Title

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Journal

Emotion, 19(8)

ISSN

1528-3542

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Publication Date

2019-12-01

DOI

10.1037/emo0000534

Peer reviewed

American Psychological Association

Emotion

1528-3542/19/$12.00

2019, Vol. 19, No. 8, 1437–1449
http://dx.doi.org/10.1037/emo0000534

Responding to the Emotions of Others: Age Differences in Facial Expressions and Age-Specific Associations With Relational Connectedness

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Responding prosocially to the emotion of others may become increasingly important in late life, especially as partners and friends encounter a growing number of losses, challenges, and declines. Facial expressions are important avenues for communicating empathy and concern, and for signaling that help is forthcoming when needed. In a study of young, middle-aged, and older adults, we measured emotional responses (facial expressions, subjective experience, and physiological activation) to a sad, distressing film clip and a happy, uplifting film clip. Results revealed that, relative to younger adults, older adults showed more sadness and confusion/concern facial expressions during the distressing film clip. Moreover, for older adults only, more sadness and fewer disgust facial expressions during the distressing film clip were associated with higher levels of relational connectedness. These findings remained stable when accounting for subjective emotional experience, physiological activation, and trait empathy in response to the film clip. When examining the uplifting film clip, older adults showed more happiness facial expressions relative to younger adults at trend levels. More facial expressions of happiness were associated with higher levels of relational connectedness, but unlike the effect of sadness expressions, this was not moderated by age. These findings underscore an important adaptive social function of facial expressions—particularly in response to the distress of others—in late life.

Keywords: sadness, aging, relational connectedness, loneliness, facial expressions

Supplemental materials: http://dx.doi.org/10.1037/emo0000534.supp

In social settings we are often faced with the emotions of others, such as a child who is injured, a loved one who has experienced a significant loss, or a friend who is celebrating a positive event. These experiences may evoke strong emotional responses of our own, which signal our concern for the other person's well-being. This, in turn, can lead to positive relationship outcomes such as mutual feelings of interpersonal connection and closeness (Gray, Ishii, & Ambady, 2011). In the present study we asked whether facial expressions in response to others' situations and emotions differ across age groups, and whether these differences are related to our sense of connection with other people.

The Social Functions of Facial Behaviors

Emotional facial expressions have high social visibility (Hager & Ekman, 1979), making them a particularly effective way for conspecifics to exchange emotional information (Darwin, 1998; Schmidt & Cohn, 2001). When experiencing distress, displaying negative emotion (e.g., sadness, fear) can communicate to others that assistance and support are needed (Campos, Campos, & Barrett, 1989; Fischer & Manstead, 2008) and motivate them to provide aid (Clark, Ouellette, Powell, & Milberg, 1987; Graham, Huang, Clark, & Helgeson, 2008). Smiling and laughter also bring others to our side, evoking liking (e.g., Johnston, Miles, & Macrae,

This article was published Online First February 7, 2019.

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The research was supported by National Institute on Aging grants R01 AG041762 and P01 AG019724 to Robert W. Levenson, and Bruce L. Miller. We thank Michael D. Edge for his help with analyses and for his helpful comments on all versions of the article, Deepak Paul for his help with data processing, and Emily Ma and Michelle Pardo for their assistance with coding emotional facial expressions. Sandy J. Lwi, Claudia M. Haase, and Robert W. Levenson developed the study concept. Scott L. Newton performed the facial coding, Sandy J. Lwi processed the data, and both Sandy J. Lwi and Claudia M. Haase analyzed the data. Sandy J. Lwi wrote the first draft of the article, and all authors contributed to revisions of the article. Robert W. Levenson supervised all phases of the project.

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2010), perceptions of agreeableness and extroversion (e.g., Mehu, Little, & Dunbar, 2008), and cooperation (e.g., Danvers & Shiota, 2018; Scharlemann, Eckel, Kacelnik, & Wilson, 2001).

Emotional displays have longer-term social functions as well (Shiota, Campos, Keltner, & Hertenstein, 2004). Using the face to mirror the emotions being experienced by another person, and to display care and concern, can help build and strengthen meaningful interpersonal relationships (Gray et al., 2011). For individuals observing others in a negative situation, emotional displays can signal concern for that person's well-being (Eisenberg et al., 1989; Keltner, 2009; Keltner & Kring, 1998) and reduce their distress (Batson, 2011). When interacting with others in a positive situation, smiling and laughing communicate responsiveness, encouragement, and respect, and can lead to higher relationship satisfaction (Gable, Gonzaga, & Strachman, 2006). These relationship-building functions may be particularly important in late life, when individuals afford heightened priority to interpersonal goals (Carstensen, 1993).

Prosocial Responding to Others' Distress in Late Life

Responding to the distress of others can be a particularly prominent feature of late life. Many older adults are involved in providing care for significant others, including spouses and grandchildren (Schulz & Eden, 2016), and are more likely than their younger counterparts to aid strangers who are in need (Midlarsky & Hannah, 1989; Sze, Gyurak, Goodkind, & Levenson, 2012). Older adults' peers also tend to experience greater losses in a number of life domains (Charles & Carstensen, 2010; Prohaska et al., 2006; Salthouse & Babcock, 1991; Steverink, Westerhof, Bode, & Dittmann-Kohli, 2001), making it more common for them to encounter other people in distress.

Older adults' increased exposure to loss and distress has been theorized to strengthen their responsiveness to displays of these emotions in others (Seider, Shiota, Whalen, & Levenson, 2011). Extant research is consistent with this notion, as laboratory-based research has found that older adults report greater subjective sadness experience (Kunzmann & Grühn, 2005; Seider et al., 2011) and show greater autonomic reactivity (Sze et al., 2012) in response to films depicting the distress of others. In contrast, two prior studies comparing older adults with young or middle-aged adults found no differences in facial responses to sad film clips (Seider et al., 2011; Tsai, Levenson, & Carstensen, 2000). In both of these studies however, the sad stimulus (a film clip depicting a fictional boy's response to his father's death) evoked very low levels of sadness expression across the sample; thus, a floor effect may have concealed age effects. Clearly more research is needed that examines age differences in expressive responses to high-intensity, realistic depictions of others' emotions (both distress and happiness), because this expressivity may play an important role in older adults' social relationships.

Older individuals afford high priority to strengthening or maintaining meaningful social relationships (Carstensen, 1992; Carstensen, Isaacowitz, & Charles, 1999; Fredrickson & Carstensen, 1990), but simultaneously are vulnerable to shrinking social networks and physical changes that can limit the frequency of their social contacts. In particular, older adults become less able to rely on social obligations commonly found in the lives of young and middle-aged adults (e.g., living with family members and/or roommates, group leisure activities, work-related interactions), reducing opportunities for social connection and potentially resulting in isolation and loneliness (Lang, Staudinger, & Carstensen, 1998; Pinquart & Sorensen, 2001). The ability to maintain close social connections may increasingly rely on signaling readiness for emotional engagement when opportunities do arise. Thus, older adults who can strongly signal concern and care for others' experiences—especially their experiences of distress and loss, which are more common among late life peers—may be most successful at building and maintaining close relationships.

Thus far, little research has addressed whether empathetic sadness reactivity is differentially associated with social outcomes across age groups. In one study, we found that self-reported sadness reactivity in response to an emotionally ambiguous film clip was associated with greater well-being in older adults, but not in younger or middle-aged adults (Haase, Seider, Shiota, & Levenson, 2012), suggesting that this aspect of sadness reactivity can be particularly beneficial in late life. This finding suggests that more research is needed on the social implications of expressive responding to others' emotional experience, and the extent to which this is moderated by age.

The Present Study

The present study used a community sample of young, middle-aged, and older participants to examine: (a) age differences in facial responses of sadness to others' distress; (b) age differences in facial responses of happiness to others' joy; and (c) age differences in the association between these facial responses and aspects of social connectedness (i.e., relational connectedness). Participants watched two short film clips, one that depicted people experiencing intense distress, and another more uplifting one that depicted people experiencing personal success and empowerment. Trained coders rated participants' facial expressions of the target emotion for each clip (sadness for the distressing clip, and happiness for the uplifting clip), as well as expressions associated with other emotions (confusion/concern, disgust, and fear).

We tested two primary hypotheses. Hypothesis 1 was that older adults would show more prosocial facial expressions than middle-aged and young adults in response to distressing and uplifting film clips depicting people in emotionally evocative situations. Hypothesis 2 was that more facial expressions of sadness, in particular, would be associated with higher levels of relational connectedness in older adults, but not in young and middle-aged adults. We focused on relational connectedness as the outcome of interest because it captures a sense of deep connection with close others (Hawkley, Browne, & Cacioppo, 2005), and aligns with the way older adults are thought to invest in meaningful relationships (Carstensen, 1992). The association between social connectedness and happiness facial expressions displayed during the uplifting film was examined as well, but the case for expecting age to moderate this effect is weaker than for sadness. Follow-up analyses addressed the specificity of the association between prosocial facial expressive responding and social connectedness, while accounting for the expression of alternative emotions, other aspects of emotional reactivity (subjective experience, physiological responding), and overall trait empathy.

This study utilized data from a larger research project from which other findings have been reported previously. Specifically, using these data Sze et al. (2012) showed that older adults evidenced heightened personal distress, physiological activation, and

prosocial behavior (i.e., monetary donations) in response to the films compared with young and middle-aged adults. Facial expression data, which takes much longer to code and quantify than other aspects of emotional responding, were not yet available and thus has not been previously reported. Similarly, none of the self-reported measures of social connection were reported previously.

Method

Participants

Sixty-nine young participants (age range 20–30 years, $M = 23.14$, $SD = 3.18$), 67 middle-aged participants (age range 40–50 years, $M = 44.36$, $SD = 2.91$), and 66 older participants (age range 60–80 years, $M = 66.36$, $SD = 5.49$) were recruited using flyers and online postings in the local community and from a research participant database administered by the University of California, Berkeley ($N = 202$). Participants were recruited such that sex and ethnicity were stratified similarly across all three age groups. The sample contained 66% women and 34% men. In terms of ethnicity, 71% were European American, 13% Asian American, 7% African American, 4% Latinx American, and 5% other. Participants were paid $50 for completing a questionnaire packet and participating in a 2.5-hr laboratory study. Table 1 presents sociodemographic characteristics of the sample. For a MANOVA with 202 participants across three groups, we had a power of 0.96 at $\alpha = .05$ to detect a main effect of age assuming a medium effect size (Cohen's $f^2 = .10$), and a power of .99 at $\alpha = .05$ to detect a regression interaction effect assuming a medium effect size (Cohen's $f^2 = .15$; Faul, Erdfelder, Buchner, & Lang, 2009). All variables were mean-centered for regression analyses.

Procedure

Prior to the laboratory session, participants completed a questionnaire packet at home. The questionnaires assessed a number of constructs including empathy, personality, and social desirability, some of which have been previously reported (Sze et al., 2012). For the full list of questionnaires, see online supplementary materials, Supplementary Table 2. The packet included measures of loneliness/social connectedness (Russell, Peplau, & Cutrona, 1980) and empathy (Davis, 1983), which were included in the present analyses. Approximately one week after completing the questionnaires, participants came to the Berkeley Psychophysiology Laboratory for a laboratory session. Upon arrival, they were informed that they would be participating in a study of emotion and that their physiological, behavioral, and self-reported responses would be recorded and videotaped. Prior to the start of the session, participants had physiological sensors attached (see below). Throughout the session, participants' upper body and face were filmed with a partially concealed video camera. The output of the camera was routed through video time-code generators that added both computer-readable and visible timing information. At the end of the experiment, participants provided consent for varying levels of usage of the video recording (e.g., research only, public showings). The experimental protocol included a number of laboratory tasks that were designed to measure different aspects of emotional functioning. For the present study, we examined the task during which participants viewed two film clips, one best described as distressing and the other as uplifting.

The "distressing" film clip began with a brief introduction to the political crisis in the Darfur region of Sudan, followed by images of the people of Darfur displaying distress at the loss of loved ones, suffering from starvation, and having serious wounds (117 s in length). The "uplifting" film clip began with a brief introduction to childhood autism, followed by images of children with autism successfully learning how to surf at a nonprofit camp called Surfers Healing (116 s in length). The film clip pans to the faces of many young children and portrays the joy they feel as they learn how to surf, and the empowerment gained from their new skills. The two films were shown in counterbalanced order. Both film clips were preceded by a 1-min resting period, during which participants were asked to clear their minds, relax, and focus on an X in the center of the video screen. Fifty-three seconds into the resting period, a written message appeared above the X indicating that the film clip was about to start. After the film clip ended, participants reported on their current emotional state using an 18-item emotion checklist (see below).

Measures

Facial expressions. Participants' facial expressions were videotaped while they were watching the film clips, and were subsequently coded by trained coders using the Emotional Expressive Behavior coding system (Gross & Levenson, 1993). Coders (blind to the film clips being watched and the hypotheses) rated the occurrence of 10 positive and negative facial expressions (anger, confusion/concern, contempt, disgust, embarrassment, fear, happiness, interest, sadness, and surprise). Sadness was coded when participants displayed inner eyebrow raises, downturned lip corners (i.e., frowns), or crying. Happiness was coded when partici-

Table 1
Sociodemographic Characteristics of Young, Middle-Aged, and Older Adults

	Young adults (20–30 years)	Middle-aged adults (40–50 years)	Older adults (60–80 years)
n	69	67	66
Age (*M* [*SD*])	23.14 (3.18)	44.36 (2.91)	66.36 (5.49)
Females (%)	70	64	64
European American (%)	72	66	74
Asian American (%)	16	13	11
African American (%)	3	12	6
Latinx American (%)	3	6	1
Other (%)	6	3	8

pants smiled, that is, turned the lip corners upward. For each second that an expression was seen, its intensity was rated using a 1 to 3 scale (e.g., 1 = *slight downturned lip or inner eyebrow raise* and 3 = *strong inner eyebrow raise and downturned lip, or crying*). Overall interrater reliability across codes was high (Cronbach's alpha = .90), with reliability for individual codes ranging from Cronbach's alpha = .87–.97. Anger expression was removed from analyses due to poor reliability (Cronbach's alpha = .49), and expressions of contempt, embarrassment, interest, and surprise were removed from analyses due to infrequent occurrence (<1% in the sample). Final analyses included only the codes of confusion/concern, disgust, fear, happiness, and sadness. Of note, the Emotional Expressive Behavior coding manual defines confusion as a "brow furrow." Prior research has linked brow furrowing to sympathetic concern (Eisenberg et al., 1998) and concentration (Rozin & Cohen, 2003), suggesting that this behavior may be associated with different emotions and states. We thus referred to this code in this article as "confusion/concern." For each facial expression code, means were computed for each participant by summing the intensity scores for every second in which the expression was present and dividing by the total number of seconds in the film clip. Thus, each participant ended up with five scores (one for each facial expression) for each film clip. Logarithmic transformations were applied to the data to reduce skewness (Cohen, Cohen, West, & Aiken, 1983).

Subjective experience. Upon arriving at the laboratory and immediately after each film clip, participants rated their experience of 18 positive and negative emotions (afraid, amused, angry, ashamed, calm, compassionate, disgusted, disturbed, embarrassed, enthusiastic, interested, moved, proud, sad, sympathetic, surprised, upset, and worried) using a 5-point Likert scale (1 = *not at all* to 5 = *extremely*). Reliabilities for both the presession emotion ratings and postfilm emotion rating were high (α = .82 and α = .90, respectively).

Physiological activation. While participants were watching the film clips, continuous, second-by-second recordings of 10 physiological measurements of autonomic nervous system activity were measured using either a Grass Model 7 polygraph or a BIOPAC polygraph and a computer equipped for processing multiple channels of analog information. Using a computer program written by Robert W. Levenson, physiology was monitored and averaged on a second-by-second basis for each of the following measures: (a) heart rate (Beckman miniature electrodes with Redux paste or Vermed SilveRest ECG pregelled electrodes were placed on opposite sides of the participant's abdomen; the interbeat interval was calculated as the number of milliseconds between successive R waves); (b) finger pulse amplitude (on the nondominant hand, a UFI photoplethysmograph attached to the tip of the ring finger recorded the volume of blood in the finger and the trough-to-peak amplitude of the finger pulse was determined); (c) finger pulse transmission time (the number of milliseconds between the R wave of the electrocardiogram (ECG) and the upstroke of the peripheral pulse recorded by the photoplethysmograph on the finger was determined); (d) ear pulse transmission time (a UFI photoplethysmograph attached to the left earlobe recorded the volume of blood in the ear and the number of milliseconds between the R wave of the ECG and the upstroke of peripheral pulse at the ear was determined); (e) systolic blood pressure; (f) diastolic blood pressure (on the nondominant hand, a cuff was placed on the middle finger and blood pressure was measured on each heartbeat using an Ohmeda Finapress 2300); (g) skin conductance (on the ring and index fingers of the nondominant hand, a constant-voltage device passed a small voltage between two Beckman standard electrodes or BIOPAC electrodes filled with an electrolyte of sodium chloride in Unibase); (h) finger temperature (on the nondominant hand, a thermistor was attached to the top of the pinky finger); (i) respiration intercycle interval (a cloth belt wrapped around the participant's chest compressed an inflated rubber bladder to provide a measure of chest wall movement; the number of milliseconds between the onset of inspiration of each respiration cycle was calculated); and (j) general activity (an electromechanical transducer attached to a platform under the participant's chair generated an electrical signal proportional to the amount of body movement in any direction).

Reactivity scores were computed by subtracting the prefilm baseline average of each physiological measure from its average level during each film clip. To reduce the number of physiological variables and control for Type I error, a maximum-likelihood factor analysis of the 10 physiology channels was conducted, followed by varimax rotation. Using parallel analysis (Horn, 1965; O'Connor, 2000) three factors were extracted. For each of the three rotated factors, we computed an unweighted average of the standardized physiology channels that had loadings larger than .30. Rotated factor loadings are shown in Table 2.

Relational connectedness. Relational connectedness was measured using the 20-item UCLA Loneliness Scale (Russell et al., 1980). Although originally conceptualized as a one-factor measure, subsequent research has demonstrated that this scale actually has a three-factor structure (Hawkley et al., 2005), with five items indicating *relational connectedness* (e.g., "There are people who really understand me;" 1 = *never* to 4 = *always*), four items indicating *collective connectedness* (e.g., "I have a lot in common with the people around me;" 1 = *never* to 4 = *always*), and 10 items indicating *isolation* (e.g., "I lack companionship;" 1 = *never* to 4 = *always*). The three-factor model of the UCLA Loneliness Scale has subsequently been used in a number of empirical studies (Cacioppo et al., 2008; Wildschut, Sedikides, Routledge, Arndt, & Cordaro, 2010). To verify this factor structure in our data, we conducted two confirmatory factor analyses (CFA) with the lavaan package in R using generalized least squares estimation. The first CFA loaded all of the items on a single factor, while the second CFA loaded all of the items on the three

Table 2
Rotated Factor Loadings of Physiology Channels

	Factor		
	1	2	3
Interbeat interval (heart rate)	−.050	.129	−.440
Activity	−.094	.112	.832
Intercycle interval (respiration)	.005	−.002	−.428
Finger pulse transmission time	.092	.989	−.113
Finger pulse amplitude	−.172	−.326	−.038
Systolic blood pressure	.779	.025	−.009
Diastolic blood pressure	.991	−.048	.121
Ear pulse transmission time	.132	.042	−.001
Skin conductance	.061	−.077	.076
Temperature	−.128	−.025	.008

Note. On the basis of parallel analysis (Horn, 1965; O'Connor, 2000) three factors were extracted. For each of the three rotated factors, we computed an unweighted average of the standardized physiology channels that had a loading larger than .30.

factors indicated by Hawkley and colleagues (2005; see Appendix). When comparing the differences between models, the likelihood ratio test rejected the one factor model in favor of the three-factor model, $\chi^2(3, N = 210) = 52.201$, $p < .001$. Full scale reliability ($\alpha = .93$) and subscale reliabilities were high in our sample (αs for relational connectedness = .86; collective connectedness = .72; isolation = .90). Means of the full scale and each subscale are shown in Table 3.

For the present research questions, the relational connectedness subscale is the most conceptually relevant. Whereas the isolation subscale emphasizes an extreme, negative sense of aloneness and withdrawal, and the collective connectedness subscale emphasizes feeling like part of a social group, the relational connectedness scale emphasizes the belief that one has multiple psychologically intimate relationships with other individuals, characterized by closeness, understanding, and support. Consistent with this, the analysis using the relational connectedness subscale as the outcome provides the best test of Hypothesis 2. Nonetheless, we also examined the other two subscales as well as the full loneliness scale in separate analyses.

Trait empathy. Trait empathy was assessed using four subscales of the Interpersonal Reactivity Index (IRI; Davis, 1983): empathic concern (e.g., "When I see someone being taken advantage of, I feel kind of protective toward them"); personal distress (e.g., "In emergency situations, I feel apprehensive and ill-at-ease"); perspective taking (e.g., "When I am upset at someone, I usually try to put myself in his shoes for a while"); and fantasy (e.g., "I really get involved with the feelings of the characters in a novel"). Full scale reliability ($\alpha = .78$) and subscale reliabilities were adequate (αs: empathic concern = .78, personal distress = .79, perspective taking = .83, fantasy = .79). Means of each subscale are shown in Table 3, and correlations between these scales and facial expressions can be found in Supplemental Table 1.

Data Analysis

To examine our first hypothesis (i.e., older adults would show more prosocial facial expressions than young and middle-aged adults in response to the distressing and uplifting film clips), we conducted multivariate ANOVAs where the five individual facial expressions (i.e., confusion/concern, disgust, fear, happiness, and sadness) were treated as dependent variables, and age was included as a fixed factor. To examine our second hypothesis (i.e., more facial expressions of sadness would be associated with higher levels of relational connectedness in older adults), we examined whether age was a significant moderator of the relationship between relational connectedness and sadness facial expressions in response to the distressing clip using Model 1 of the PROCESS macro with 50,000 bias-corrected bootstrapped samples (Hayes, 2008). This latter analysis was then repeated for the uplifting positive film clip.

Three sets of post hoc follow-up analyses were conducted using the same PROCESS macro and 50,000 bias-corrected bootstrapped samples, all assessing specificity of the link between sadness facial expressions and relational connectedness in older adults. First, we examined whether the association between sadness facial expressions and relational connectedness remained stable after accounting for trait empathy and the two other measured aspects of emotional reactivity in response to the film clip: (a) ratings of subjective emotional experience and (b) our three factors of physiological activation. Trait empathy was found to be significantly associated with facial expressivity (see Supplementary Table 3), and thus was included as a covariate in order for us to examine whether associations between facial expressions and social connection remained after adjusting for this variable. Second, to examine whether sadness facial expressions contributed unique effects beyond facial expressions of other emotions, we repeated our moderation analysis including all of the other facial responses to the distressing film (i.e., confusion/concern, disgust, fear, and happiness) and each expression's interaction with age. Third, to examine whether associations with relational connectedness were specific to sadness facial expressions, we computed separate regression analyses entering each of the facial expressions other than sadness and their interaction with age, using data from both films.

Results

Manipulation Checks

Distressing film clip. Dependent sample *t* tests comparing postfilm ratings of subjective emotional experience with presession ratings indicated that participants experienced the largest increases in feeling sad and disturbed (*M diffs* = 2.89, $p < .001$), while smaller increases (*M diffs* ranging from .38 to 2.66, ps $< .001$) were observed for feeling moved, upset, disgusted, sympathetic, angry, worried, compassionate, ashamed, embarrassed, afraid, and surprised. Decreases were revealed for interest, pride, amusement, calm, and enthusiasm (*M diff*s ranging from −.36 to −1.63, ps $< .001$).

Table 3
Self-Reported Loneliness and Empathy by Age

	Young adults *M* (*SD*)	Middle-aged adults *M* (*SD*)	Older adults *M* (*SD*)
UCLA Loneliness Scale			
Relational connectedness	3.39 (.52)	3.20 (.60)	3.44 (.57)
Collective connectedness	3.21 (.54)	3.18 (.49)	3.32 (.55)
Isolation	2.11 (.56)	2.29 (.63)	2.04 (.64)
Full scale	38.26 (9.80)	40.94 (10.42)	36.89 (10.82)
Interpersonal Reactivity Index			
Empathic concern	3.80 (.69)	4.01 (.65)	4.07 (.55)
Perspective taking	3.71 (.71)	3.66 (.74)	3.63 (.73)
Personal distress	2.57 (.73)	2.24 (.69)	2.22 (.71)
Fantasy	3.49 (.74)	3.09 (.84)	3.28 (.89)

Uplifting film clip. Dependent sample *t* tests comparing post-film ratings of subjective emotional experience with presession ratings indicated that participants experienced the largest increases in feeling moved (*M diff* = 2.09, $p < .001$), sympathetic (*M diff* = 1.23, $p < .001$), and compassionate (*M diff* = 1.17, $p < .001$). Smaller increases (*M diff*s ranging from .18 to .66, *p*s < .05) were observed for surprise, sadness, pride, enthusiasm, feeling disturbed, upset, and amused. Decreases in calm and worry (*M diff*s ranging from −.24 to −.15, *p*s < .02) were also observed, while a decrease in embarrassment was trending (*M diff* = −.077, $p = .051$). No changes were found for disgust, anger, interest, shame, or fear (*M diffs* ranging from = −.08 to .07, *p*s > .063).

Age Differences in Facial Expression Responses to Distressing and Uplifting Film Clips

For the distressing film, the MANOVA revealed significant main effects of age on sadness facial expressions $F(2, 199) = 5.06$, $p = .007$, with post hoc analyses indicating that older adults expressed more sadness than younger adults (*M diff* = .55, $p = .005$) but not middle-aged adults (*M diff* = 0.28, $p = .319$; see Figure 1). Age differences were not significant for any other facial expression (*p*s > .190) except for confusion/concern $F(2, 199) = 4.71$, $p = .010$, with post hoc analyses indicating that older adults expressed more confusion/concern than younger adults (*M diff* = .52, $p = .009$) but not middle-aged adults (*M diff* = 0.36, $p = .112$). As previously reported by Sze and colleagues (2012), older adults also responded with greater personal distress and physiological activation to the distressing film clip. These results can be viewed in Table 4.

For the uplifting film clip, results revealed a main effect of age on happiness facial expressions, $F(2, 199) = 3.27$, $p = .040$, with post hoc analyses indicating that older adults expressed more happiness than middle-aged and younger adults at trend levels (*M diff* = 0.38, *p*s > .077). The main effects of age on all other facial expressions were not significant (*p*s > .160). These results can be viewed in Figure 1.

Associations Between Facial Expressions and Relational Connectedness

Primary analyses. For the distressing film, the regression analysis revealed a significant interaction between sadness facial expression and age in predicting relational connectedness (*B* =

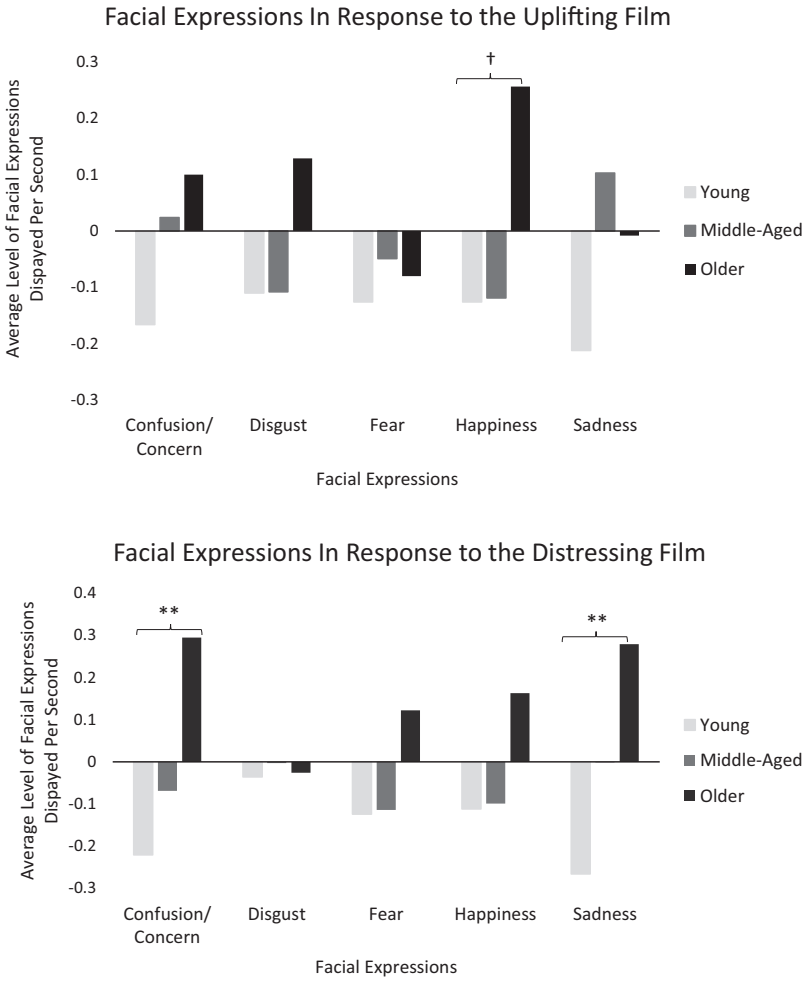

Figure 1. Age differences in facial expression responses when viewing both films for young, middle-aged, and older adults. † $p = .08$. ** $p < .01$.

.03, $SE(B)$ = .01, p = .009, 95% CI [.007, .046]). The Sadness Facial Expression × Age interaction was not significant in predicting the full UCLA Loneliness scale or its subscales, although results were in the expected direction: full scale (B = −.28, $SE(B)$ = .18, p = .133, 95% CI [−.64, .09]), collective connectedness (B = .01, $SE(B)$ = .01, p = .213, 95% CI [−.01, .03]) and isolation (B = −.01, $SE(B)$ = .01, p = .221, 95% CI [−.04, .00]). For confusion/concern facial expressions, no main effects or age interaction effects were significant for any of the three subscales (ps > .638).

The Sadness Facial Expression × Age interaction predicting relational connectedness was decomposed using simple slopes analysis, with the effect of sadness facial expression estimated at three levels of age. Results showed that among older adults (estimated at mean age +1 *SD*, or 62.7 years), those who expressed more sadness when viewing the film clip of others in distress reported higher levels of relational connectedness (B = .64, $SE(B)$ = .22, p = .004, 95% CI [.21, 1.07]). This effect was not significant for middle-aged (estimated at mean age, or 44.6 years; B = .16, $SE(B)$ = .19, p = .397, 95% CI [−.21, .54]) or young adults (estimated at mean age −1 *SD*, or 26.4 years; B = −.32, $SE(B)$ = .30, p = .291, 95% CI [−.91, .28]). These results can be viewed in Figure 2. Exploratory simple slope analyses were also conducted for the other subscales as well as the full UCLA Loneliness Scale, to examine whether age slopes were in the expected direction. In general, findings were that older adults who displayed more sadness facial expressions reported less total loneliness (p = .005) and isolation (p = .115), and higher levels of collective connectedness (p = .035). These associations were largely nonsignificant for sadness facial expressions displayed by middle-aged and younger adults.[1] Correlations between facial expressions and these subscales can be viewed in Supplementary Table 1.

For the uplifting film, the regression revealed a significant main effect of happiness facial expressions in predicting relational connectedness (B = .43, $SE(B)$ = .17, p = .014, 95% CI [.09, .77]); this association was not significantly moderated by age (p = .813).[2]

Follow-up analyses. To assess whether findings for sadness facial expressions remained stable when accounting for trait empathy and the two other aspects of emotional responding (i.e., ratings of subjective emotional experience and physiological activation), we repeated our moderation analysis while including these variables as additional predictors of relational connectedness. The Sadness Facial Expression × Age interaction remained robust (B = .021, $SE(B)$ = .011, p = .059, 95% CI [−.001, .04]).

To examine whether sadness facial expressions contributed above and beyond other facial expressions, we repeated our moderation analysis while including all of the other facial expressions (i.e., confusion/concern, disgust, fear, and happiness) and each expression's interaction with age. The Sadness Facial Expression × Age interaction remained significant (B = .03, SE(B) = .01, p = .008, 95% CI [.007, .05]).

To examine whether our findings were specific to sadness facial expressions, we conducted separate hierarchical linear regression analyses examining facial expressions of confusion/concern, disgust, fear, and happiness in response to the distressing film clip, and each of these variables' interaction with age, as predictors of relational connectedness. No significant main effects of facial expressions were found (ps > .078). When examining interaction effects between these facial expressions and age, the Disgust Facial Expression × Age interaction was significant (B = −.07, SE(B) = .03, p = .018, 95% CI [−.13, −.01]), with simple slopes indicating that older adults who expressed more disgust while viewing the distressing film clip reported lower levels of relational connectedness (B = −1.83, $SE(B)$ = .72, p = .012, 95% CI [−3.26, −0.40]; see Figure 3). Simple slopes for middle-aged and young adults were not significant (ps > .329). The Disgust Facial Expression × Age interaction remained significant when accounting for trait empathy and the two other aspects of emotional responding (i.e., ratings of subjective emotional experience and physiological activation), p = .009, and other facial behaviors and their interactions with age in the same model (p = .044). No other Facial Expression × Age interactions were significant predictors of relational connectedness (ps > .182).

Discussion

A central tenet of functionalist theories is that all emotions, both those typically considered to be "positive" (e.g., amusement, joy) and those typically considered to be "negative" (e.g., sadness, anger), can lead to adaptive outcomes for the individual (Gruber, Mauss, & Tamir, 2011; Keltner & Kring, 1998). The ability to display emotional responses to other people's situations adds another level of functionality, demonstrating care and concern for others and helping build relational bonds (Keltner, Haidt, & Shiota, 2006; Shiota et al., 2004). In the present study we found that, compared with middle-aged and younger adults, older adults exhibited more prosocial, situationally appropriate facial expressions in response to film clips depicting others in distressing and joyful situations. Moreover, more sadness and fewer disgust facial expressions in response to others' distress were associated with higher reported levels of relational connectedness in older adults, but not in middle-aged and younger adults. This association remained robust even after accounting for other emotional facial expressions, two other aspects

[1] Although the interaction effect between Sadness Facial Expression × Age was only significant for the relational connectedness subscale, we conducted exploratory analyses of simple slopes for the full UCLA Loneliness Scale as well as for the isolation and collective connectedness scales to examine whether the direction of the results would be consistent with our hypotheses. Results indicated that older adults who displayed more sadness facial expressions reported significantly less full-scale loneliness (B = −11.40, $SE(B)$ = 3.98, p = .005, 95% CI [−19.24, −3.56]), trend levels of less isolation (B = −.38, $SE(B)$ = .24, p = .115, 95% CI [−.84, .09]), and significantly higher levels of collective connectedness (B = .43, $SE(B)$ = .20, p = .035, 95% CI [.03, .83]). Middle-aged adults who expressed more sadness reported less full-scale loneliness at trend levels (B = −6.37, $SE(B)$ = 3.48, p = .069, 95% CI [−13.23, .49]), but otherwise slopes for middle-aged and young adults were not significant for full-scale loneliness or any of the subscales (p > .219).

[2] Although the interaction of Happiness Facial Expression × Age was not significant for the uplifting film, we also conducted exploratory analyses of simple slopes for the full UCLA Loneliness Scale as well as for the individual subscales. Results revealed that both middle-aged and older adults who expressed more happiness reported less full-scale loneliness (ps < .013) and isolation (ps < .034), and more relational (ps < .031) and collective connectedness (ps < .006). For young adults, expressing happiness was significantly associated with more collective connectedness (p = .024) and at trend levels for less full-scale loneliness (p = .091). The slopes for young adults' relational connectedness and isolation were not significant (ps > .144).

Table 4
Facial Expressions, Self-Reported Emotions, and Physiological Responses by Age

	Distressing film clip			Uplifting film clip		
	Young *M* (*SD*)	Middle-aged *M* (*SD*)	Older *M* (*SD*)	Young *M* (*SD*)	Middle-aged *M* (*SD*)	Older *M* (*SD*)
Facial expressions per second						
Sadness	.09 (.17)	.15 (.22)	.21 (.26)	.00 (.01)	.04 (.13)	.03 (.11)
Disgust	.02 (.06)	.02 (.08)	.02 (.07)	00 (.00)	.00 (.00)	.01 (.06)
Happiness	.00 (.01)	.00 (.01)	.01 (.03)	.16 (.21)	.16 (.23)	.25 (.27)
Confusion/concern	.02 (.05)	.04 (.09)	.08 (.16)	.02 (.07)	.04 (.10)	.04 (.13)
Fear	.00 (.03)	.01 (.03)	.02 (.08)	.00 (.01)	.00 (.03)	.00 (.01)
Self-reported emotions						
Afraid	1.83 (1.01)	1.94 (1.16)	1.82 (1.16)	1.10 (.52)	1.08 (.36)	1.08 (.40)
Amused	1.17 (.73)	1.15 (.73)	1.00 (.00)	2.23 (1.07)	2.27 (1.12)	2.29 (1.22)
Angry	2.20 (1.20)	2.94 (1.30)	3.58 (1.39)	1.12 (.58)	1.11 (.53)	1.05 (.27)
Ashamed	2.17 (1.14)	2.64 (1.32)	3.33 (1.47)	1.19 (.73)	1.12 (.48)	1.06 (.49)
Calm	2.09 (1.10)	1.97 (1.11)	1.97 (1.18)	3.14 (1.19)	3.45 (1.23)	3.36 (1.33)
Compassionate	3.75 (1.16)	4.26 (1.04)	4.61 (.86)	3.17 (1.10)	3.77 (1.04)	4.24 (.91)
Disgusted	2.62 (1.10)	3.38 (1.48)	3.80 (1.46)	1.10 (.60)	1.12 (.60)	1.06 (.39)
Disturbed	3.55 (1.16)	4.06 (1.23)	4.42 (0.99)	1.22 (.80)	1.38 (.96)	1.36 (.82)
Embarrassed	1.72 (1.03)	2.29 (1.46)	2.79 (1.60)	1.10 (.55)	1.09 (.34)	1.09 (.38)
Enthusiastic	1.09 (.28)	1.35 (.89)	1.15 (.47)	2.59 (1.19)	3.06 (1.24)	3.86 (1.18)
Interested	2.94 (1.29)	3.71 (1.25)	3.79 (1.21)	3.25 (1.22)	3.70 (1.05)	4.26 (.88)
Moved	3.75 (1.29)	4.31 (1.06)	4.55 (.83)	2.91 (1.26)	3.77 (1.02)	4.21 (1.00)
Proud	1.07 (.36)	1.09 (.42)	1.11 (.40)	2.16 (1.18)	2.64 (1.36)	3.02 (1.59)
Sad	3.52 (1.27)	4.05 (1.29)	4.52 (.90)	1.41 (.89)	1.60 (.97)	1.92 (1.13)
Surprised	1.70 (1.00)	2.03 (1.25)	1.71 (1.08)	1.75 (1.13)	1.98 (1.21)	2.25 (1.34)
Sympathetic	3.68 (1.13)	4.26 (1.09)	4.42 (.98)	2.55 (1.05)	3.21 (1.26)	3.86 (1.14)
Upset	3.29 (1.41)	3.71 (1.36)	4.21 (1.16)	1.25 (.81)	1.29 (.76)	1.41 (.86)
Worried	2.72 (1.44)	2.89 (1.54)	3.53 (1.35)	1.22 (.70)	1.26 (.69)	1.27 (.62)
Physiological responses						
Physio—blood pressure	−.03 (.73)	−.09 (.94)	.07 (1.00)	−.12 (.93)	.08 (.85)	.02 (.94)
Physio—peripheral	.05 (.90)	.07 (.79)	−.02 (.86)	.13 (.66)	.05 (.66)	−.17 (1.01)
Physio—cardiac and respiration	.08 (.70)	.01 (.65)	−.10 (.87)	−.09 (.71)	.03 (.68)	.02 (.67)

of emotional responding (subjective emotional experience and physiological activation), and trait empathy.

Heightened Prosocial Facial Expressions in Response to Others' Experience in Late Life

Viewing others in distress can be a powerful emotional stimulus for people at all ages (Hoffman, 1975), but our findings indicate that the distress of others may be particularly potent for older adults, who displayed more sadness facial expressions. In this context, sadness is an important interpersonal emotion that signals empathy (Eisenberg et al., 1989; Keltner, 2009), motivates people to provide support (Clark et al., 1987; Graham et al., 2008), reduces distress in others (Batson, 2011), and promotes feelings of social connection (Gray et al., 2011). Our finding that older people respond more strongly to the distress of others with sadness is consistent with theories that envision older adults as prioritizing social relationships (Carstensen, 1992), as well as studies demonstrating heightened reactivity in subjective emotional experience and physiology (Seider et al., 2011; Sze et al., 2012) to themes of loss. Older adults also showed more "knit brow" or confusion/concern expressions during this film clip, suggesting that overall attentiveness to and concern for others' distress is heightened in older adults. Expressions of disgust, fear, and happiness in response to this clip did not differ across age groups.

Age was also associated with happiness expressions in response to the uplifting film clip, with older adults displaying more happiness than middle-aged and younger adults at trend levels. This finding sheds some light on positive emotion expressions in older adults. Previous studies have found that older adults expressed more positive emotions such as affection in some positive contexts (Carstensen, Gottman, & Levenson, 1995; Levenson, Carstensen, & Gottman, 1993) but not others (Gross et al., 1997; Levenson, Carstensen, Friesen, & Ekman, 1991; Magai, Consedine, Krivoshekova, Kudadjie-Gyamfi, & McPherson, 2006; Tsai et al., 2000). It is possible that procedures invoking themes that align with older adults' goals of investing in relationships and meaningful connections (e.g., dyadic interactions with loved ones) and age-relevant stimuli (Kunzmann & Grühn, 2005) are best able to uncover age differences in positive emotional expressions. Our uplifting stimulus focused on children, and may have been particularly salient to older adults in their roles as parents and grandparents.

Facial Expressions and Relational Connectedness in Late Life

We also found that more sadness facial expressions in response to a depiction of others' suffering was distinctly associated with heightened relational connectedness. As a response to one's own loss, sadness has been linked to a number of positive interpersonal consequences including motivating others to provide support (Clark et al., 1987; Graham et al., 2008) and promoting feelings of social connection (Gray et al., 2011). These positive social outcomes may be particularly important in late life given increasingly

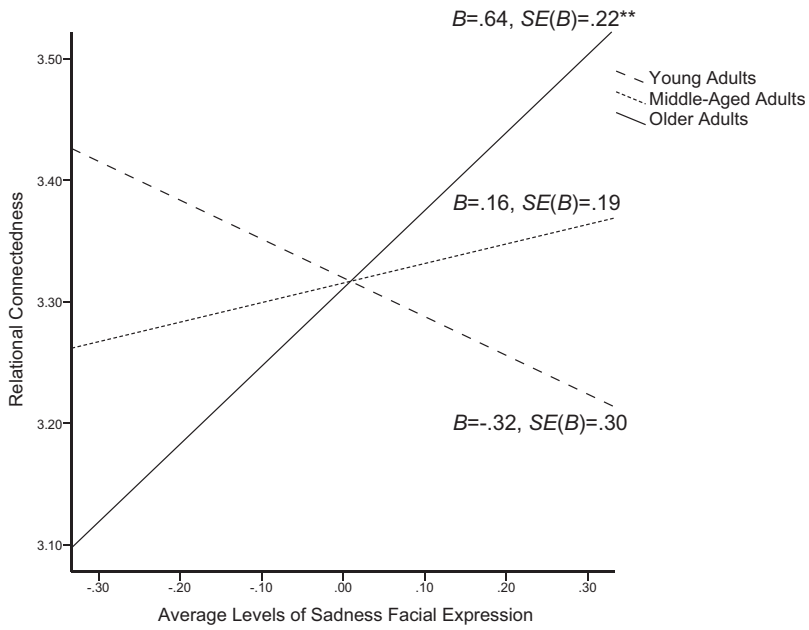

Figure 2. Simple slopes for sadness facial expression as a predictor of relational connectedness for young, middle-aged, and older adults. Disgust facial expression plotted at low ($M - 1\ SD$) and high ($M + 1\ SD$) levels. Age plotted at 62.7 years (older adults), 44.6 years (middle-aged adults), and 26.4 years (younger adults). Standardized regression coefficients and standard errors are shown. ** $p < .01$.

frequent losses, greater physical frailty and increased dependence on others (Charles & Carstensen, 2010; Prohaska et al., 2006; Steverink et al., 2001), and strong associations between social connectedness and health and well-being (Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006; Hawkley, Masi, Berry, & Cacioppo, 2006).

Our findings suggest that displays of sadness in response to others' distress may also be particularly useful in late life. Our prior research showed that heightened sadness reactivity (i.e., greater subjective sadness in response to an emotionally ambiguous film clip) is associated with greater well-being in late life (Haase et al., 2012). The present study expands upon these findings, linking more facial expressions of sadness in response to others' suffering (arguably the most socially visible aspect of an emotional response) with greater relational connectedness in older individuals. Older adults often have more physical limitations relative to young and middle-aged adults, and fewer social obligations that push them to maintain interpersonal connections. Thus, it may become particularly important that they signal active emotional engagement when opportunities for connection do arise. Older adults who are more likely to signal and express sadness for others may be best at maintaining this sense of closeness (i.e., relational connectedness) with others in their lives.

We found that more facial expressions of happiness in response to others' joy was associated with higher relational connectedness regardless of age. This is consistent with, and adds to, a body of literature documenting the relationship-building effects of shared positivity in response to happy events (e.g., Gable et al., 2006; Gable, Reis, Impett, & Asher, 2004). By sharing news about one's own positive event with relationship partners, one opens the door to "capitalizing" on that event, amplifying and extending the positive emotions associated with it (Gable et al., 2004). When the relationship partner engages actively and constructively in talking about the positive event, this facilitates capitalization and boosts relationship outcomes for both people (Gable et al., 2004, 2006). The present findings suggest that this interpersonal upward spiral contributes in valuable ways to the social well-being of young, middle-age, and older adults alike. Prior research has found that people whose behaviors match those of the people they are interacting with tend to have more positive social interactions and are more empathic (Chartrand & Bargh, 1999; Iacoboni, 2009), which in turn can facilitate the close social relationships captured by relational connectedness. Expressing emotions that are not congruent with the context can be associated with social disturbances, which has been found in people with psychopathology (Keltner & Kring, 1998) and neurodegenerative disease (Chen et al., 2017).

Directions for Future Research

The present findings have implications for future research on emotional aging and the functions of emotion. In terms of research on emotional aging, early emotion research viewed older adults as emotionally flat (Jung, 2001) or disengaged (Cumming & Henry, 1961). The advent of newer theories in social gerontology (Carstensen et al., 1999; Labouvie-Vief, Diehl, Jain, & Zhang, 2007) spurred discovery of many ways in which older adults respond with heightened positive emotions (Carstensen et al., 1995; Levenson, Carstensen, & Gottman, 1993). The present study shows a more nuanced picture. Older adults appear to be exquisitely attuned to social context—they express more sadness when watching others in a distressing

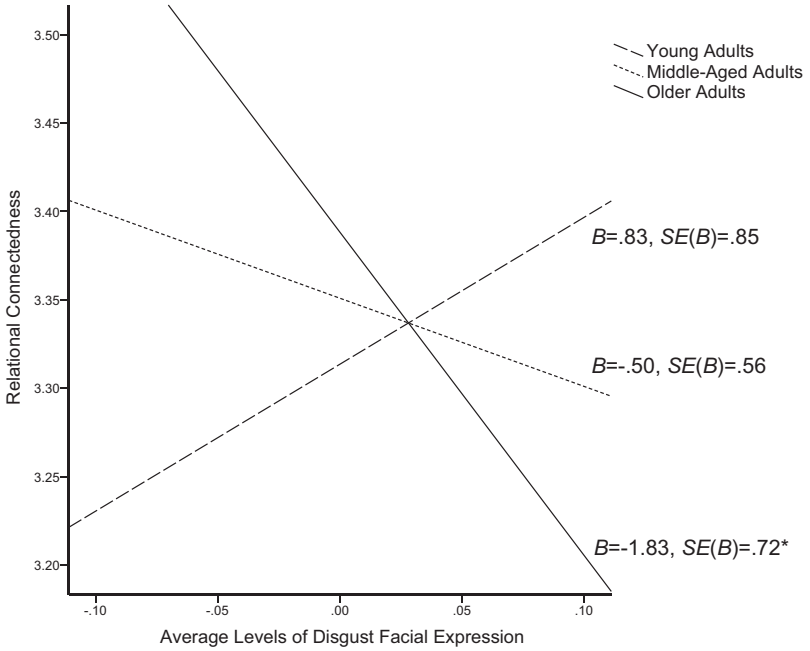

Figure 3. Simple slopes for disgust facial expression as a predictor of relational connectedness for young, middle-aged, and older adults. Disgust facial expression plotted at low ($M - 1$ *SD*) and high ($M + 1$ *SD*) levels. Age plotted at 62.7 years (older adults), 44.6 years (middle-aged adults), and 26.4 years (younger adults). Standardized regression coefficients and standard errors are shown. * $p < .05$.

context as well as more happiness when watching others in an uplifting context. Future research should continue to examine age differences in specific emotions in specific contexts, in line with a discrete emotions perspective on emotional aging (Kunzmann, Kappes, & Wrosch, 2014).

In terms of the functions of emotions, many studies have demonstrated the adaptive functions of sadness (Fischer & Manstead, 2008; Graham et al., 2008). Our work suggests that these functions become particularly adaptive for relational connectedness and well-being (Haase et al., 2012) at specific ages, highlighting the importance of examining how functions of emotions can differ with age. Moreover, the sadness facial expressions we focused on in the present study were momentary responses of moderate intensity to specific stimuli. Our findings that these expressions are associated with positive social outcomes do not mean that chronic, high intensity activation of sadness would be associated with similar positive social outcomes. Indeed, there is clearly a point beyond which greater sadness facial expressions no longer have social benefits but instead have palpable social costs (e.g., when chronic depression leads to fewer close relationships, impaired social functioning, or less social support; Coyne, 1976; Hirschfeld et al., 2000; Keltner & Kring, 1998). Characterizing the boundary conditions and contexts that determine whether sadness facial expressions are adaptive or maladaptive is an important area for future research.

Beyond sadness, we also obtained evidence for the adaptiveness of a few other specific emotions. Displaying more facial expressions of happiness in response to the uplifting film clip was associated with greater relational connectedness across all ages, in line with theories on the functions of positive emotions (Fredrickson, 2000). Moreover, displaying fewer facial expressions of disgust in response to the distressing film clip was associated with greater relational connectedness in late life. Theories on disgust suggest that the emotion serves the function of avoiding disease (Rozin, Haidt, & McCauley, 1993), or perhaps serves to express displeasure at unfairness (Chapman, Kim, Susskind, & Anderson, 2009; Moretti & Di Pellegrino, 2010). Studies have yet to examine whether the expression and function of disgust differs with age. For older adults who often end up serving as the main caregivers for spouses and friends receiving care at home (Schulz & Eden, 2016; Sneed & Schulz, 2017), avoiding situations that many may find disgusting (e.g., wounds from physical conditions, bedpans) or unfair (e.g., a spouse contracts a terminal illness) could impede their ability to serve as caregivers and have certain kinds of meaningful late-life relationships. Further research is needed to replicate this finding and explore the functions of disgust across the life span.

Strengths and Limitations

Strengths of this research include the use of a community sample of male and female participants representing three different age groups and the multimethod assessment of emotional reactivity using objectively coded facial expressions, subjective experience, and peripheral physiological responding. Limitations included the cross-sectional design, which raises the possibility that found age differences could reflect cohort rather than age. The cross-sectional design also impacts our ability to determine the directionality of found associations. For example, it is possible that older adults higher in relational connectedness are more likely to

express sadness facial expressions in response to the distress of others.[3] In addition, although we included both a sadness film and an uplifting film, we did not consider other contexts or films with other emotion-eliciting or distress-eliciting themes that might have revealed additional associations between facial expressions and relational connectedness at other ages. Thus, although our findings suggest that sadness facial expressions are particularly functional in late life, it is also possible that in contexts not examined in our study, sadness facial expressions may be particularly functional for other age groups as well. Finally, our study also did not consider instances in which people respond with more than one emotion (Chen et al., 2017; Ersner-Hershfield, Mikels, Sullivan, & Carstensen, 2008), given the constraints of the coding protocol used.

Conclusion

The present study found evidence that older adults who express more sadness and less disgust in response to viewing others in distress report greater relational connectedness. Thus, in late life, greater facial expression of sadness, an emotion generally thought to be negative, is associated with a positive social outcome. This finding underscores the drawback of viewing particular emotions as inherently "good" or "bad," and supports the view that different emotions can be adaptive or maladaptive depending on the interaction of particular goals, contexts, outcomes, and stages of development. This also is a cautionary note for "one size fits all" models of emotion (e.g., all positive emotions are always good and all negative emotions are always bad) and the interventions that grow out of these models (e.g., individuals should always strive to increase positive emotion and decrease negative emotion). Just as positive emotions can have a darker side (Gruber et al., 2011), negative emotions like sadness can have a brighter side as well.

[3] Sadness facial expressions evidence an important social bidirectionality. When we are distressed, displaying sadness indicates that we need help, comfort, and support. When we see a person in distress, displaying sadness can convey that we care, are concerned, and might be willing to help. In our view, it is this bidirectionality, acting against the backdrop of greater losses typically experienced by older individuals, that underlies the critical role that sadness expressions play in strengthening social relationships in late life.

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Appendix

UCLA Loneliness Scale—Three Factor Subscales

Isolation Subscale

I lack companionship.
There is no one I can turn to.
I feel alone.
I am no longer close to anyone.
My interests and ideas are not shared by those around me.
I feel left out.
My social relationships are superficial.
No one really knows me well.
I feel isolated from others.
I am unhappy being so withdrawn.

Relational Connectedness

People are around me but not with me.
There are people I feel close to.
I can find companionship when I want it.
There are people who really understand me.
There are people I can talk to.
There are people I can turn to.

Collective Connectedness

I feel in tune with the people around me.
I feel part of a group of friends.
I have a lot in common with the people around me.
I am an outgoing person.

Received March 30, 2016
Revision received September 6, 2018
Accepted September 9, 2018 ■