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Development and Aging

Comparing negative emotion differentiation in young and older individuals: A picture-based study

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Life span theories suggest that emotional experiences become more complex (i.e., nuanced and differentiated) with age. Theoretically, the cause of this increased complexity has been proposed to be age-related changes in life contexts such as goals and daily stressors. Consequently, age may not affect emotional complexity in settings where the influence of age-specific life contexts is reduced. However, this hypothesis has yet to be explored. In the present study, we investigated one aspect of emotional complexity, namely emotion differentiation. Extending previous research, we assessed age-group differences in negative emotion differentiation between young and older adults in a controlled experimental setting. A sample of 114 young and 132 older adults rated their emotional response to 34 negative pictures according to intensity of four negative emotions. Based on these ratings, two indicators of emotion differentiation were calculated. The results revealed no significant age-group differences in negative emotion differentiation. The findings indicate stability in negative emotion differentiation with increasing age when the influence of life context is reduced. The findings are consistent with life span theories suggesting that developmental changes in emotional complexity occur largely as a result of age-related changes in life contexts rather than more stable age-related changes in individual characteristics.

Key words: Aging, emotion, emotional complexity, emotional development.

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INTRODUCTION

Although old age is accompanied by losses within physical and cognitive domains, prominent life span theories of emotion suggest that emotional competencies improve into late midlife or early old age (e.g., Carstensen, Pasupathi, Mayr & Nesselroade, 2000; Charles, 2010). The experience of complex emotions (i.e., nuanced and differentiated emotional states; Brose, De Roover, Ceulemans & Kuppens, 2015; Grühn, Lumley, Diehl & Labouvie-Vief, 2013; Lindquist & Feldman Barrett, 2008) represents one avenue through which emotional competencies have been purported to increase with age. Theoretically, the cause of this increase has been proposed to be age-related changes in life contexts such as goals and daily stressors (e.g., Brose, Scheibe & Schmiedek, 2013; Carstensen *et al.*, 2000). For example, according to Socioemotional Selectivity Theory, older adults come to prioritize emotionally meaningful goals as they begin to perceive time as limited (Carstensen *et al.*, 2000). This motivational shift towards finding emotional meaning even in conflictual situations is proposed to result in more complex emotional experiences (Carstensen *et al.*, 2000). Moreover, Brose *et al.* (2013) recently suggested that an age-related reduction in frequency of daily stressors (e.g., having an argument) contributes to age-related changes in emotional complexity. Hence, development in emotional complexity in adulthood has been suggested to occur as a function of changes in life contexts. Consequently, age may not affect emotional complexity in settings where the influence of age-specific life contexts is reduced (e.g., by introducing a common goal or by controlling exposure to emotion-inducing events). However, this hypothesis has yet to be explored.

Emotional complexity has been operationalized in numerous ways (Brose *et al.*, 2015). One prominent approach to operationalizing emotional complexity is to measure *emotion differentiation* (i.e., the precision and specificity with which an individual can distinguish between emotional states. Also commonly referred to as *emotion granularity*; Barrett, Gross, Christensen & Benvenuto, 2001; Brose *et al.*, 2015). Recent reviews of the literature reveal that common operationalizations of emotion differentiation are based on multi-occasion, multi-subject data (i.e., data based on repeated assessments of several subjects; Brose *et al.*, 2015; Grühn *et al.*, 2013). Using such data, emotion differentiation may be operationalized in two ways: (1) as the convergence between emotional states over time; or (2) as the number of components in a principal component analysis of emotional states (Brose *et al.*, 2015; Hay & Diehl, 2011). High convergence is presumed to reflect *poor* differentiation, as it suggests that the individual tends to report the same emotions across time and different contexts. Conversely, a larger number of components in a principal component analysis (PCA) is presumed to reflect *better* differentiation because more components explain a significant amount of variation in the individual's reports of emotions.

Age-related changes in emotion differentiation have primarily been investigated in the context of daily life (i.e., through experience sampling or daily diary studies). Two studies have investigated emotion differentiation operationalized as convergence between emotional states over time and reveal contradictory findings. One study found that older adults showed better emotion differentiation than young adults (Ready, Carvalho & Winberger, 2008) and another study reported no association between age and emotion differentiation (Grühn *et al.*, 2013). Similar contradictory findings have been reported in studies of emotion differentiation operationalized as the number of components in PCAs. One study suggests a positive association

between emotion differentiation and age (Carstensen *et al.*, 2000), where another study reports that older adults show worse emotion differentiation than young adults (Hay & Diehl, 2011), and yet again other studies find no differences in emotion differentiation between young and older adults (Grühn *et al.*, 2013; Ong & Bergeman, 2004; Ready *et al.*, 2008; Shrira, Bodner & Palgi, 2015).

Although age-related changes in emotion differentiation have not previously been investigated in controlled settings, a few experimental studies focusing on affect in controlled settings indicate age-related changes in differentiation of *affective dimensions* (i.e., pleasantness and arousal). For example, Grühn and Scheibe (2008) had young and older adults rate their affective responses to emotion-inducing pictures in a controlled setting and found that ratings of arousal and valence became more conflated with age (i.e., negative valence became more strongly associated with arousal). Hence, where valence and arousal ratings from young adults showed the classic V-shaped relationship (i.e., the more positive *or* negative an emotional state is, the more arousing it is; Kuppens, Tuerlinckx, Russell & Barrett, 2013), valence and arousal ratings from older adults showed a more negative linear relationship (i.e., the more negative a state is, the more arousing it is) indicating an age-related decline in differentiation of affective dimensions. Similar findings have been reported in other picture-based studies (Keil & Freund, 2009; Ueno, Masumoto, Sato & Gondo, 2019) and studies based on emotion-inducing words (Gilet, Grühn, Studer & Labouvie-Vief, 2012; Söderholm, Häyry, Laine & Karrasch, 2013). Together, these studies suggest age-related changes in differentiation of affective dimensions even in controlled, non-age-specific settings where the influence of life context is reduced. However, as judgements about one's affective state have been proposed to depend on markedly different processes than judgements about one's discrete emotions (Barrett & Bliss-Moreau, 2009), it is unclear whether such findings generalize to differentiation of discrete emotions.

The importance of emotion differentiation – particularly *negative* emotion differentiation – for well-being has been asserted by both theorists and researchers (Erbas *et al.*, 2018; Kashdan, Barrett & McKnight, 2015). Theoretically, it has been suggested that people who are poor at differentiating between negative emotions easily become overwhelmed in stressful situations because they have poor access to the information that differentiated emotional experiences offer about the situation and possible ways of approaching it (Kashdan *et al.*, 2015). They are therefore at risk of misinterpreting their emotions, which in turn, makes it difficult for them to regulate their emotions and behavior to fit contextual demands (Kashdan *et al.*, 2015). The negative consequences of poor negative emotion differentiation have been established in studies linking it to for instance binge-drinking in response to stress, and to aggressive behavior in response to anger (Kashdan, Ferssizidis, Collins & Muraven, 2010; Pond, Kashdan, DeWall, Savostana, Lambert & Fincham, 2012).

Despite the importance assigned to negative emotion differentiation for well-being, little is known about development of differentiation of negative emotions across adulthood in non-age-specific contexts. The purpose of the present study was to address this gap in the literature. Extending previous research, we applied an emotion-induction design allowing us to control exposure to emotion-inducing stimuli, introduce a common goal for participants (i.e., attending to the emotion-inducing stimuli) and assess differentiation of negative emotions in young and older adults. Based on participants' emotional responses to standardized, negative, emotion-inducing pictures, we calculated two indicators of negative emotion differentiation. Drawing on life-span theories of emotions (e.g., Carstensen *et al.*, 2000), we hypothesized that there would be no age-group differences in emotion differentiation between young and older adults in a controlled experimental setting where the influence of life context is reduced. Furthermore, as a recent study indicates that there may be gender differences in negative emotion differentiation (Mankus, Boden & Thompson, 2016), we further explored the role of gender for emotion differentiation across and within age groups.

METHODS

Participants

Participants were recruited from an experimental study aimed at investigating the impact of a writing exercise on emotional reactivity in young and older adults (Mikkelsen, O'Toole & Mehlsen, 2019). A total of 258 healthy Danish adults from the Qualtrics Panels (www.qualtrics.com) participated in the present study. The sample was a quota sample stratified by age and gender in order to include an equal distribution of young (18–30 years of age) and older (60+ years of age) men and women. Twelve participants (7 young and 5 older) were excluded as they either provided invariant responses to more than 10 items in a row or completed the questionnaires unusually fast (<5 min). Thus, the final sample consisted of 114 young adults (18–30 years of age, $M = 22.95$, $SD = 3.45$; 54.4% female) and 132 older adults (60–84 years of age, $M = 66.58$, $SD = 4.97$; 50.8% female). A post hoc power test revealed that the study was adequately powered to detect small age-group differences ($d = 0.36$, two-tailed independent t-test, p-level: 0.05; $\alpha = 0.80$).

The age groups differed in years of education and baseline affect measured with the Positive and Negative Affect Scale (Watson, Clark & Tellegen, 1988). Older adults had more years of education ($M = 15.55$, $SD = 2.33$) than young adults ($M = 14.00$, $SD = 2.50$; $t(244) = 5.02$, $p < 0.001$). Concerning baseline affect, young adults reported significantly more negative affect ($M = 18.86$, $SD = 8.17$) compared to older adults ($M = 12.74$, $SD = 5.30$; $t(188.54) = 6.85$, $p < 0.001$). Conversely, older adults reported significantly more positive affect at baseline ($M = 33.24$, $SD = 8.22$) compared to young adults ($M = 26.26$, $SD = 8.43$; $t(244) = 6.56$, $p < 0.001$). This is in agreement with previous studies reporting on age differences in affect (e.g., Stawski, Sliwinski, Almeida & Smyth, 2008), suggesting that the age groups were representative of their respective populations. Participants were compensated with 35 DKK (approx. $6). As the study was questionnaire-based, it was declared exempt from review by the local Ethics Committee. All data were handled in accordance with the guidelines from the Danish Data Protection Agency.

Material

The visual stimuli comprised 34 high quality color pictures from the Nencki Affective Picture System (NAPS) Database (Marchewka, Żurawski, Jednoróg, & Grabowska, 2014) validated to induce negative emotions. In a pilot study, 57 healthy Danish young and older adults rated their response to 105 negative pictures from the NAPS database in terms of intensity of four negative emotions: anger, sadness, disgust and fear (see study Part I in Mehlsen, Lyby, Mikkelsen & O'Toole, 2019). The ratings were made on seven-point Likert scales (1 = not at all; 7 = very intensely) identical to the rating scales used to validate the NAPS database (Marchewka *et al.*, 2014; Riegel *et al.*, 2016). Based on the ratings from the pilot study, we selected 34 pictures that elicited a minimum of one negative emotion in both young and older adults. The criterion for emotion elicitation was a mean rating

above 3 for one or more negative emotions, indicating the presence of somewhat intense emotions. The mean number of emotions reported per picture was 2.33 (SD = 0.83), suggesting that the pictures generally induced more than one negative emotion.

Measures

Intensity of negative emotions. Participants indicated the extent to which they experienced four discrete negative emotions (i.e., anger, sadness, disgust and fear) in response to each picture. The ratings were made on rating scales identical to the ones used in the pilot study.

Procedure

Both young and older participants received an email containing a link to an online questionnaire. After an introduction to the content of the questionnaire, participants provided online consent and answered questions pertaining to sociodemographic information. Participants subsequently received the instruction: "You will now be shown a series of 30 pictures. Your task is to attend to the pictures and rate your emotional response to them." Participants proceeded to rate the intensity of their emotional response to 30 pictures selected at random from the total sample of 34 negative pictures. The pictures were presented with the corresponding rating scales below in a randomized order. An attention check question was included to ensure valid responses and all responses where scrutinized to identify and exclude non-credible responders (i.e., responders providing invariant responses and responders with very short completion times).

Statistical analysis

For each person, we calculated the average ratings of intensity of discrete emotions and two indicators of emotion differentiation: one based on the number of components in a PCA of emotional states and one based on the correlation between emotional states over time. Following Grühn *et al.* (2013), the PCA-based indicator was computed from a principal component analysis of variation in each participant's ratings of discrete emotions across pictures (i.e., p-technique; Jones & Nesselroade, 1990). The number of principal components with eigenvalues of ≥1 for the first component score was extracted. A higher number of components in a PCA indicates that more components explain a significant amount of variation in ratings and point to better emotion differentiation. The correlation-based indicator of emotion differentiation was operationalized as the *consistency* between correlations between ratings of negative emotions across pictures. To obtain this indicator, intra-class correlation coefficients (ICCs) between all pairs of negative discrete emotions were computed (Tugade, Fredrickson & Barrett, 2004). Following the approach by Erbas *et al.* (2018), negative ICCs were excluded[1] because they are theoretically difficult to interpret (Rousson, Gasser & Seifert, 2002). For the analysis of age-group differences, the remaining ICCs were z-transformed (cf. Barrett *et al.*, 2001) and reversed such that higher values indicate better emotion differentiation (i.e., the person distinguishes well between discrete negative emotions).

Independent t-tests were applied to compare emotion ratings and emotion differentiation between young and older adults, and to investigate gender differences across and within age groups. When age-group differences were non-significant, post-hoc equivalence tests using the TOST procedure described in Lakens (2017) were applied to provide support for the absence of effects. The TOST procedure involves an a priori specification of the maximum expected lower and upper-bound mean difference between two groups. Separate one-sided t-tests (90% confidence interval around the mean difference, $\alpha = 0.05$) are then conducted to assess the null-hypothesis that the difference between the means is lower than the expected lower bound or higher than the expected upper bound for the mean difference between the groups. When both one-sided t-tests are significant, the null-hypothesis is rejected, indicating that the means are equivalent. Hence, where the independent t-test determines whether two means are significantly different from each other, the TOST procedure tests whether two means are statistically equivalent. For the present study, the expected maximum difference between the age groups was specified as $d = 0.36$ ($d = 0.39$ for the correlation-based indicator), reflecting the smallest effect that the study was powered to detect.

RESULTS

Table 1 shows mean ratings of emotion intensity, mean scores for indicators of emotion differentiation as well as results from analyses of age-group differences.

As evident from Table 1, young adults provided significantly higher intensity ratings of disgust and fear, while no other significant age-group differences were apparent. Post hoc equivalence tests provided support for the absence of age-group differences in intensity ratings of sadness and anger (i.e., the effects were statistically not different from zero and statically equivalent to zero), and for the absence of age-group differences for both indicators of emotion differentiation.

Regarding gender differences, independent t-tests indicated no significant differences between men and women for the PCA-based indicator of emotion differentiation overall, $t(244) = 0.65$, $p = 0.516$, $d = 0.08$, within the young group, $t(112) = 0.39$, $p = 0.393$, $d = 0.15$, or within the older group, $t(130) = 0.02$, $p = 0.985$, $d = < 0.01$. The same pattern was identified for the correlation-based indicator of emotion differentiation when evaluated overall, $t(210) = 0.46$, $p = 0.646$, $d = 0.07$, within the young group, $t(76.35) = 0.76$, $p = 0.451$, $d = 0.16$, and within the older group, $t(102.51) = 0.19$, $p = 0.847$, $d = 0.04$.

DISCUSSION

Previous studies of age-related changes in emotional complexity have not investigated emotional complexity in controlled experimental settings where the influence of age-specific life contexts is reduced. The purpose of the present study was to investigate two different operationalizations of emotion differentiation as indicators of emotional complexity in a young and older adults. Extending previous research, we investigated emotion differentiation in a non-age-specific, controlled experimental setting. We applied an emotion-induction design allowing us to assess emotion differentiation, focusing on negative emotion differentiation given its proposed importance for well-being. Consistent with our hypothesis, the results demonstrated no statistically significant age-group differences for the two indicators of emotion differentiation. Moreover, post-hoc equivalence tests provided support for the absence of age-group differences.

Experimental research on age-related changes in emotional complexity has primarily addressed differentiation of emotions in the context of daily life. The present results provide novel evidence regarding age-related changes in emotional complexity by demonstrating that negative emotion differentiation appears to remain stable throughout adulthood when the influence of age-specific life contexts is reduced. This finding that previous findings of age-related changes in emotion differentiation measured in the context of daily life (e.g., Carstensen *et al.*, 2000; Hay & Diehl, 2011; Ready *et al.*, 2008), may have arisen due to age differences in life contexts. Such age differences may take the shape of differences in exposure to emotion-inducing situations. For example, Brose

Table 1. *Mean ratings of emotion intensity, mean scores for indicators of emotion differentiation as well as results from analyses of age-group differences*

	Total sample	Young*n* = 114	Older*n* = 132	Age-group differences, *t*-value (*df*)	95% confidence interval for difference		Effect size, *d*
					Lower	Upper	
Emotion intensity ratings							
Disgust (*M, SD*)	2.78 (1.19)	3.18 (1.19)	2.43 (1.08)	**5.18 (244)**	0.46	1.03	0.66
Sadness (*M, SD*)	3.19 (1.39)	3.20 (1.41)	3.17 (1.37)	0.19 (244)	−0.32	0.38	0.02
Anger (*M, SD*)	2.54 (1.20)	2.58 (1.25)	2.50 (1.15)	0.49 (244)	−0.23	0.38	0.07
Fear (*M, SD*)	1.85 (1.21)	2.38 (1.40)	1.38 (0.77)	**6.80 (169.91)**	0.71	1.29	0.71
Emotion differentiation indicators							
PCA-based indicator (*M, SD*)	1.50 (0.51)	1.53 (0.52)	1.45 (0.50)	1.90 (244)	−0.04	0.22	0.18
Correlation-based indicator (*M, SD*)	0.44 (0.25)	0.45 (0.28)	0.43 (0.21)	0.75 (156.91)	−0.17	0.08	0.11

Notes: Significant age-group differences at $p < 0.05$ are marked in bold. Note that the mean scores for the correlation-based indicator refer to ICCs subtracted from 1; higher scores indicate better emotion differentiation, while the results from the analysis of age-group differences were based on *z*-transformed differentiation scores.

et al. (2013) found that older adults experience fewer stressors in their daily lives compared to young adults and that this age difference contributes to age differences in emotional complexity in daily life. The results of the present study suggest that when the influence of such age-specific life contexts is reduced by controlling exposure to emotion-inducing events, age differences in emotion complexity may dissipate. This interpretation of the findings is consistent with a contextual conceptualization of emotional development, suggesting that age-related changes in emotions are closely tied to age-related changes in life contexts (Freund & Isaacowitz, 2013; Kunzmann & Isaacowitz, 2017; Mikkelsen, Lyby, Tramm & O'Toole, 2019).

Related to the discussion of the importance of context, is the notion that age-related changes in emotional functioning may depend on activated goals (Carstensen *et al.*, 2000; Freund & Isaacowitz, 2013). For example, as suggested by the Socio-emotional Selectivity Theory, older adults may prioritize emotional goals more and be more motivated to find meaning even in difficult emotional situations compared to young adults (Carstensen *et al.*, 2000). This age difference in goal prioritization may lead older adults to have more complex emotional experiences in daily life (Carstensen *et al.*, 2000). However, when young and older adults are provided with the same task-specific goal in a specific situation, age differences in emotional functioning may dissolve. Several studies report findings consistent with this idea (e.g., Grühn, Smith & Baltes, 2005; Kensinger, Brierley, Medford, Growdon & Corkin, 2002; Löckenhoff & Carstensen, 2007). For example, Grühn and colleagues found no age-group differences in memory for affective information after imposing a *common* task-specific goal on young and older adults (i.e., "remember this information as you will have to recall it later"). Applied to the present study, the lack of age-group differences in emotion differentiation may have been due to the common task-specific goal imposed on participants (i.e., "attend to the presented pictures").

The present study holds at least two important limitations. First, it is unclear whether the results of the study generalize beyond induced negative emotional experiences (e.g., to positive emotional experiences). Second, it is possible that age-group differences in emotional reactivity to the pictures (i.e., young adults rated the pictures higher on disgust and fear compared to older adults) may have influenced the computed complexity indicators.

CONCLUSION

In the present study, we investigated two indicators of negative emotion differentiation in young and older adults in a controlled experimental setting. The results revealed that negative emotion differentiation did not differ between young and older adults. The findings are compatible with the idea that age-related changes in emotion differentiation occur as a result of normative age-related changes in life contexts rather than more stable age-related changes in individual characteristics. The results emphasize the importance of considering the immediate context when interpreting research on age-related changes in emotional complexity.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

NOTE

[1] A total of 34 negative ICCs were excluded leaving the sample with correlation-based indicators at 212 (95 young adults and 117 older adults)

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