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Beyond “happy, angry, or sad?”: Age-of-poser and age-of-rater effects on multi-dimensional emotion perception

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Young, middle-aged, and older raters ($N=154$) evaluated 1,026 prototypical facial poses of neutrality, happiness, anger, disgust, fear, and sadness stemming from 171 young, middle-aged, and older posers. The majority of poses were rated as multi-faceted, that is, to comprise several expressions of varying intensities. Consistent with the notion of age-related increases in negativity–avoidance/positivity effects, crossed-random effects analyses showed an age-related *decrease* in the attributions of negative, but not positive and neutral, *target* expressions (that the poser intended to show), and an age-related *increase* in the attributions of positive and neutral, but not negative, *non-target* expressions (that the posers did not intend to show). Expressions were more difficult to read the older the posers, particularly for male posers. These age-of-poser effects were independent of the valence of the expression, but partly differed across age groups of raters. The study supports the idea of multi-dimensionality and age-dependency of emotion perception.

Keywords: Facial expressions; Emotion recognition; Age of rater; Age of poser; Own-age effect; Multi-dimensional rating.

Emotional displays serve communicatory functions. For example, people may display anger to signal the seriousness of their position in an interpersonal argument, or put on a sad face to discourage another person from behaving in an undesired way. Thus, emotional displays are not

necessarily spontaneous expressions of an individual's experience, but are often intentionally used (or “posed”) to convey social information or to influence interaction partners (Buck & VanLear, 2002). Whether or not these communication goals are met depends, among other

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things, on how interaction partners perceive the expression.

In this article, we demonstrate that reading emotional poses is among the interpersonal phenomena at the intersection of emotion and cognition that cannot be adequately understood without taking the *age-group memberships* of both the perceiving and the expressing person into account. We report a study that investigated how young, middle-aged, and older raters evaluated a large number of prototypical facial poses from young, middle-aged, and older posers on each of the six dimensions of neutrality, happiness, anger, disgust, fear, and sadness. The purposes of this study were to demonstrate: (i) that raters typically interpret emotional poses in more complex than mere categorical terms; (ii) how such multi-dimensional evaluations of emotional poses differ depending on the age of the posing and the rating person; and (iii) that these effects are influenced by the valence of the attributed expressions.

Reading emotional poses: Categorical or multi-dimensional?

The most frequently used paradigm in the investigation of emotional poses presents participants with prototypical facial expressions of intense basic emotions and asks them to select the single best matching emotion from a list of alternatives. This “forced-choice approach” assumes that people interpret emotional poses categorically. We propose that this may not always be the case, and that people may often interpret emotional poses in more complex terms. This assumption is based on prior evidence that emotional experiences are often multi-faceted (e.g., Hemenover & Schimmack, 2007). Typical approaches to measuring emotional *experiences* account for this potential complexity by presenting participants with a list of emotion words. Participants are then asked to indicate, for each of these emotions, how intensely they are currently feeling this way. People from various age groups often describe their momentary emotional experiences as comprising several affect facets of varying intensity (e.g., Riediger, Schmiedek, Wagner, &

Lindenberger, 2009). In addition, there is some evidence that people interpret facial emotional *expressions* of other individuals in more complex than categorical terms when given the option to do so (Hall & Matsumoto, 2004; Phillips & Allen, 2003).

The possibility that facial expressions may require complex interpretations is also acknowledged in theoretical frameworks on emotion expression and perception. Proponents of the “basic-emotions approach” (e.g., Ekman, 1992), for example, suggest that emotional experiences may go beyond basic emotions and comprise more complex affective experiences, referred to as “emotional plots” and “emotional blends”, which should also be reflected in facial displays. Similarly, proponents of the “dimensional-contextual approach” (e.g., Russell & Bullock, 1986) maintain that people may evaluate facial expressions in a complex manner. They propose that facial expressions are initially perceived in terms of the extent of pleasure and arousal expressed. Then, in order to verbalise the meaning of the expression, they are associated with specific emotion categories. This latter step may result in the attribution of one or multiple emotion categories (of varying prototypicality) to an emotional expression.

Based on these considerations, we predicted that raters would not typically interpret emotional poses categorically, but would rather interpret poses in more complex terms when given the option to do so. In addition, we hypothesised that such multi-dimensional evaluations of facial poses would differ between raters and posers from different adult age groups, and that the valence of attributed expressions would play a role in this respect, as will be elaborated next.

Age differences in the interpretation of emotional poses: How does valence matter?

Prior evidence suggests that older adults are less accurate at decoding facial emotional pose than young adults. However, this age-related decline appears to be more consistent and pronounced for expressions of anger, fear, and sadness than for expressions of happiness, surprise, and disgust (see

Ruffman, Henry, Livingstone, & Phillips, 2008, for a meta-analysis).

The mechanisms underlying age differences in reading facial expressions are not yet well understood. They appear to be relatively independent of age-related declines in fluid-cognitive functioning (Phillips, MacLean, & Allen, 2002; Sullivan & Ruffman, 2004; but see Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006). Some researchers have argued that age-related gradual atrophy of brain structures involved in emotion processing, or reduced availability of neurotransmitters leading to decreased activation of these areas, may contribute to age differences in reading emotional expressions (e.g., Ruffman et al., 2008).

Another line of argument maintains that adult age differences in the identification of emotional poses reflect age-related shifts in the motivation to process emotional information (e.g., Williams et al., 2006). This position derived from evidence of an age-related increase in preferential attention to positively, or away from negatively, valenced information (see Carstensen & Mikels, 2005, for a review). These effects have been interpreted within the framework of socioemotional selectivity theory, which proposes that increasing awareness of limited remaining lifetime shifts older adults' motivation towards wanting to maximise their emotional well-being. Age differences in the processing of positive and negative information are seen as instrumental in this respect (Carstensen, Fung, & Charles, 2003).

These age-differential cognitive styles in the processing of valenced information might also be at work in the multi-dimensional interpretation of emotional poses. Here, they might result in age-related differences in attributing expressions that the poser *intended* to show and/or in attributing expressions that the poser did *not* intend to show. For example, when interpreting an angry pose, negativity avoidance/positivity effects might be reflected in ascribing a lower intensity of anger and/or in attributing some happiness. We therefore expected systematic valence-specific age differences in (i) the attributions of expressions that the poser intended to show (*target expressions*) and (ii)

the attributions of other expressions that the poser did not intend to show (*non-target expressions*). Specifically, we hypothesised that age differences in the motivation to attend to emotional information of different valence lead to an age-related decline in the attribution of negative, but not positive or neutral, target expressions, coupled with an age-related increase in attributions of positive, but not negative or neutral, non-target expressions.

How does age of poser affect the interpretation of emotional poses?

We further hypothesised that age-related changes in facial features and skin texture of posers make emotional expressions of older as compared to young posers more difficult to recognise. We therefore expected raters to attribute less target and more non-target expressions the older the posers, irrespective of the valence of the expression. This prediction is consistent with findings of the few available studies involving posers of various ages (Borod, Yecker, & Brickman, 2004; Ebner, He, & Johnson, 2011 this issue; Ebner & Johnson, 2009; Malatesta, 1987).

We also expected these age-of-poser effects to be less pronounced for older raters. We derived this prediction from evidence that people are best at interpreting emotional expressions by individuals of their own nationality, ethnicity, or cultural group (see Elfenbein & Ambady, 2002, for a meta-analysis). Several mechanisms to explain these in-group effects have been discussed, such as a better knowledge base for interpreting facial expressions conveyed by individuals of one's own culture, or a higher motivation to attend to, and process, expressions of individuals that belong to a cultural group with which one self-identifies. These in-group advantages in expression identification also extend to other group memberships, such as university affiliations or shared interests (Thibault, Bourgeois, & Hess, 2006). Thus, it stands to reason that age-group membership may have similar effects.

Empirical evidence regarding own-age advantages in expression identification is still scarce. Malatesta and colleagues (1987) found that

expression recognition rates were lower when decoding spontaneous facial expressions of older adults as compared to decoding spontaneous facial expressions of young adults. This difference was less pronounced in older than in young raters, but older raters did not perform better than young raters when decoding emotional expressions of older adults. However, the numbers of expressers and raters per age group in this study were small. Two other investigations found no support for an own-age advantage in decoding posed facial expressions (Ebner et al., 2011 this issue; Ebner & Johnson, 2009). Both of these studies, however, used forced-choice paradigms, and primarily focused on the identification of target, but not non-target, expressions. Furthermore, only young and older, but not middle-aged, adults were compared. The present study sought to extend this previous research, as summarised next.

The present study

Taken together, older adults, as compared to young adults, have been found to be less accurate at identifying emotional poses. In most previous studies, however, participants evaluated a relatively small number of poses, and were limited to choosing one single best matching emotion from several response options. This forced-choice approach assumes that people interpret emotional poses in categorical terms, when in fact they may attribute several simultaneous emotions to one facial emotion expression. The relatively small sets of stimuli may also limit the generalisability of these prior findings. Moreover, previous studies have typically analysed the “hit rate” of responses (i.e., correct recognition of the expression the poser intended to show). However, age differences may also be evident in systematic differences in attributing expressions that were *not* intended by the poser. Furthermore, while earlier studies often varied the age of the persons who *rated* the expressions, they did not typically vary the age of the persons who *posed* the expressions. Interpretations of emotional poses, however, may be influenced not only by the age of the perceiver, but also by the age of the poser. Finally, the

majority of studies compared young and older adults only. Little is known about how middle-aged adults interpret emotional poses.

The present study sought to address these methodological limitations of earlier investigations. Specifically, we tested the following hypotheses: Participants would attribute more complex emotional experiences to emotional poses (instead of interpreting them in categorical terms) when given the option to do so in a multi-dimensional response format (*Hypothesis 1*). In line with assumptions of age-related increases in negativity-avoidance/positivity effects, we furthermore expected systematic valence-specific age differences in the attribution of both target and non-target expressions. In particular, we predicted an age-related decrease in correct attributions of negative expressions (anger, disgust, fear, and sadness), but not in correct attributions of happiness or neutrality (*Hypothesis 2a*). In addition, we expected an age-related increase in the attribution of happiness to expressions that were not intended to show happiness, while we expected no age-related increase in the attribution of negative expressions (anger, fear, disgust, and sadness) or neutrality to expressions that did not target these emotions (*Hypothesis 2b*). Furthermore, we hypothesised that raters would attribute less target, and more non-target, expressions to poses from middle-aged or older as compared to young posers, irrespective of the valence of the expressions (*Hypothesis 3*). Finally, we expected that these latter age-of-poser effects would be attenuated the older the raters (*Hypothesis 4*).

METHOD

Participants

The sample consisted of 154 ($n = 76$ female) raters from three age groups: Young (20 to 31 years, $n = 52$), middle-aged (44 to 55 years, $n = 51$), and older (70 to 81 years, $n = 51$) adults. Men and women were approximately equally distributed within each age group. All raters were German speaking and Caucasian. The latter criterion was included because the to-be-rated

emotional poses also were from Caucasian individuals, who represent the vast majority of the population in Germany. Participants were recruited through the Max Planck Institute for Human Development's subject pool and advertisements in local newspapers. Self-reported physical functioning in the sample was good (single item, "How would you describe your current general physical functioning?", scale 1 to 8, with 8 = *excellent*; $M = 5.5$, $SD = 1.5$) and did not vary significantly between age and gender groups (all $ps > .05$). Participants' visual-motor processing speed as assessed with the Digit-Symbol-Substitution Test (Wechsler, 1981) was comparable to typical performance levels (with young women and men, $M_{YW} = 66.3$, $SD = 11.1$; $M_{YM} = 64.0$, $SD = 9.6$, scoring higher than middle-aged, $M_{MW} = 46.0$, $SD = 9.1$; $M_{MM} = 48.5$, $SD = 14.4$, and older women and men, $M_{OW} = 44.8$, $SD = 10.7$; $M_{OM} = 47.7$, $SD = 12.1$).

Posed facial expressions

Facial expressions were taken from the FACES database (Ebner, Riediger, & Lindenberger, 2010). In two parallel sets, the database contains 2,052 pictures of 171 Caucasian posers, each displaying neutral, happy, angry, disgusted, fearful, and sad facial expressions. Posers were young (19 to 31 years, $n = 58$), middle-aged (39 to 55 years, $n = 56$), or older (69 to 80 years, $n = 57$) adults, with approximately equal numbers of men and women in each of these groups. The creation of the database involved a standardised production and selection procedure to obtain maximally prototypical facial expression from each poser (see Ebner et al., 2010, for details). Figure 1 presents examples of facial expressions in the three age groups.

Rating procedure

Each rater was assigned to one of the two parallel sets, each containing 1,026 pictures.¹ First, participants were informed about the testing procedure and signed a consent form. Next, participants

were told that they would see faces, one at a time, and be asked to indicate (among other ratings) the extent to which each face expressed: (a) neutrality; (b) happiness; (c) anger; (d) disgust; (e) fear; and (f) sadness.

Facial expressions and rating dimensions were presented in randomised order. Response options ranged from 0 (*does not apply at all*) to 100 (*applies completely*), and were selected by adjusting a slider. Having rated a given expression on all six expression dimensions prompted the next facial expression to appear. Rating sessions were terminated after 100 minutes each. Participants rated a median number of 1,024 faces in an average of 11.28 ($SD = 4.7$) test sessions. All participants were reimbursed for study participation. The study was approved by the ethics committee of the Max Planck Institute for Human Development.

Crossed-random effects analyses

For the majority of our analyses we used crossed-random effects models; an approach that has recently been receiving increased attention (e.g., Baayen, Davidson, & Bates, 2008; Hoffman & Rovine, 2007). Crossed-random effects models offer a number of advantages over traditional analysis of variance models, such as the examination of associations among study variables within (rather than between) raters, the possibility of estimating the extent to which effects vary between posers and/or raters, and the maximisation of power through the use of full-information maximum likelihood (Baayen et al., 2008; Hoffman & Rovine, 2007). The conceptual approach of crossed-random effects models is similar to that of multilevel models. In contrast to multilevel models, which assume a nested (hierarchical) data structure, however, crossed-random effects models permit independent sources of variance, which in our case refer to the posers and raters.

Using the lme4 (Bates & Maechler, 2009) and languageR packages (Baayen, 2009), we specified

¹ Stimulus set did not explain any variance in the analyses reported. We therefore collapsed across this factor in all analyses.



Figure 1. Sample facial expressions of posers from the three age groups. [To view this figure in colour, please visit the online version of this Journal].

six separate models with participants' ratings of the six expression dimensions as dependent variables. Predictors included the target expression (dummy coded with 1 indicating that the dependent variable corresponded to the target expression), the poser's age (dummy coded with young adults as reference group), and their interactions. The intercept was allowed to vary between posers and raters, and the slopes of the dummy variables for target expression and poser age group were allowed to vary between raters. All random effects were assumed to follow a

normal distribution and were treated as orthogonal. Likewise, the error term was assumed to be normally distributed with zero mean and variance σ_r^2 . Moreover, we included the rater's age (dummy coded with young adults as reference group) as explanatory variable to predict the random effects (intercept and slopes).² We also conducted follow-up analyses to explore whether the reported effects differed between men and women. Apart from few exceptions, which are reported in the results section, this was not the case.

² Crossed-random effects model equations: $y_{ijk} = \beta_{0j} + \beta_{1j} (\text{Target expression}) + \beta_{2j} (\text{Middle poser}) + \beta_{3j} (\text{Older poser}) + \beta_{4j} (\text{Target expression} \times \text{Middle poser}) + \beta_{5j} (\text{Target expression} \times \text{Older poser}) + W_k + r_{ijk}$. Predictors of random coefficients: $\beta_{0j} = \gamma_{00} + \gamma_{01} (\text{Middle rater}) + \gamma_{02} (\text{Older rater}) + u_{0j}$; $\beta_{1j} = \gamma_{10} + \gamma_{11} (\text{Middle rater}) + \gamma_{12} (\text{Older rater}) + u_{1j}$; $\beta_{2j} = \gamma_{20} + \gamma_{21} (\text{Middle rater}) + \gamma_{22} (\text{Older rater}) + u_{2j}$; $\beta_{3j} = \gamma_{30} + \gamma_{31} (\text{Middle rater}) + \gamma_{32} (\text{Older rater}) + u_{3j}$; $\beta_{4j} = \gamma_{40} + \gamma_{41} (\text{Middle rater}) + \gamma_{42} (\text{Older rater})$; $\beta_{5j} = \gamma_{50} + \gamma_{51} (\text{Middle rater}) + \gamma_{52} (\text{Older rater})$. Where y_{ijk} is the rating of the i th expression stimulus from the k th poser by the j th rater, W_k is the random effect for posers, and r_{ijk} is the random residual term. The fixed intercept (i.e., the expected rating of a young rater of a non-target expression posed by a young poser) is denoted by γ_{00} , the fixed intercept of the m th random coefficient (β_{0j} to β_{5j}), by γ_{m0} ; γ_{ml} represents the fixed slope for age-of-rater dummy codes as predictors of the m th random coefficient, and u_{mj} is the random residual term associated with the m th random coefficient for the j th rater (i.e., the rater-specific deviation from the fixed effect examined).

RESULTS

Multi-dimensional expression ratings (Hypothesis 1)

For $M = 35.9\%$ ($SD = 26.0$) of rated expressions, raters used exactly one rating dimension and chose zeros on all other dimensions, with no significant differences between age groups of raters, $F(2, 151) = 0.84$, $p = .434$. Thus, consistent with Hypothesis 1, the majority of evaluations reflected more complex, multi-faceted attributions rather than mere categorisations into discrete emotions. On average, raters chose values above zero for $M = 2.46$ ($SD = 1.15$) of the six rating dimensions for a given expression, with no significant differences between age groups, $F(2, 151) = 1.04$, $p = .357$. However, while on average the highest rating on one of the six rating dimensions was 82.93 ($SD = 11.35$), the average second highest rating was only 21.82 ($SD = 16.30$). Again, raters from different age groups did not differ in this respect for the highest, $F(2, 151) = 0.98$, $p = .377$, and the second highest ratings, $F(2, 151) = 0.70$, $p = .499$, respectively. That is, as expected, raters interpreted facial poses in more complex than merely categorical terms, but nevertheless typically made a clear attribution to a primary expression.

Valence-specific variations in age-of-rater effects (Hypothesis 2)

The following results were derived from the crossed-random effects models previously introduced. As shown in Table 1, with the exception of happiness, the fixed intercepts in these models were significantly different from zero, but relatively small (< 12 on a scale from 0 to 100). Thus, on average and with the exception of happiness, young raters attributed significant but small intensities of non-target expressions to young adults' poses. Variance components and random effects coverage ranges (the latter indicating the range of individual intercepts for 95% of the young posers and the range of individual intercepts for 95% of the young raters) indicate

considerable variations of intercepts between posers and raters, respectively.

In all six models, fixed slopes of target expression were of substantial size (i.e., > 64) and significantly different from zero. This indicates that young raters, on average, differentiated well between expressions that were targeted and those that were not targeted in facial expressions of young posers. For example, young raters attributed 69.23 scale points more anger to young anger expressions than to young non-anger expressions. The variance components for these slopes were significant in all models, and the random effects coverage rates revealed substantial variation in the extent to which raters differentiated between target and non-target expressions.

Hypothesis 2a predicted an age-related decrease in the extent to which raters attributed negative affect (i.e., anger, disgust, fear, sadness), but not neutrality and happiness, to poses that were intended to show these expressions. Relevant parameter estimates are represented in the interactions between target expression and age group of raters, indicating whether ratings of target expressions differed between middle-aged (or older) and young raters. In line with our prediction, the interactions involving older raters were significant for anger, disgust, fear, and sadness, but not for neutrality and happiness (see Part A of Table 1). That is, young and older raters did not differ in their attributions of neutrality and happiness to neutral and happy target expressions, respectively. Older adults, however, attributed significantly less anger, disgust, fear, and sadness to poses that intended to show these expressions than did young raters. Middle-aged raters showed a similar pattern for two of the four negative expressions, that is, they attributed significantly less disgust and sadness to poses that intended to show these expressions than did young raters. None of these results differed between male and female raters (i.e., interactions with gender of raters: $p > .05$).

Hypothesis 2b predicted an age-related increase in the extent to which raters attributed positive (i.e., happiness) but not negative affect (i.e., anger, disgust, fear, sadness) or neutrality to

Table 1. Crossed-random effects analyses predicting ratings of facial expressions from target expression, age of rater, and age of poser.

Parameters	Neutral	Happy	Angry	Disgusted	Fearful	Sad
Fixed effects						
Intercept	4.10** (1.26)	1.27 (0.70)	11.72** (1.72)	10.46** (1.39)	10.12** (1.73)	9.12** (1.45)
95% CR (posers)	0 to 9.79	0 to 4.33	5.21 to 18.23	0 to 16.35	5.59 to 14.65	0.52 to 17.72
95% CR (raters)	0 to 21.35	0 to 10.91	0 to 35.60	0 to 29.50	0 to 34.65	0 to 28.22
Expression ^a						
● Target	80.90** (2.38)	89.83** (1.65)	69.23** (2.45)	64.44** (2.24)	67.04** (2.60)	67.90** (2.12)
95% CR	47.08 to 100	66.28 to 100	34.62 to 100	32.79 to 96.09	30.08 to 100	38.12 to 97.68
<i>Part A (Hypothesis 2a)</i>						
Target ×						
● Middle rater	-2.37 (3.38)	-2.65 (2.34)	-4.36 (3.49)	-6.76* (3.19)	-4.91 (3.69)	-5.97* (3.01)
● Older rater	-4.72 (3.38)	-2.66 (2.34)	-14.10** (3.49)	-11.91** (3.19)	-7.79* (3.69)	-7.16* (3.01)
<i>Part B (Hypothesis 2b)</i>						
Age of rater ^b						
● Middle rater	1.20 (1.72)	1.15 (1.20)	0.71 (2.37)	-0.84 (1.90)	-0.51 (2.43)	-1.27 (1.90)
● Older rater	4.40* (1.72)	2.15* (0.96)	2.96 (2.37)	1.60 (1.90)	2.38 (2.43)	1.54 (1.90)
<i>Part C-1 (Hypothesis 3)</i>						
Target ×						
● Middle poser	-6.83** (0.55)	-1.53** (0.30)	-6.33** (0.70)	-2.22** (0.64)	-1.18* (0.59)	-6.35** (0.65)
● Older poser	-14.68** (0.54)	-3.72** (0.30)	-15.10** (0.70)	-9.18** (0.64)	-1.99** (0.58)	-12.25** (0.65)
<i>Part C-2 (Hypothesis 3)</i>						
Age of poser ^c						
● Middle	0.92 (0.62)	0.28 (0.32)	1.88** (0.68)	0.04 (0.62)	0.96* (0.49)	2.00** (0.85)
95% CR	-2.07 to 3.91	-0.78 to 1.34	—	—	—	—
● Older	3.38** (0.77)	1.07** (0.37)	4.54** (0.73)	-0.35 (0.66)	0.79 (0.53)	3.65** (0.93)
95% CR	-3.88 to 10.64	-1.90 to 4.04	0.54 to 8.54	-3.82 to 3.12	-2.05 to 3.63	-1.76 to 9.06
<i>Part D-1 (Hypothesis 4)</i>						
Target × Middle poser ×						
● Middle rater	1.17 (0.78)	0.39 (0.43)	2.63** (0.99)	-1.04 (0.91)	1.06 (0.83)	-1.74 (0.93)
● Older rater	0.34 (0.77)	0.62 (0.43)	4.81** (0.99)	-1.27 (0.91)	-0.14 (0.83)	-0.92 (0.93)
Target × Older poser ×						
● Middle rater	-0.66 (0.77)	0.23 (0.43)	1.42 (0.99)	-0.06 (0.91)	0.43 (0.83)	-2.82** (0.93)
● Older rater	-0.99 (0.77)	1.92** (0.43)	4.70** (0.98)	1.29 (0.91)	-0.06 (0.82)	-2.38** (0.92)

Table 1 (Continued)

Parameters	Neutral	Happy	Angry	Disgusted	Fearful	Sad
<i>Part D-2 (Hypothesis 4)</i>						
Middle poser ×						
● Middle rater	−0.06 (0.44)	−0.24 (0.21)	−0.35 (0.42)	−0.40 (0.40)	−0.15 (0.34)	−0.78* (0.40)
● Older rater	−1.15** (0.44)	−0.13 (0.21)	−0.34 (0.42)	−0.26 (0.40)	0.03 (0.34)	−0.16 (0.40)
Older poser ×						
● Middle rater	1.02 (0.79)	−0.37 (0.35)	−1.13* (0.57)	−0.60 (0.51)	0.29 (0.45)	−0.46 (0.66)
● Older rater	−0.32 (0.79)	−0.76* (0.34)	−2.35** (0.57)	−0.36 (0.51)	0.78 (0.44)	0.61 (0.66)
Variance components						
Intercept ^d						
● Posers	8.08 **	2.34 **	10.60 **	8.66 **	5.12 **	18.51 **
● Raters	74.39 **	23.24 **	142.61 **	90.64 **	150.46 **	91.16 **
Slopes ^e						
● Target	285.97 **	138.81 **	299.54 **	250.44 **	341.57 **	221.67 **
● Middle poser	2.24 **	0.28 **	0.26	0.55	<.01	0.57
● Older poser	13.18 **	2.20 **	4.00 **	3.01 **	2.02 **	7.32 **
● Residual ^f	314.31 **	96.65 **	510.02 **	432.47 **	359.35 **	448.98 **

Notes: Results from crossed-random effects models estimated using the lme4 (Bates & Maechler, 2009) and languageR packages (Baayen, 2009). **Bold font** indicates significant results. Values for fixed effects reported in table: parameter estimates (standard errors). Significance levels for fixed effects were estimated using the pvals function defined in the languageR package. Significance levels for variance components were determined by fitting the model with and without the respective variance components and comparing the quality of fits using likelihood ratio tests (Baayen et al., 2008). 95% CR = 95% coverage range for the random effect (variation) around the fixed effect (fixed parameter estimate $\pm 2\sqrt{\text{random parameter estimate}}$; Hoffman & Rovine, 2007). Middle rater/poser = middle-aged rater/poser. ^a Dummy coded, reference group non-target expression. ^b Dummy coded, reference group young rater. ^c Dummy coded, reference group young poser. ^d Estimated variation of intercepts between posers and between raters. ^e Between-rater variance slopes. ^f Remaining within-person variance. * $p \leq .05$; ** $p < .01$.

poses that did not target these expressions. Relevant parameter estimates involve the fixed slopes of the dummy variables for age group of raters, which denote the difference in the ratings of non-target expressions by middle-aged (or older) compared to young raters. Consistent with our prediction, older raters attributed significantly more happiness to expressions that were not intended to show happiness (see Part B of Table 1) than did young raters. Middle-aged and young raters did not differ in this respect. Unexpectedly, the same pattern of findings also emerged with respect to neutrality ratings (i.e., older compared to young raters attributed more neutrality to non-neutral expressions). As expected, however, there were no significant age-of-rater effects for any of the four negative dimensions, indicating that the extent to which raters attributed anger, disgust, fear, or sadness to poses that did not target these expressions did not differ significantly between age groups. None of these results differed between male and female raters (i.e., each interaction with gender of raters: $p > .05$).

Age-of-poser effects (Hypothesis 3)

Hypothesis 3 predicted that poses from middle-aged or older as compared to young posers would be more difficult to interpret, irrespective of their valence. Significant target expression \times age of poser interactions indicated for all rating dimensions that young raters attributed significantly less of the intended expressions to poses by middle-aged and older posers than to poses expressed by young posers (see Part C-1 of Table 1). Interestingly, follow-up analyses showed that these age-of-poser effects were moderated by the gender of the posers for all expressions except neutrality and anger. For disgust, fear, and sadness most of these effects were less pronounced in female posers; parameter estimates for target expression \times age of poser \times gender of poser interactions (1 = female): disgust, 4.21, $p < .001$ (middle-aged posers), 8.08, $p < .001$ (older posers); fear, 1.60, $p = .019$ (middle-aged posers), -1.09 , $p = .107$ (older posers); sadness, 3.22, $p < .001$ (middle-aged posers), 6.40,

$p < .001$ (older posers). For happiness, the pattern was reversed and age-of-poser effects were slightly more pronounced for female than for male posers; parameter estimates for target expression \times age of poser \times gender of poser interactions (1 = female): -0.90 , $p = .011$ (middle-aged posers), -0.80 , $p = .023$ (older posers).

The fact that 7 (out of 12) age-of-poser effects were significant is also largely consistent with Hypothesis 3 (see Part C-2 of Table 1). These effects indicate that young raters, on average, attributed more non-targeted expressions (i.e., expressions that were not intended by the poser) to poses from middle-aged and/or older posers than to poses from young posers. The significant effects pertained to non-target attributions of anger, fear, and sadness for poses from middle-aged posers and to non-target attributions of neutrality, happiness, anger, and sadness for poses from older adults and held for poses from male and female posers (each interaction with gender of posers: $p > .05$). Two variance components of the slopes for middle-aged posers (ratings of neutrality and happiness), and all variance components of the slopes for older posers were significantly different from zero. This indicates some between-rater variation in the effects for poses from middle-aged posers, and substantial between-rater variation in these effects for poses from older posers.

Age-of-rater partly moderates age-of-poser effects (Hypothesis 4)

Hypothesis 4 predicted that age-of-poser effects previously described would be most evident among young raters and less pronounced the older the raters. Results summarised in Part D of Table 1 support this prediction only partially. Six (out of 12) target-expression \times age-of-poser \times age-of-rater interactions were significantly different from zero (see Part D-1 of Table 1). These interactions involved happiness, anger, and sadness. For happiness and anger, the effects were in the hypothesised direction. That is, middle-aged and older raters were less affected in their target ratings of happy and angry poses by

the age of the posers than were young raters. The upper panel of Figure 2 exemplifies this finding for anger ratings. It shows that, as expected, differences in target anger ratings between age groups of raters were most pronounced for angry expressions posed by young posers, and less evident for expressions posed by middle-aged and/or older posers. For sadness, the pattern was reversed. Contrary to our predictions, differences in target ratings of sadness between age groups of raters were most evident for expressions by older posers (see lower panel of Figure 2).

Regarding ratings of non-target expressions, five (out of 12) age-of-poser \times age-of-rater interactions were significantly different from zero (see

Part D-2 of Table 1). These interactions involved neutrality, happiness, anger, and sadness, that is, four of the five rating dimensions with significant age-of-poser effects. In all of these cases, the direction of the moderation was in the hypothesised direction: Middle-aged and older raters were less affected in their attributions of non-target expression by the age of the posers than were young raters. In other words, young, as compared to middle-aged or older, raters showed a steeper increase in attributing neutrality, happiness, anger, and sadness to poses that did not target these expressions when the posers were middle-aged or older than when they were young. These results, however, need to be interpreted with caution because the effect sizes were small and the repeated significance testing may have increased the probability of falsely rejecting the null hypothesis.

DISCUSSION

This study demonstrates that, to understand how people read emotional poses, it is necessary to take the age of posers and perceivers into account. Our study extends earlier research by investigating how young, middle-aged, and older raters evaluated a large number of facial expressions posed by young, middle-aged, and older posers on multiple dimensions. Results showed that raters used more complex, as opposed to merely discrete categorical, evaluations when given the option to do so, and that these multi-dimensional expression evaluations differed between age groups of raters and posers. Furthermore, age-related differences between raters in evaluating target *and* non-target expressions varied systematically with the valence of the attributed expressions and, partly, with the age of the posers.

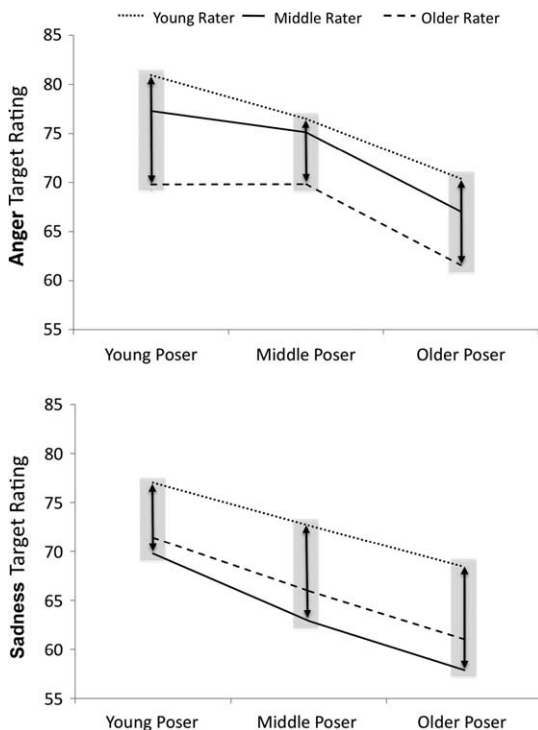


Figure 2. Age-of-poser \times age-of-rater effects for the examples of anger and sadness ratings for anger and sadness expressions (model predictions): Differences between age groups of raters in attributions of anger to anger expressions were most evident for young posers, and less pronounced for middle-aged and older posers (upper panel). For sadness (lower panel), the pattern was reversed: Age-of-rater effects in target ratings of sadness were most evident for expressions by older posers. Arrow length reflects difference between young and older raters.

Interpretations of emotional poses are often multi-faceted

Raters of all age groups attributed multi-faceted experiences to the majority of expressions. Typically, participants assigned a primary expression of high intensity and at least one additional expression of substantially lesser intensity to posed

expressions. Although theoretical frameworks on emotion expression and perception acknowledge that facial expressions may invite complex interpretations (e.g., Ekman, 1992; Russell & Bullock, 1986), prior research typically used forced-choice measures that do not allow for this possibility. It may be possible, however, that the multi-dimensional approach used in this study elicited demand characteristics, which may have further contributed to participants' tendency to attribute a mixture of different feelings of varying intensities to an emotional pose. Nevertheless, the findings discussed next suggest that a multi-dimensional approach may be more suited than "traditional" forced-choice paradigms to capture the, in parts subtle, age differences in interpretations of emotional poses.

Age-of-rater effects differ by valence of attributed expression

Age differences in reading emotional poses varied systematically depending on the valence of the attributed expression. This finding is consistent with proposals of an age-related increase in the motivation to attend to positive, and away from negative, information, presumably as a means to maximise emotional well-being (Carstensen & Mikels, 2005). Extending earlier investigations, our study showed that age-related increases in negativity-avoidance/positivity effects were evident in attributions of both expressions that the posers *intended* to show and expressions that the posers *did not intend* to show: Older as compared to young raters attributed less anger, disgust, fear, and sadness to poses that targeted these expressions. These effects were limited to negative expressions, with no evidence of age-related differences in attributing neutrality and happiness to neutral and happy expressions. In addition, older as compared to young raters attributed more neutrality and happiness to expressions that were not targeted at expressing neutrality or happiness, respectively. There were no age-related differences in the attribution of negative non-target expressions.

In short, there was an age-related *decrease* in the attributions of negative, but not positive and neutral, *target* expressions, coupled with an age-related *increase* in the attributions of positive and neutral, but not negative, *non-target* expressions. These age differences were largely specific to comparisons between young and older raters, with only few significant differences between young and middle-aged raters.

This pattern of findings speaks against the argument that negativity avoidance/positivity effects in emotion identification simply represent a methodological artefact that results from the fact that happiness is easier to recognise than negative emotions (Ebner & Johnsons, 2009; Isaacowitz et al., 2007; Ruffman et al., 2008). This argument cannot account for our finding that older raters attributed more happiness to expressions that were not intended to show happiness. We therefore conclude that our findings are consistent with the idea that age-differential cognitive styles in processing emotional information are at work when reading emotional poses (e.g., Bucks, Garner, Tarrant, Bradley, & Mogg, 2008; Keightley et al., 2006; Orgeta & Phillips, 2008). Disentangling of the specific cognitive processes involved herein remains an important task for future studies. Age differences in selective attention to those cues of an expression that signal a particular positive or negative experience may play a role here. Also, there may be age differences in the intensity thresholds of cues that raters use for particular positive and negative emotions. It may, for example, be that with increasing age, positive-affect cues can be less intense, but negative-affect cues need to be more intense, to be interpreted as signals of a particular positive and negative expression, respectively. This may result in older adults' interpreting expressions as more positive and less negative than younger age groups.

The age-related increase in the attribution of neutrality to non-neutral expressions was unexpected. Overall, the present pattern of findings suggests that some of the age differences in reading facial poses may reflect older adults' heightened motivation to attend to positive

information, while averting attention away from negative information.

Given the large number of facial expressions rated in the present study, it seems unlikely that our findings are specific to this set of stimuli, a possibility more likely in studies using considerably fewer stimuli. This methodological difference among studies may also explain discrepancies between the present and previous findings, such as those suggesting that age differences in ratings of disgust in faces may be different from those of other negative expressions, such as anger, fear, or sadness (e.g., Calder et al., 2003; Orgeta & Phillips, 2008), or those suggesting that older adults may generally tend to attribute less intense experiences to facial expressions, regardless of their valence (Phillips & Allen, 2003).

Age of poser matters, too

Attributions of target and non-target expressions not only varied between raters, but also between posers of different age groups. With increasing age of the posers, raters tended to attribute less of the expression the poser intended to show. Interestingly, for disgust, fear, and sadness, these age-of-poser effects were smaller, and for happiness, they were larger in female than in male posers. Age-of-poser effects were also evident in raters' assigning more non-target expressions on all rating dimensions except disgust with increasing age of the posers.

Overall, our findings are consistent with previous evidence suggesting that facial expressions are more difficult to decode for older than for young posers (Borod et al., 2004; Ebner & Johnson, 2009; Malatesta, 1987). They also suggest that this may be particularly pronounced if the poser is male. Estimates of variance components in our analyses, however, indicated substantial between-rater variability in age-of-poser effects, particularly for older posers. That is, there were differences among raters regarding the extent to which their expression ratings varied depending on the age of the posers. The causes that may underlie these age-of-poser effects, and the between-rater variations therein, remain to be investigated in

future studies. Possible factors may be characteristics of both the poser (such as facial structures, skin texture, or ability to follow the multi-stage instructions used in the creation of the stimulus material) and/or the rater (such as subjective theories about emotional experiences in men and women of different ages, or differences in the amount of contact with different age groups; Harrison & Hole, 2009).

Some support for the latter conjecture that characteristics of the raters may matter in this respect comes from the fact that some, but not all, of the age-of-poser effects differed across age groups of raters. These effects were partly evident for ratings of neutrality, happiness, anger, and sadness, and were comparatively most pronounced for anger and sadness. The majority of these effects indicated that young raters showed a steeper decline in accuracy than middle-aged or older raters when decoding expressions posed by middle-aged or older adults as compared to adults of their own age group. There was, however, one exception: With increasing age of the poser, raters attributed less sadness to expressions that targeted sadness, and this effect was especially pronounced with increasing age of the raters.

It is possible that such in-group effects of reading emotional poses result from the better knowledge, or greater experience, that people have about the facial expressions of their own social group. They may also derive from a stronger motivation to attend to, and process, expressions of individuals that belong to a group with which one self-identifies. These explanations cannot, however, account for middle-aged and older raters' attributions of less sadness to sad expressions of older posers. Sadness may become a more self-relevant emotion throughout adulthood when losses in various life domains gradually outweigh gains. One could therefore speculate that attribution of a lower intensity of sadness to sad older, as compared to sad young, faces may serve mood-regulatory functions in middle-aged and older adults. In addition, this effect may reflect age differences in subjective theories about how adults of different age groups experience and express episodes of sadness. Further research is necessary

to replicate these differences in the direction of own-age effects as a function of the facial expression, and to reveal the underlying mechanisms.

Importantly, only a subset of the age-of-poser \times age-of-rater effects was significant in this study, and all of the effects were small and therefore difficult to detect in studies with lower power. This may explain why previous research with forced-choice ratings, representing less sensitive measures, did not yield any such effects (Ebner & Johnson, 2009; Ebner et al., 2010). Furthermore, and similar to the study by Malatesta and colleagues (Malatesta, 1987), the own-age effects in the present study did not reverse the direction of any of the main effects of age of raters. That is, middle-aged and older raters never outperformed young raters, even when they rated expressions displayed by members of their own age group. Rather, our findings suggest that for neutrality, happiness, and anger, differences between age groups of raters may be overestimated when only expressions from young, but not middle-age and older, posers are considered, and that they may be underestimated in the case of sadness.

Summary and outlook

This study suggests that evaluations of emotional poses are often multi-faceted. Furthermore it demonstrates that the age of both the poser and the rater influence the reading of emotional poses. Among raters, there was an age-related *decrease* in the attribution of negative, but not positive and neutral, *target* expressions, and an age-related *increase* in attributions of positive and neutral, but not negative, *non-target* expressions. This pattern of findings is consistent with the idea of age-differential cognitive styles in attending to positive, and away from negative, information. Furthermore, reading posed facial expressions was more difficult the older the poser, particularly for male posers. These age-of-poser effects partly differed across age groups of raters: While some of the age-of-poser effects for neutrality, happiness, and anger were most pronounced in young raters, and attenuated (but never reversed) in

middle-aged and older raters, the opposite pattern emerged for sad expressions.

Future studies will have to explore whether the present results generalise to less intense facial expressions than the ones used in this study, to other modalities of emotional posing (e.g., voice or posture), and to spontaneous (i.e., non-posed) and dynamically changing expressions of emotional experiences. Moreover, whether the observed cross-sectional differences between age groups reflect cohort differences or generalise to within-person changes over time also remains to be investigated. Another important future research question pertains to potential implications that the age effects in reading emotional poses may have for the social lives of adults from different ages. Based on our findings, we argue that addressing these future research questions will benefit from using more sensitive measures than forced-choice paradigms, from varying the age of the posing as well as of the rating persons, and from investigating relevant effects with respect to both expressions that the poser intended to show and expressions that the poser did not intend to show.

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