reactivity. The Age Group × Instruction interaction was not significant. However, the three-way Age Group × Instruction × Reappraisal Type interaction was significant, $F(2, 61) = 4.68$, $p = .013$; see Table 2. Decomposing this interaction revealed a marginally significant difference in physiological reactivity between just watch and detached reappraisal instruction trials for the 20s age group, $t(22) = 1.83$, $p = .081$, but no significant effect for the 40s, $t(23) = 0.75$, *ns,* or 60s age groups, $t(23) = -0.80$, *ns.* In contrast, there were no significant differences in physiological reactivity between the just watch and positive reappraisal instruction trials for the 20s, $t(25) = -0.25$, *ns,* or 40s, $t(25) = -0.73$, *ns,* age groups, but in the 60s age group, this effect was significant, $t(23) = 2.44$, $p = .023$. No other interactions involving age group and instruction were significant.

In summary, the findings for physiological reactivity mirrored those for subjective emotional experience. Whereas young adults showed the greatest effect of detached reappraisal in reducing physiological responses and this effect diminished with age, older adults showed the greatest effect of positive reappraisal.[4]

Facial expression. The Age Group × Instruction interaction was not significant, nor were any higher order interactions involving age group and instruction (see Table 2).

Age Differences in Effects of Behavior Suppression Instruction

Self-reported suppression success. The main effect of age group was not significant (20s = 2.72, 40s = 2.73, 60s = 2.86), $F(2, 136) = .21$, *ns*, nor were any interactions involving age group.

Facial expression. The Age Group × Instruction interaction was not significant, nor were any higher order interactions involving age group and instruction (see Table 3).

Self-reported emotional experience. The Age Group × Instruction interaction was not significant. However, the three-way Age Group × Instruction × Sex interaction was significant, $F(2, 100) = 3.45$, $p = .036$. Decomposing this interaction, the decrease in disgust from the just watch trial to the suppress trial was greater among men in their 40s than among women in their 40s. No other interactions involving instruction and age group were significant.

Physiological reactivity. The Age Group × Instruction interaction was not significant, nor were any higher order interactions involving age group and instruction (see Table 3).

Discussion

We examined the ability of participants in their 20s, 40s, and 60s to implement three different emotion regulation strategies—two forms of reappraisal (detached vs. positive) and behavior suppression—while viewing distressing films. This study builds on a rich body of research addressing young adults' use of these strategies (e.g., Gross, 2002; Gross & Levenson, 1993; Hagemann et al., 2006; Jackson et al., 2000; Shiota, 2006; Tugade & Fredrickson, 2004), expands on our earlier study of suppression in older individuals (Kunzmann et al., 2005), and is, to our knowledge, the first laboratory study of emotion regulation with such diversity of regulation strategies and age groups. The pattern of results suggests that age impacts different emotion regulation strategies in different ways. Furthermore, these findings underscore the value of studying emotion regulation under controlled laboratory conditions and of using a multimethod approach to assessing regulation success.

[3] Note that this effect contradicts the findings of several studies, in which instructed suppression had no effect on target emotion experience. Given that the same film clip was used in all suppression trials, it is likely that this clip was simply less intense than the clips used in the just watch and reappraise trials—a comment made by a number of our participants.

[4] This pattern was also observed in analyses *z* scoring differences between reappraise and just watch trials for each physiological variable and averaging these *z* scores to produce an index of reappraisal success.

Table 2
Effects of Detached and Positive Reappraisal Instructions on Subjective Target Emotion Experience, Physiological Reactivity, and Facial Expression in Three Age Groups

Dependent variable and instruction condition	Detached reappraisal			Positive reappraisal		
	20s	40s	60s	20s	40s	60s
Subjective experience*						
Watch	4.43 (0.42)	5.30 (0.41)	5.03 (0.40)	4.58 (0.40)	5.21 (0.39)	5.88 (0.42)
Reappraise	3.25 (0.45)	4.08 (0.43)	5.08 (0.43)	4.49 (0.42)	5.42 (0.41)	5.20 (0.44)
Physiological reactivity[a]*						
Watch	0.01 (0.07)	0.04 (0.07)	−0.10 (0.07)	0.01 (0.07)	−0.02 (0.07)	0.22 (0.07)
Reappraise	−0.13 (0.08)	−0.05 (0.08)	0.02 (0.08)	0.05 (0.08)	0.05 (0.07)	0.06 (0.08)
Facial expression[b]						
Watch	0.28 (0.08)	0.38 (0.08)	0.30 (0.08)	0.30 (0.07)	0.23 (0.07)	0.33 (0.08)
Reappraise	0.14 (0.09)	0.28 (0.09)	0.21 (0.09)	0.19 (0.08)	0.27 (0.08)	0.32 (0.09)

Note. Cell values reflect estimates based on modified population marginal means; standard errors are in parentheses.
[a] More negative physiological reactivity values indicate smaller increases in arousal from baseline to film clip. Apparent increases from just watch trials to reappraise trials are an artifact of the separate z scoring for these trials and reflect smaller decreases in reactivity across trials, rather than actual increases. [b] Mean values represent the average intensity of target emotion expression across all 5-s bins of the film clip.
* The three-way interaction among instruction (just watch vs. reappraise), age group, and reappraisal type was significant at $p < .05$.

Consistent with survey findings (Gross et al., 1997), where age differences in self-reported emotion regulation success were found, older participants felt they were more successful. Older participants in the present study reported greater success than young participants at both kinds of reappraisal, although not at behavior suppression. These results likely reflect pre-existing beliefs about emotion regulation abilities and how these are affected by age. Perceived success at enacting reappraisal appears to follow the adage "older but wiser," reflecting the belief that greater experience leads to a more mature and balanced perspective. In contrast, by early adulthood, individuals are already confident in their ability to enact brute force strategies, such as suppression, and this confidence remains stable through the 60s.

Table 3
Effects of Suppression Instruction on Facial Expression, Subjective Target Emotion Experience, and Physiological Reactivity in Three Age Groups

Dependent variable and instruction condition	20s	40s	60s
Facial expression[a]			
Just watch	0.47 (0.10)	0.53 (0.10)	0.48 (0.11)
Suppress	0.08 (0.06)	0.17 (0.06)	0.20 (0.07)
Subjective experience			
Just watch	4.78 (0.33)	5.80 (0.32)	5.20 (0.34)
Suppress	3.66 (0.42)	5.18 (0.41)	4.95 (0.43)
Physiological reactivity[b]			
Just watch	0.05 (0.07)	0.00 (0.07)	−0.03 (0.08)
Suppress	−0.11 (0.07)	0.08 (0.06)	0.01 (0.07)

Note. Cell values reflect estimates based on modified population marginal means; standard errors are in parentheses.
[a] Mean values represent the average intensity of disgust expression across all 5-s bins of the film clip. [b] More negative physiological reactivity values indicate smaller increases in arousal from baseline to film clip. Apparent increases from just watch trial to suppress trial are an artifact of the separate z scoring for these trials and reflect smaller decreases in reactivity across trials, rather than actual increases.

The measures of actual regulatory performance—subjective emotional experience, physiological reactivity, and facial expression—fleshed out this picture in important ways. We found little evidence of age differences in the behavioral, subjective, and physiological consequences of behavior suppression, consistent with participants' beliefs about how well they had done and with our previous study of aging and suppression (Kunzmann et al., 2005). The present study extends our previous study in two important ways: (a) by including a middle-aged cohort and (b) by using stimulus films that proved more equivalent in their impact across the three age groups (in the earlier study, films of surgical procedures evoked less disgust among older participants). Thus, all indicators, both objective and subjective, point to behavior suppression as an aspect of emotional functioning that is relatively preserved as people age (Levenson, 2000).

The effects of age were more textured for detached and positive reappraisal. Although older adults reported greater success than younger adults at both types of reappraisal, the measures of actual emotional responding indicated that the effects of age depended on reappraisal type. This discrepancy between the effects of age on self-reported reappraisal success and the effect on actual emotional responding underscores the difficulty people have in estimating their own emotional performance in a number of domains (Levenson & Ruef, 1992; Reisenzein, Bordgen, Holtbernd, & Matz, 2006; Todd et al., 2004).

Specifically, success at detached reappraisal (i.e., reduced negative emotion experience and physiological reactivity) declined with age in a roughly linear manner, with young adults showing the greatest success, middle-aged adults showing somewhat less success, and older adults showing considerably less success. We have speculated that detached reappraisal draws heavily on aspects of executive functioning that decline throughout adulthood (DeLuca et al., 2003) and that this may explain age-related difficulties in using this strategy.

In contrast, success at positive reappraisal increased with age, with young adults showing the least success at using this strategy, middle-aged adults showing somewhat more success, and older adults showing considerably more success. These results are consistent with studies documenting an age-related positivity bias, in which older adults tend to allocate greater attention to positive stimuli (Charles & Carstensen, 2007). The present findings offer an extension of this principle, in that our older adults showed considerable success at engaging with positive aspects of a clearly negative situation.

Because our experimental design included both male and female participants and included both sad and disgusting stimuli, we had an opportunity to test the robustness of these findings across sex and type of emotion. In each case, we found little evidence of differences in the basic pattern of effects, increasing our confidence in the generalizability of our findings. The comparability of effects across emotions is quite consistent with our previous studies of behavior suppression in young adults, where we also found far more similarities than differences across emotions (Gross & Levenson, 1997). In terms of sex differences, there have been reports that men and women approach emotion regulation in different ways (e.g., Eschenbeck, Kohlmann, & Lohaus, 2007; Nolen-Hoeksema, Larson, & Grayson, 1999). However, these differences might be more apparent in spontaneous emotion regulation than in the kinds of instructed regulation tasks studied here.

The pattern of differing age effects on the consequences of detached versus positive reappraisal, observed in subjective emotional experience and physiological reactivity, did not extend to emotional facial expressions. Across all age groups and both reappraisal types, reappraisal instructions had a modest effect in reducing facial expressions, and the effects of behavior suppression also did not appear to vary with age. It may be that age-related changes in regulation ability primarily affect the internal aspects of emotion (subjective experience and peripheral physiology) and not the expressions that signal our intentions and reactions to others. However, further research is needed with cohorts more advanced in age and showing more pronounced declines in executive function.

Implications

Taken together, our findings highlight the fact that emotion regulation encompasses a variety of strategies drawing on different underlying abilities and showing different age-related trajectories of change. This suggests that different regulation strategies may be applied more successfully at different times of life. A similar point has been made by others (Blanchard-Fields, 2007; Carstensen et al., 1999), who have noted that older adults have distinctive life circumstances and goals that make particular regulation strategies feasible and appropriate. For example, several studies have found that older adults are likely to avoid stressful interpersonal situations as a way of controlling negative affect (Birditt & Fingerman, 2005; Coats & Blanchard-Fields, 2008). This strategy, however, runs the risk of increasing social isolation, which can have extremely negative effects on late-life health and well-being (Berkman & Syme, 1979; Hawkley & Cacioppo, 2007). Our findings concerning positive reappraisal are especially promising in this regard. Positive reappraisal allows one to remain involved in difficult situations, while still managing emotions effectively. Extrapolating from our findings, older adults may be better served by staying socially engaged and using positive reappraisal to deal with stressful, challenging situations, rather than disconnecting from situations that offer opportunities to enhance quality of life.

Strengths and Limitations

As noted earlier, the present study is the first to use an experimental design that includes three age groups, laboratory assessment of emotion regulation ability, three kinds of emotion regulation, and multimethod assessment of actual emotional responding as well as perceived regulation success. The value of this approach was seen in a pattern of findings that revealed important differences in the effects of age as a function of type of regulation and aspect of emotional responding.

The study also had several limitations. First, this was a study of instructed emotion regulation—participants were given specific instructions as to when and how to regulate their emotions. This approach is a critical first step in understanding the complexities of emotion regulation and age. However, the capacity to regulate on command may or may not reflect what individuals do spontaneously in situations that call for emotion regulation. In work with neurological patients, for example, Goodkind, Gyurak, McCarthy, Miller, and Levenson (in press) found that patients with different kinds of brain damage show different deficits in instructed versus spontaneous regulation, suggesting that different neural mechanisms are involved in these processes.

Second, we have speculated that the observed age-related changes in emotion regulatory success are associated with age-related changes in executive function, life experience, and biases toward positive stimuli. However, we did not directly measure these potential mediating mechanisms. Future studies that measure these variables directly are needed to test these hypothesized relationships.

Third, we used a cross-sectional design to examine age differences. For this reason, we cannot be certain whether observed differences between groups reflect age per se or reflect cohort differences that could have an impact on regulatory ability. Longitudinal designs are needed to determine whether the group differences can, in fact, be attributed to age. Also, the age of our oldest cohort was 60–69 years, and participants in this cohort were quite cognitively and psychosocially high functioning. The emotion regulation abilities of this age group are likely to differ dramatically from the abilities of adults in their 70s, 80s, and beyond.

Fourth, we assessed age differences in the regulation of only two emotions (disgust and sadness) and with only film clips as stimuli. Testing additional emotions and emotion elicitors would provide a richer picture of the relationship between aging and emotion regulation.

Finally, there is the issue of stimulus equivalency in studies of aging and emotional responding. We found in previous work that surgical films effectively elicited disgust in young adults but were less effective with older participants (Kunzmann et al., 2005). Our analyses of the just watch trials in the present study indicated that almost all of the films we used showed age equivalence. However, one of our sad films (*21 Grams*) evoked stronger responses from our older cohort (for a broader discussion of heightened sadness reactivity in the elderly, see Kunzmann & Gruhn, 2005). Although this particular effect does not explain our findings of age differences in regulatory success (order of clips was counterbalanced across trials within each age group, and the pattern of age effects was observed with disgusting as well as sad stimuli), it is important to continue to seek stimuli that are equally effective with different age groups.

Conclusion

Research on aging and emotion regulation has a great deal to offer, both to those interested in the psychology of aging and to those interested in healthy and effective emotion management at any age. Our findings suggest that the effect of age on emotion regulation success depends on the specific strategy used: Ability to implement positive reappraisal improves with age, ability to suppress emotional behavior is maintained, and ability to implement detached reappraisal declines. These findings have important theoretical and practical implications, shedding light on the mechanisms by which various emotion regulation strategies have their effects and identifying strategies that are most likely to be effective at different stages of life. The judicious use of emotion regulation strategies in late life may provide important clues for understanding and promoting successful aging.

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