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Effects of Age and Task Difficulty on Recognition of Facial Affect

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Current evidence suggests that older adults are less accurate than young adults in their ability to identify facial expressions of emotion. In the present study, young and older adults' ability to correctly recognize facial affect representative of 6 different emotions (happiness, surprise, disgust, fear, anger, and sadness) was examined in 3 conditions varying in difficulty. Task difficulty was measured by varying the number of labels available in a forced choice recognition task to 2, 4, and 6. Results showed that age differences were present in the 2 more difficult conditions for fear and sadness. Older adults were impaired in recognizing facial expressions of surprise only in the 4-label condition. Current findings suggest that task difficulty moderates age differences in emotion labeling. The present study has contributed to previous research by illuminating the conditions under which age differences in the accuracy of labeling of facial affect are more likely to be observed.

Key Words: Age—Emotion labeling—Facial emotion—Facial expressions—Labels.

THE idea that the ability to recognize facial affect may decline with age has attracted considerable attention by researchers (Suzuki, Hoshino, Shigemasu, & Kawamura, 2007). Several studies have found an age-related decline in the ability to identify fear, anger, and sadness (McDowell, Harrison, & Demaree, 1994). Other studies have found a linear reduction in the ability to recognize fear and anger with increasing age (Calder et al., 2003), whereas several reports demonstrate age-related emotion recognition impairments limited to an inability in identifying sadness (Suzuki et al.) and not other emotions.

Despite consistent evidence of age-related decline in the ability to recognize facial emotion, little is known about the variables that might interact with age. In the study by Isaacowitz and colleagues (2007), age differences in the recognition of emotion were dependent on the type of task used to assess emotion recognition accuracy, with tasks composed of a large verbal component more likely to be associated with age deficits. Emotion recognition tasks may be tapping cognitive rather than emotion processing, given the complex task demands associated with choosing one label from six overlapping constructs (Wieser, Muhlberger, Kenntner-Mabiala, & Pauli, 2006; but see Sullivan & Ruffman, 2004). This hypothesis would be consistent with previous studies suggesting that number of choices available in several cognitive tasks influences older adults' performance (Fozard, Vercryssen, Reynolds, Hancock, & Quilter, 1994).

In light of the limited number of studies devoted in investigating the hypothesis that the age effects may be task dependent, the present study examined whether age effects are influenced by number of labels available to choose from in an emotion-labeling task. The present study investigated whether the effects of age on emotion recognition ability are sensitive to type of emotion-labeling task (by varying the number of label choices between two, four, and six). I hypothesized that if number of labels influences age differences in labeling emotions, then older adults would show differential performance in emotion recognition across the two-, four-, and six-choice emotion-labeling tasks.

Methods

Participants

Eighty adults participated in this study. Forty participants (27 women and 13 men) were university undergraduate students ranging in age from 17 to 48 years (M = 22.35, SD = 6.06). Forty older participants (27 women and 13 men) were community residents, ranging in age from 60 to 82 years (M = 69.73, SD = 4.58). The two groups did not differ in terms of current health ratings, $t(78) = -.44$, $p > .05$, $d = -.10$ (M = 6.90, SD = 1.23 for young adults; M = 7.03, SD = 1.29 for older adults), or years of education, $t(78) = .73$, $p > .05$, $d = .05$ (M = 14.48, SD = 2.13 for young adults; M = 14.00, SD = 3.49 for older adults). Older adults (M = 1.76, SD = 0.14) exhibited a decline in their visual ability compared with young adults (M = 1.88, SD = 0.18), $t(78) = 4.20$, $p < .001$, $d = .83$, in the Pelli–Robson Contrast Sensitivity Test (Pelli, Robson, & Wilkins, 1988).

In order to screen all participants aged more than 60 years for possible dementia, the Mini-Mental State Examination was used (Folstein, Folstein, & McHugh, 1975). Participants were also assessed on the National Adult Reading Test (NART, Nelson, 1982). The old group (M = 12.78, SD = 5.24) made significantly fewer errors (indicating better performance) on the NART, $t(78) = 10.83$, $p < .001$, $d = 2.42$, compared with young group (M = 24.78, SD = 4.64). The young group (M = 60.03, SD = 9.95) significantly outperformed the old group (M = 48.50, SD = 9.05) on the Digit

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Table 1. Emotion Foils Presented in the two-, four-, and six-Choice Labeling Condition for Each Emotion

	Emotion					
Condition	Happiness	Surprise	Disgust	Fear	Anger	Sadness
2 Labels	Happiness	Surprise	Disgust	Fear	Anger	Sadness
	Surprise	Fear	Anger	Surprise	Disgust	Fear
4 Labels	Happiness	Fear	Disgust	Surprise	Disgust	Sadness
	Sadness	Anger	Fear	Fear	Fear	Happiness
	Anger	Happiness	Sadness	Sadness	Anger	Disgust
	Surprise	Surprise	Anger	Anger	Surprise	Fear
6 Labels	Happiness	Happiness	Happiness	Happiness	Happiness	Happiness
	Surprise	Surprise	Surprise	Surprise	Surprise	Surprise
	Disgust	Disgust	Disgust	Disgust	Disgust	Disgust
	Fear	Fear	Fear	Fear	Fear	Fear
	Anger	Anger	Anger	Anger	Anger	Anger
	Sadness	Sadness	Sadness	Sadness	Sadness	Sadness

Symbol Substitution Test assessing processing speed (Wechsler, 1981), $t(78) = 5.41$, $p < .001$, $d = 1.21$.

Materials and Procedure

Emotion-labeling task.—The facial images presented in the emotion-labeling task were taken from the Facial Expressions of Emotion: Stimuli and Tests (Young, Perrett, Calder, Sprengelmeyer, & Ekman, 2002). A total of 108 trials were presented depicting the six fundamental emotions. In order to ensure comparable difficulty across the subtasks, the distractor labels were selected from the most common errors made in response to each emotional expression (see Young et al.). These choices were based on the facial expression hexagon reflecting a sequence of facial expressions in which the facial cues are ordered by their maximum confusability, placing each adjacent to the one with which it is most likely to be confused (Young et al.). Table 1 presents the foils used in each emotion category and labeling condition (for details of the task, see Phillips, Channon, Tunstall, Hedenstrom, & Lyons, 2008).

Each trial consisted of the simultaneous presentation of the emotional expression (target) and the emotional labels (2 or 4 or 6) from which participants had to choose the label that best described the presented emotion. The presentation of emotional expressions, the number, and presentation of labels were random in every trial. Previous research in the emotion recognition literature (Elfenbein & Ambady, 2002) suggests that when employing multiple choice emotion identification tasks, it is necessary to correct emotion recognition accuracy percentages for the degree of accuracy expected due to chance guessing. Given that a small number of choices limits the range of percentage accuracy, a standard correction formula was used (see Nunnaly & Bernstein, 1994). It is further recommended by previous research (Elfenbein & Ambady) that a formula is used not only for the degree of accuracy due to chance guessing but also for the degree of accuracy due to response bias. In the current study, emotion recognition accuracy was corrected for response biases by calculating unbiased hit rates, which takes into consideration not only the percentage of accurate scores but also the confusion matrices indicating the pattern of errors (Wagner, 1993). These corrections were used in order to ensure that recognition accuracy was not influenced by response guessing or response bias effects. The formula used to calculate unbiased hit rates, described in detail by Wagner, was: $Hu = a^2/(a + b + c) \times (a + d + g)$, where a = number of correct identifications of happiness, b = number of identifications of happiness as surprise, c = number of identifications of happiness as disgust, d = number of identifications of surprise as happiness, and g = number of identifications of disgust as happiness (see Table 2 for an example of the confusion matrix developed). Because the correction formula yielded identical results as those based on the uncorrected data, for ease of interpretation, only analyses on the uncorrected data are reported. Average scores as a function of age, number of labels, and emotion can be seen in Table 3 for both the corrected and the uncorrected scores. For the emotion of happiness, results achieved ceiling effects for both age groups and all labeling conditions, so happiness was not analyzed further.

Results

Effects of Age and Labeling Condition on Emotion Recognition

Accuracy of emotion labeling (percentage correct) at the different levels of labeling was analyzed by conducting a 2 × 5 × 3 analysis of variance (ANOVA) with age as a between-subject factor and type of emotion and number of

Table 2. Example of Confusion Matrix

	Response		
Stimulus	Response 1	Response 2	Sum
Stimulus 1	a	b	$a + b$
Stimulus 2	c	d	$c + d$
Sum	$a + c$	$b + d$	$a + b + c + d$

Table 3. Percentage Hit Rate (H) and Unbiased Hit Rate (Hu) for the Emotion Labeling Task by Age Group, Emotion and Labeling Condition

		Emotion, mean (*SD*)											
		Happiness		Surprise		Disgust		Fear		Anger		Sadness	
Condition	Group	H	Hu	H	Hu	H	Hu	H	Hu	H	Hu	H	Hu
2 Labels	Young	97.81 (.99)	0.98 (.06)	90.63 (2.44)	0.79 (.05)	87.50 (2.97)	0.78 (.07)	71.56 (1.96)	0.66 (.07)	84.06 (2.10)	0.91 (.04)	84.69 (2.12)	0.80 (.07)
	Old	98.75 (.60)	0.94 (.05)	91.25 (2.29)	0.78 (.07)	92.50 (1.94)	0.79 (.06)	75.00 (2.28)	0.65 (.04)	86.88 (1.79)	0.83 (.07)	87.19 (1.87)	0.79 (.08)
4 Labels	Young	98.13 (.96)	0.92 (.06)	82.81 (1.76)	0.63 (.04)	82.19 (1.73)	0.83 (.03)	65.94 (1.67)	0.52 (.06)	76.88 (1.45)	0.70 (.05)	85.94 (1.86)	0.77 (.04)
	Old	96.88 (1.07)	0.86 (.07)	71.25 (1.80)	0.42 (.03)	82.81 (1.94)	0.84 (.04)	49.38 (1.67)	0.36 (.04)	81.25 (1.95)	0.67 (.06)	79.38 (1.52)	0.55 (.05)
6 Labels	Young	97.19 (1.05)	0.91 (.05)	80.94 (2.05)	0.64 (.05)	79.38 (1.76)	0.73 (.04)	65.63 (2.48)	0.59 (.05)	85.31 (1.48)	0.75 (.04)	80.94 (1.67)	0.82 (.06)
	Old	98.13 (.76)	0.85 (.04)	76.56 (2.16)	0.54 (.03)	83.44 (1.76)	0.79 (.05)	57.81 (2.18)	0.34 (.05)	85.31 (2.05)	0.77 (.04)	66.56 (1.52)	0.59 (.05)

labels as within-subject factors (Table 4). In order to explore the three-way interaction further, separate ANOVAs were conducted for each type of emotion with age group as a between-subject factor and number of labels as the within-subject factor. Follow-up analyses examining the Age × Emotion interaction revealed that older adults were worse in identifying surprise, fear, and sadness. The Age × Emotion × Label interaction revealed that older adults only had a poorer performance in the six-label condition for fear, $t(78) = 2.57$, $p < .05$, $d = .53$, and sadness, $t(78) = 5.56$, $p < .001$, $d = 1.24$, and in the four-label condition for surprise, $t(78) = 4.65$, $p < .001$, $d = 1.04$, fear, $t(78) = 7.00$, $p < .001$, $d = 1.54$, and sadness, $t(78) = 2.74$, $p < .01$, $d = .61$. No other significant differences were observed.

Discussion

In the present study, age differences in the identification of specific emotions were examined by varying task difficulty in an emotion recognition task and unlike analyses in previous studies, response biases in the recognition of facial emotion were systematically controlled. As hypothesized, the main effect of age was qualified by a set of interactions, suggesting that the pattern of age differences varied across task difficulty (number of labels) and across specific emotions. The results of the present study are consistent with the notion that older adults' deficiency in identifying facial representations of emotion does not reflect a general deficit

Table 4. Summary of Results of ANOVAs

Effect	*df*	*F*	η_p^2
Emotion[a]	4, 312	96.56***	.55
Emotion × Age[a]	4, 312	8.29***	.10
Emotion × Number of Labels[a]	8, 624	8.05***	.11
Emotion × Age × Number of Labels[a]	8, 624	3.69***	.05
Age[a]	1, 78	10.15**	.12
Surprise[b]	1, 78	8.44**	.10
Disgust[b]	1, 78	3.51	.04
Fear[b]	1, 78	14.15***	.15
Anger[b]	1, 78	2.18	.03
Sadness[b]	1, 78	14.05***	.15
Number of labels[a]	2, 156	75.85***	.49
Surprise[b]	2, 156	27.08***	.26
Disgust[b]	1.79, 139.48	10.56***	.12
Fear[b]	1.85, 144.64	34.62***	.31
Anger[b]	2, 156	8.91***	.10
Sadness[b]	2, 156	25.68***	.25
Age × Number of Labels[a]	2, 156	15.19***	.16
Surprise[b]	2, 156	4.42*	.05
Disgust[b]	1.79, 139.48	0.64	.01
Fear[b]	1.85, 144.64	13.24***	.15
Anger[b]	2, 156	0.82	.01
Sadness[b]	2, 156	11.51***	.13

Note: ANOVA = analysis of variance.

[a] Three-way ANOVA (Age × Emotion × Number of Labels).

[b] Two-way ANOVA for each of the five emotions (Age × Number of Labels).

*$p < .05$; ** $p < .01$; ***$p < .001$.

affecting all facial emotions and labeling conditions but a disproportionate impairment in the recognition of facial expressions of surprise in the four-label condition and in labeling sadness and fear in the four- and six-label conditions.

Current results showed that young and old adults performed equally well when identifying fear and sadness required choosing from two alternative labels. Importantly, performance in the two-label task failed to reach ceiling levels of accuracy for the emotions of fear, anger, and sadness; therefore, the absence of group differences cannot be attributed to a lack of test sensitivity. Present findings demonstrate that older adults are less likely to make errors in identifying facial emotion when presented with two alternative choices, suggesting that the effects of age on emotion recognition depend on the type of task used to assess recognition accuracy.

Older adults were impaired in their ability to identify facial expressions of surprise, consistent with reports of marginal effects of age in the recognition of surprise (Suzuki et al., 2007). The present study observed age differences in the identification of surprise only in the four-label condition, but not in the six-label condition, and it is likely that methodological artifacts of the task might explain the observed finding. However, previous studies also report inconsistent results in the identification of surprise. For example, Rorring, Hines, and Charness (2006) found age differences in the recognition of surprise, and Suzuki and colleagues have reported marginal age-related decline in the identification of surprise, whereas no other study reports age effects in the recognition of surprise. No age differences were found in the identification of facial expressions of anger, consistent with studies that did not report age-related deficits in identifying this facial emotion (Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006).

The present study demonstrated that decreasing the number of foils to two reduces the likelihood of age-related differences in labeling accuracy of facial expressions of affect. Current results are consistent with the notion that recognition of facial affect is preserved in several types of conditions with age. Current data suggest that task difficulty (as measured in the present study) moderates age differences in emotion labeling, specifically in the recognition of surprise, fear, and sadness. The emotions of fear and sadness are those that are most often associated with age effects, and the present study has demonstrated that the moderating effects of number of labels seem to reflect a type of environmental support. Specifically, for the most difficult items (the ones that older adults have the most problems identifying), performance becomes better as the number of possible interpretations is reduced, which in turn disproportionately benefits older adults.

In conclusion, present findings have demonstrated the importance of considering task parameters of emotion identification tasks when examining age-related differences in the ability to identify facial emotion. The results indicate that, when compared with young adults, older adults have more difficulty recognizing emotions in four- and six-label conditions but not when the number of labels presented is limited to two, where age differences are less likely to be observed. Therefore, current findings demonstrate that task difficulty needs to be carefully controlled when examining age differences in the ability to recognize facial emotion and that the observed age differences might reflect well-known age-related changes in cognition rather than emotion recognition per se. The present study has contributed to previous research by helping illuminate the conditions under which age differences in emotion recognition are most likely to occur.

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