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Facial expression recognition across the adult life span

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Abstract

We report three experiments investigating the recognition of emotion from facial expressions across the adult life span. Increasing age produced a progressive reduction in the recognition of fear and, to a lesser extent, anger. In contrast, older participants showed no reduction in recognition of disgust, rather there was some evidence of an improvement. The results are discussed in terms of studies from the neuropsychological and functional imaging literature that indicate that separate brain regions may underlie the emotions fear and disgust. We suggest that the dissociable effects found for fear and disgust are consistent with the differential effects of ageing on brain regions involved in these emotions.

Keywords: Fear; Disgust; Ageing; Emotion; Facial expression; Vocal expression; Amygdala; Insula; Basal ganglia

1. Introduction

It is well established that normal ageing causes a gradual decline in certain cognitive and perceptual functions [7,37], particularly the mental processes relating to so-called frontal tasks. These findings are generally attributed to neurological factors, such as the disproportionate effects of ageing on the prefrontal regions. The effects of ageing on emotion-related functions are less clear, and while this area has not been neglected, the majority of research has focused on the manner in which ageing affects the experience and regulation of emotion [21]. In general, these studies have found a reduction in the frequency of negative emotions expressed/experienced by older participants; in addition, some studies have also found corresponding increase for positive emotions. In the social cognition literature this is normally interpreted as an increased ability to regulate and control emotions with age. However, human emotional functioning does not only involve monitoring one's own emotional state, but also the emotions experienced by others. Consequently, it is important to examine the extent to which ageing affects the *recognition* of human signals of emotion.

On the basis of the social cognition research showing preserved, and even enhanced, experience and regulation of emotion in older participants, one might predict that recognition of emotion would show a similar benefit with age. Conversely, given the neurological decline associated with ageing, and its detrimental effects on certain aspects of cognition, it is possible that emotion recognition is adversely affected. As far as we are aware, however, few studies have investigated the recognition of facial expressions across different age groups of participants.

In one of these studies, Malatesta et al. [24] investigated the recognition of facial expressions of anger, fear and sadness, in three age groups of female participants—young (25–40 years), middle aged (45–60 years), and older (65–80 years). The results showed that the recognition of all three facial expressions decreased with increasing age. A second study, by Moreno et al. [26], contrasted the recognition of negative (sad and disgust) and positive (happy and surprise) facial expressions in female participants in similar age bands to those used by Malatesta et al. The results showed that, with increasing age, happiness improved slightly and sadness decreased slightly. The ceiling levels of recognition for disgust and surprise preclude clear interpretation of age effects for these expressions.

The general pattern that emerges from these studies is that recognition of certain facial expressions decreases with age, while the recognition of others remains relatively

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stable, or even improves. But exactly which facial expression categories are more affected than others is unclear because there is little consistency in the emotions tested. In addition, the fact that Moreno et al. [26] restricted their stimulus set to just four examples of each facial expression category makes it difficult to judge the effects of age on the recognition of the individual emotions.

At the time these two studies were conducted, the prevailing view in human neuropsychology was that all emotions were processed by a single integrated system. Consequently, less interest was shown in participants' recognition rates for individual emotion categories. Recent neuropsychological research, however, has highlighted the importance of assessing the recognition of the individual emotions effectively because it is now clear that damage to different neural regions can affect the recognition of certain emotions more than others (for a recent review see [10]. For example, bilateral amygdala damage impacts primarily on peoples' ability to recognise signals of fear and, to a lesser extent, anger [1,11,38,43]. In contrast, Huntington's disease, an autosomal genetic disorder that principally affects the striatal regions of the basal ganglia, can cause a disproportionately severe impairment in recognising disgust [16,41]. Similarly, Calder et al. [9] have recently reported a case-study of a patient who shows a highly selective deficit in recognising facial and vocal signals of disgust following damage to the left insula and basal ganglia. The above findings are supported by recent brain-imaging research showing that viewing facial expressions of fear engages the amygdala [5,27,44], whereas viewing facial signals of disgust produces increased signals in the insula and basal ganglia [33,34,40].

A clear message of these studies is that investigations of facial expression recognition should use tests that tap individual basic emotions. Consequently, our present study used tests that were originally used in a number of the neuropsychological studies discussed [6,9,23,41,42]. In an initial exploratory study (Experiment 1) we compared the recognition of facial affect in younger (20–30 years) and older (60–70 years) age groups. Experiments 2a and 2b provide detailed assessments of facial expression recognition across the full range of adult ages between 20–75 years.

2. Experiment 1

2.1. Method

2.1.1. Participants

Forty-eight participants from the MRC Cognition and Brain Sciences Unit volunteer panel took part in the experiments for payment. Half ($n = 24$) of the participants were aged between 18 and 30 years (mean age = 25.00 years, S.D. = 3.84), and half were aged between 58 and 70 years (mean age = 65.08 years, S.D. = 3.84). Each age group contained equal numbers of men and women ($n = 12$). Participants in the two groups were matched for estimated IQ (NART-R) [30] (younger participants, mean IQ = 113.21, S.D. = 7.22; older participants, mean IQ = 114.08, S.D. = 10.49). A *t*-test comparison (equal variance not assumed) of the younger and older participants' IQ scores produced no significant difference ($P > 0.5$). All participants had normal or corrected-to-normal vision and no known neurological damage.

2.1.2. Materials

Photographs of six facial expressions (happiness, sadness, anger, fear, disgust and surprise), posed by each of 10 models (six female, four male), were taken from Ekman and Friesen's [12] pictures of facial affect series; a total of 60 pictures. The 10 models were selected so that each emotion was well recognised in Ekman and Friesen's [12] norms.

2.1.3. Design, and procedure

The faces were presented individually in random order on a computer monitor and participants were asked to select one of the six expression labels (listed above) that best described the emotional expression. The labels were visible throughout testing and participants were given as much time as they needed to make their selection. No feedback was given regarding the appropriateness of any response.

2.2. Results

Participants' mean correct recognition rates are summarised in Fig. 1. The correct recognition rates were submitted to an ANOVA with Greenhouse–Geisser corrections. The factors of interest were emotions tested anger, disgust, fear, happy, sad, and surprise; repeated measures), age group (younger and older participants; between subjects), and sex of participant (between subjects). The results of these analyses are described below. The results of the ANOVA showed a significant main effect of emotion, $F(3.6, 167) = 25.68$, $P < 0.0001$, qualified by a significant interaction between emotion and age group, $F(3.6, 167) = 8.73$, $P < 0.0001$. There was also a border-

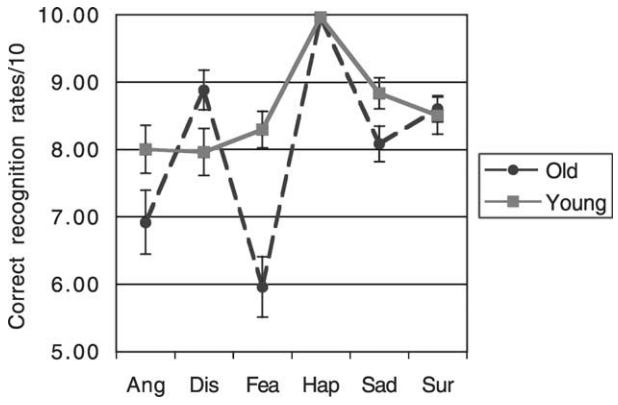

Fig. 1. From Experiment 1: younger and older participants' correct recognition rates for the Ekman 60 test of facial expression recognition [46]. Error bars show standard errors.

line effect of age group, $F(1, 46) = 4.55$, $P = 0.04$. No other effects reached statistical significance. The source of the interaction effect was investigated using *t*-test comparisons (equal variance not assumed). The results indicated that older participants showed significantly worse recognition of fear ($t(37.5) = -4.46$, $P < 0.0001$) and, to a lesser extent, sadness ($t(45.2) = -2.02$, $P < 0.05$), however, their recognition of disgust ($t(44.6) = 2.20$, $P < 0.05$) was significantly better than younger participants. No other comparisons reached statistical significance.

It was possible that the older participants' improved recognition of disgust was simply a consequence of them using the "disgust" label as a default response for expressions that they were unsure of. To address this we compared the number of times the older and younger participants mis-labelled facial expressions as 'disgust' (i.e. disgust false positives). A *t*-test comparison of these data showed no significant difference between the younger and older participants, $t(42.5) = -0.67$, $P > 0.5$, and hence, provided no support for the default-label interpretation.

2.3. Discussion

Experiment 1 found that older participants showed a disproportionate problem in recognising facial expressions of fear. A less marked impairment was also evident for sadness, whereas older participants' recognition of disgust showed a slight improvement.

Following on from the findings of this initial experiment, Experiments 2a and b investigated the effects of ageing on the recognition of emotion in a larger sample of participants whose ages spanned the full range between 20 and 75 years. This allowed us to address whether the elderly participants' reduced recognition of fear reflected a gradual linear decline or a sudden onset impairment at a particular age. Likewise, it allowed us to address whether the less marked effect of improved disgust recognition in older participants would (i) persist in a larger sample, and (ii) show a linear effect.

3. Experiments 2a and 2b

Experiment 2a used the test described in Experiment 1a (Ekman 60), whereas Experiment 2b used a second test of facial expression recognition (Emotion Hexagon) that has also been used in previous research with brain injured populations [8,11,41–43]. To facilitate interpretation, the results of Experiments 2a and 2b [46] are presented in the same section.

3.1. Experiment 2a: Ekman 60

3.1.1. Method

3.1.1.1. Participants. Two hundred and twenty-seven participants took part in the experiment for payment. The majority ($n = 162$) were from the Cognition and Brain Sciences Unit's volunteer panel; the remainder ($n = 65$) were tested at the University of Bochum, Germany. Participants were aged between 17 and 70 years and were divided into five age groups (17–30, 31–40, 41–50, 51–60, and 61–70 years). Table 1 shows the mean age, mean IQ (NART-R), and breakdown of males and females for each group. All participants had normal or corrected-to-normal vision and no known neurological damage.

Table 1
Mean age, mean IQ, and breakdown of male and female participants in the five age groups from Experiments 2a and 2b

Age group	Females/males	Mean age (S.D.)	Mean IQ (S.D.)
Experiment 2a			
17–30 years	36 female/37 male	24.30 (3.20)	112.97 (8.97)
31–40 years	20 female/12 male	35.00 (2.69)	112.19 (8.22)
41–50 years	17 female/12 male	46.79 (3.02)	109.59 (9.49)
51–60 years	19 female/16 male	56.40 (2.37)	109.31 (11.08)
61–70 years	32 female/26 male	65.24 (2.99)	113.40 (10.18)
Experiment 2b			
18–30 years	14 female/14 male	23.93 (2.85)	112.86 (7.93)
31–40 years	11 female/12 male	34.52 (2.83)	110.22 (8.94)
41–50 years	15 female/14 male	47.24 (2.37)	110.97 (9.84)
51–60 years	11 female/11 male	55.18 (2.65)	109.73 (12.82)
61–75 years	12 female/11 male	66.48 (4.51)	109.00 (11.49)

Standard deviations are shown in brackets.

The materials, design and procedure were identical to those used in Experiment 1.

3.2. Experiment 2b: Emotion Hexagon

3.2.1. Method

3.2.1.1. Participants. One hundred and twenty-five participants took part in the experiment for payment. The majority ($n = 86$) were tested at the University of Bochum, the remainder were from Cognition and Brain Sciences Unit's volunteer panel. Participants were aged between 20 and 75 years and were divided into five age groups (20–30, 31–40, 41–50, 51–60, and 61–75 years). Table 1 shows the mean age, mean IQ (NART-R), and breakdown of males and females for each group. All participants had normal or corrected-to-normal vision. Sixty-seven of the participants had also taken part in Experiment 2a.

3.2.1.2. Materials. For Experiment 2b we used the 'Emotion Hexagon' task, an experiment containing morphed (blended) facial expressions posed by model JJ from the Ekman and Friesen [12] pictures of facial affect series. A detailed description of the test can be found in Calder et al. [11]. Briefly, the test comprises morphed (or blended) continua ranging between the following six expression pairs, happiness–surprise, surprise–fear, fear–sadness, sadness–disgust, disgust–anger, anger–happiness. Each continuum consists of five morphed images blended in the same proportions. For example, the images in the happy–surprised

continuum contain the following percentages of the happy and surprised expressions, 90% happy–10% surprise, and then 70–30%, 50–50%, 30–70%, and 10–90% of the same two expressions. Data from neurologically intact participants show that stimuli that contain 90 or 70% of an expression are consistently identified as the intended emotion [11,41,47]. The stimulus set consists of 30 images in total (six continua × five morphed faces).

3.2.1.3. Design and procedure. The 30 morphed images were presented individually on a computer monitor in random order (i.e. they were not grouped into the underlying continua). The task was to decide which of six emotion labels (happy, sad, anger, fear, disgust, and surprise) best described the facial expression displayed. The labels were visible throughout testing and participants were given as much time as they needed to make their selection. No feedback was given regarding the appropriateness of any response. Participants undertook a total of six blocks of trials. Each block contained one presentation of each of the 30 morphed faces in random order. The first block of trials was discounted as practice, leaving five blocks of 30 trials for analysis.

Performance on the Emotion Hexagon was assessed as follows. The 30 morphed faces were divided into six sections containing morphs that the controls consistently identified with one of the six expression labels. Each expression region comprised four morphs, two of these contained 90% of the target expression and the other two 70%, for example, the surprise section contained the morphs 70% surprised–30% happy, 90% surprised–10% happy, 90% surprised–10% afraid, and 70% surprised–30% afraid. Performance was based on five presentations of each image, giving a total score out of 20 for each emotion.

3.2.2. Results and discussion

The data from Experiments 2a and 2b were analysed in an identical fashion and showed similar patterns of results. Consequently, the results of these analyses are discussed together.

The IQ scores for the five age groups from each experiment were submitted to separate univariate ANOVAs with age group (20–30, 31–40, 41–50, 51–60, and 61–70 years (or 61–75 years, Experiment 2b)), as the factor of interest. Neither experiment showed any significant effect of age group, Experiment 2a, $F(4, 222) = 1.63$, $P > 0.1$; Experiment 2b, $F < 1$. Hence, any differences among age groups' recognition of facial expressions are unlikely to be caused by differences in IQ.

The mean correct recognition rates for the six facial expression categories, broken down by age group, are summarised in Fig. 2 for the Ekman 60, and in Fig. 3 for the Emotion Hexagon. For each experiment the participants' correct recognition rates for the individual facial expressions were submitted to a three-factor repeated measures ANOVA with Greenhouse–Geisser corrections. The factors of interest were emotion (anger, disgust, fear, happy, sad, and surprise; repeated measure), age group (20–30, 31–40, 41–50, 51–60, and 61–70 (or 61–75, Experiment 2b) years; between subjects), and sex of participant (between subjects). For Experiment 2a (Ekman 60) the results showed a significant main effect of emotion, $F(4.2, 910) = 65.97$, $P < 0.0001$, qualified by a significant interaction between emotion and age group, $F(16.8, 910) = 2.70$, $P < 0.0001$. Experiment 2b (Emotion Hexagon) showed a similar pattern of results—a significant main effect of emotion, $F(4, 462) = 18.98$, $P < 0.001$, and a significant interaction between emotion and age group, $F(16.1, 462) = 2.32$, $P < 0.005$. No other effects reached statistical significance in either analysis.

To identify the source of the interaction between emotion and age group in each experiment, the recognition rates for each emotion were examined using separate two-way univariate ANOVAs examining age group and sex. In each ANOVA, the age group factor was submitted to polynomial contrasts. The results of these analyses are summarised in Table 2; none of the non-linear contrasts reached statistical significance and, hence, are not reported.

Table 2 shows that for both experiments, correct recognition rates for facial expressions of fear showed a significant

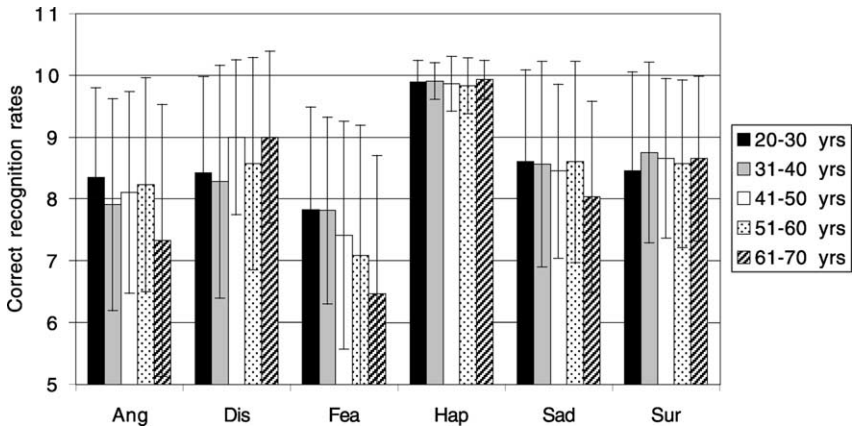

Fig. 2. From Experiment 2a: correct recognition rates for the Ekman 60 facial expression test across five age groups of participants. Error bars show standard deviations.

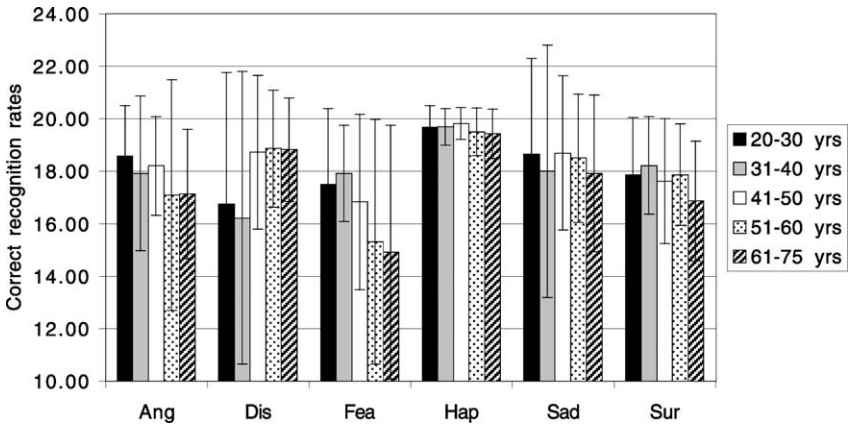

Fig. 3. From Experiment 2b: correct recognition rates for the Emotion Hexagon (morphed facial expression) test across five age groups of participants. Error bars show standard deviations.

decrease with increasing age. Moreover, for both the Ekman 60 and Emotion Hexagon this was expressed as a significant linear trend across the five age groups. The Emotion Hexagon data also showed a main effect of sex for the fear ANOVA. This reflected poorer recognition of this emotion by male participants, however, both males and females showed the same linear reduction. The recognition of facial signals of anger also showed evidence of a similar pattern of worsening performance with increasing age. However, that the anger effect was marginal for the Emotion Hexagon task in the form of a non-significant main effect of age group ($P = 0.25$) but a significant linear trend ($P < 0.05$). In the context of these effects for fear and anger, it is interesting that both experiments also showed that recognition of facial signals of disgust *improved* with increasing age; although the effect was less marked for Experiment 2a (Ekman 60) which showed a borderline main effect of age group ($P = 0.11$) but a significant linear trend ($P < 0.05$).

The disgust data suggest that the reduction in correct recognition of fear with increasing age is unlikely to be a consequence of a general cognitive impairment affecting the recognition of the more difficult to recognise facial

Table 2
Top half: summary of the results of the individual ANOVAs investigating the effect of age group across the five age groups in Experiment 2a. None of the analyses showed significant interactions between age group and sex (all $F < 1.2$, $P > 0.3$). Hence, the *F*-values for the interaction terms are not included. Bottom half: summary of the results of the individual ANOVAs investigating the effect of age group across the five age groups in Experiment 2b. None of the analyses showed significant interactions between age group and sex (all $F < 1.7$, $P > 0.1$). Hence, the *F*-values for the interaction terms are not included. Effect sizes for the main effect and linear contrasts (partial eta-squared, η_p) of the age factor in both experiments are also shown

	Sex (*F*)	Age group		Age group linear contrast	
		F	(η_p)	β	(η_p)
Experiment 2a					
Dfs	1,217	4,217			
Anger	<1	2.96*	0.05	−0.58*	0.03
Disgust	<1	1.89^{ns}	0.03	0.44*	0.02
Fear	<1	4.96***	0.08	−1.12***	0.08
Happy	<1	<1		–	
Sad	<1	<1.27^{ns}		–	
Surprise	<1	<1		–	
Experiment 2b					
Dfs	1,115	4,115			
Anger	<1	1.36^{ns}	0.04	−1.19*	0.04
Disgust	<1	2.63*	0.08	2.16**	0.06
Fear	5.04*	3.23*	0.10	−2.49***	0.09
Happy	<1	<1		–	
Sad	<1	<1		–	
Surprise	1.86^{ns}	1.35^{ns}		–	

ns = not significant.
* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

expressions. However, the observation that facial signals of fear are more difficult to recognise than other facial signals has been noted elsewhere [35]. So to address the level-of-difficulty interpretation formally, we compared the participants' total scores on each facial expression test for all emotions *excluding fear* (the emotion that showed the most marked effect of age). If the fear deficit observed was caused by general cognitive decline, then a reduction in participants' recognition of other expressions might be expected. This was assessed using separate univariate ANOVAs comparing the participants' total-excluding-fear scores across the five age groups. Neither ANOVA showed any evidence of a significant decline with age (Experiments 2a and 2b, $F < 1$), providing further support for the idea that participants' recognition of fear was not caused by a general cognitive decline.

4. General discussion

Both experiments showed that with increasing age, participants demonstrated less accurate recognition of facial signals of fear, and to a lesser extent sadness (Experiment 1) and anger (Experiments 2a and 2b), whereas some improvement was observed in older participants' recognition of facial signals of disgust (Experiments 1 and 2a and 2b).

The effects of age observed were not large, however, they were significant and consistent. Moreover, in the case of fear, Experiments 2a and 2b showed a definite linear reduction in the recognition of this emotion with increasing age, beginning at around 40 years of age. For disgust there was some evidence of the reverse pattern, although Figs. 2 and 3 show that this effect is most evident between the youngest and oldest age groups. In other words the disgust effect is not the converse of the effect found for fear. Consequently, it seems more appropriate to interpret the effect for disgust as evidence of *preserved* recognition of disgust with increasing age, rather than evidence of an improvement.

As discussed in Section 1, a number of studies have shown that the recognition of fear and disgust may be served by separate neural substrates with the amygdala being particularly associated with fear, and the insula and basal ganglia regions with disgust (for a recent review see [10]). However, there is also evidence of exceptions to this pattern. For example, not all functional imaging studies of disgust have activated the insula and basal ganglia [15], and there is evidence of amygdala activation for emotions other than fear [4,5]. Consequently, the neural substrates of emotion are clearly more complicated than a straightforward division between fear and disgust. However, given that functional imaging data are inherently noisy, it is important that a recent meta-analysis of the neuroanatomy of emotion has found that fear is primarily associated with the amygdala, while disgust is associated most with the basal ganglia [31]. Disgust was also found to be associated with the insula, but no more so than sadness and fear; although no distinction was made between the different insular regions. The evidence to date, then, is largely consistent with a significant degree of separability between the neural substrates of fear and disgust.

In light of this dissociation, it is interesting that we have found different effects of ageing on the recognition of these two emotions. It is also worth noting that the decline in older participants' recognition of angry facial expressions (Experiments 2a and 2b) concurs with the observation that impaired recognition of fear, seen in patients with bilateral amygdala damage, is often accompanied by lesser impairments affecting the recognition of facial signals of anger [2,11]. Moreover, in addition to the numerous functional imaging studies showing a role for the amygdala in processing facial signals of fear, there is evidence of an amygdala response to facial expressions of anger [45].

5. Emotion recognition and the neuropathology of ageing

Given the association between the amygdala and fear it is relevant that a number of studies have shown that medial temporal pathology is a consequence of normal ageing [25,29]. For example, neurofibrillary tangles and senile plaques, the histopathological hallmarks of Alzheimer's disease, are found in less frequent numbers in the amygdalae of normal elderly brains [3,25]; other areas that are similarly affected include the hippocampus and entorhinal cortex. In addition, there is evidence that the amygdala/hippocampal regions show age-related loss of neurons and neuronal atrophy [29] (see also [36]), while structural MRI data show a significant age-related reduction in medial temporal (amygdala/hippocampus) volume [22,28,39]. These observations concur with recent functional imaging research demonstrating that older participants show reduced amygdala activation to negative facial expressions in comparison to younger participants [20].

Numerous other brain areas are affected by normal ageing, however, with frontal cortex showing the largest reduction in volume [36]. Consequently, it is possible that the effects we have observed are caused by changes in frontal cortex functioning with age. Somewhat against this account, Phillips et al. [32] have presented a recent review of the effects of normal ageing on frontal cortex and frontal tasks in which they propose that the areas of prefrontal cortex associated with emotion processing, the ventromedial regions, show relatively little evidence of age effects until around the seventh decade. Rather, it is dorsolateral areas of prefrontal cortex, associated more with cognitive tasks, that show the largest impact from around 30 years of age onwards. Hence, it is perhaps unlikely that the observed linear decline in fear recognition could be accounted for in terms of frontal cortex pathology.

Phillips et al.'s [32] observations also suggest that individuals older than the maximum age groups in our experiments (Ekman 60, 60–70 years; Emotion Hexagon, 60–75

years) should show a more widespread and severe reduction in their recognition of facial expressions. This concurs with the finding that damage to ventromedial frontal lobes results in a general facial expression recognition impairment affecting a number of emotions [19,23].

An interpretation of our data in terms of the neuropathology of ageing would not only have to account for the linear decline in fear recognition, but also the decided absence of any change (or slight improvement) in older participants' recognition of disgust. It is therefore important to consider the effects of normal ageing on the insula and the basal ganglia, the two regions that have been identified as important for processing facial expressions of disgust. With regard to the insula, there is evidence that its anterior section shows accelerated loss of grey matter volume with normal ageing [14]. In contrast, postmortem and in vivo studies of the basal ganglia and diencephalon indicate that while ageing exerts moderate negative effects on the gross structure and neurochemistry of the neostriatal nuclei (i.e. caudate and putamen), the paleostriatum (i.e. globus pallidus) is largely spared [36]; although see [17] for some evidence of age effects on globus pallidus volume in men but not women. The relative sparing of the globus pallidus is particularly relevant when we consider that a recent meta-analysis of functional imaging studies exploring the neural correlates of viewing disgust facial expressions found that the majority of points of maximal activation fell in the region of the right globus pallidus/putamen [10].

6. Alternative interpretations

Although the differential effects of ageing on the human brain can provide one interpretation of the data presented, we acknowledge that other interpretations are possible. One, that we have attempted to address is level of difficulty, brought about by the increased cognitive decline associated with ageing. We have suggested that this is unlikely because of the small increase observed in participants' recognition of disgust, and absence of any effect of age on an accumulative score across all emotions except fear. Yet, despite these factors, it is not inconceivable that general decline could result in a disproportionate fear impairment. For example, one possibility stems from the fact that fear is often confused with surprise, while the reverse confusion is much less frequent. Ageing may enhance this confusion due to deterioration of general perceptual function (facial signals of fear and surprise are physically similar) or higher order mechanisms (fear and surprise are conceptually similar). Consequently, it would be interesting to determine whether the age effects we have found for fear persist for a forced-choice task that does not include surprise, or tasks that do not rely on the forced-choice procedure [1,2].

Finally, it is worth returning to the sociocognitive research we discussed in the introduction. This has shown that older participants express and experience fewer negative, but not positive, emotions. These findings are generally interpreted as an enhanced ability to control and regulate emotions with age [21]. However, given that our findings, and those of others [24,26], show impaired recognition of certain negative emotions with age, it is possible that the same mechanisms may account for changes in older people's recognition and expression/experience of particular negative emotions. In other words, it may be more appropriate to interpret the expression/experience data as *reduced* processing of certain negative emotions rather than as enhanced general emotional functioning.

The effects we have observed for disgust would suggest that not all negative emotions are affected. In line with this observation it is of interest that other research in social psychology has linked heightened disgust sensitivity, as measured with Haidt et al. [18] disgust sensitivity questionnaire with increased awareness of ones own mortality [13]. While we are not aware of any research examining disgust sensitivity in older participants, the mortality awareness research is consistent with our own observation that individuals closer to the end of their lives showed increased correct recognition rates for disgust in facial expressions.

In summary, the reduced recognition of afraid facial expressions, in the context of intact, and even improved, recognition of disgust facial expressions, seen in older participants, could very well relate to the differing effects of ageing on particular neural systems involved in recognising fear and disgust. Moreover, it is possible that the reduced expression/experience of negative emotions shown by older participants in the sociocognitive studies might be caused by the same underlying aetiology that affects older participants' recognition of negative emotions, but in particular fear.

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