Recognition of disgust is selectively preserved in Alzheimer’s disease

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Abstract

The neural substrates that subserve decoding of different emotional expressions are subject to different rates of degeneration and atrophy in Alzheimer’s disease (AD), and there is therefore reason to anticipate that a differentiated profile of affect recognition impairment may emerge. However, it remains unclear whether AD differentially affects the recognition of specific emotions. Further, there is only limited research focused on whether affect recognition deficits in AD generalize to more ecologically valid stimuli. In the present study, relatively mild AD participants (n = 24), older controls (n = 30) and younger controls (n = 30) were administered measures of affect recognition. Significant AD deficits were observed relative to both the younger and older control groups on a measure that involved labeling of static images of facial affect. AD deficits on this measure were observed in relation to all emotions assessed (anger, sadness, happiness, surprise and fear), with the exception of disgust, which was preserved even relative to the younger adult group. The relative preservation of disgust could not be attributed to biases in the choice of labels made, and it is suggested instead that this finding might reflect the relative sparing of the basal ganglia in AD. No significant AD effect was observed for the more ecologically valid measure that involved dynamic displays of facial expressions, in conjunction with paralinguistic and body movement cues, although a trend for greater AD difficulty was observed.

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1. Introduction

In the neuropsychological literature, considerable emphasis has been placed on the potential role of dissociable neural substrates in recognizing specific emotions (Adolphs, Tranel, Damasio, & Damasio, 1994; Calder, Keane, Lawrence, & Manes, 2004). For instance, when it comes to facial expressions, the orbitofrontal cortex and the ventral striatum have been particularly linked to decoding expressions of anger (Blair & Cipolotti, 2000; Blair, Morris, Frith, Perrett, & Dolan, 1999; Fine & Blair, 2000; Iidaka et al., 2001; Sprengelmeyer, Rausch, Eysel, & Przentek, 1998), the amygdala (Adolphs & Tranel, 2004; Blair et al., 1999; Breiter et al., 1996; Lennox, Jacob, Calder, Lupson, & Bullmore, 2004; Yang et al., 2002), fusiform gyrus (Surguladze et al., 2003, 2005), and the anterior cingulate cortex (Blair et al., 1999; Killgore & Yurgelun-Todd, 2004; Lennox et al., 2004; Phan, Wager, Taylor, & Liberzon, 2002) to sadness, and the basal ganglia and insula to disgust (Calder, Keane, Manes, Antoun, & Young, 2000).

In Alzheimer’s disease (AD), prominent atrophy and tau deposition is observed in limbic regions (including the amygdala), as well as temporal and frontal neocortices with subcortical structures such as the basal ganglia typically less affected until later in the disease process (Boller & Duykaerts, 2003; Braak & Braak, 1991; Delacourte et al., 1999; Hyman & Gomez-Isla, 1998). Thus, because the neural substrates that subserve decoding of different emotions are subject to different rates of degeneration and atrophy in AD, a differentiated profile

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of affect recognition impairment may be anticipated. In support of this prediction, Rosen et al. (2006) found that poor recognition of anger, sadness and fear in a mixed dementia sample was associated with specific regional grey matter shrinkage in areas of the temporal lobes. Although this study does not provide direct evidence for such a link in AD in that Rosen et al.'s sample included heterogeneous dementia diagnoses, it does provide grounds for thinking that a differentiated profile of affect recognition might exist in AD due to different rates of brain change.

Importantly, differential difficulty recognizing specific emotions has been observed in normal aging and has been linked to brain changes (e.g., Calder et al., 2003; Sullivan & Ruffman, 2004a; Sullivan & Ruffman, 2004b). In a meta-analytic review of this literature, Ruffman et al. (in press) concluded that the predominant pattern across all emotions and modalities was of age-related decline, that recognition of anger and sadness was particularly impaired, but that older adults may be better at recognizing facial expressions of disgust compared to young adults. Age-related neural volume loss occurs earliest and most rapidly in frontal and temporal lobe structures (Allen, Bruss, Brown, & Damasio, 2005; Grieve et al., 2005; Raz, 2000), with the orbitofrontal cortex experiencing particularly rapid decline (Convit et al., 2001; Lamar & Resnick, 2004; Raz et al., 1997; Resnick, Pham, Kraut, Zonderman, & Davatzikos, 2003), and the anterior cingulate cortex also experiencing consistent decline (Convit et al., 2001; Garraux et al., 1999; Ohnishi, Matsuda, Tabira, Asada, & Uno, 2001; Pardo et al., 2007; Petit-Taboué, Landeau, Desson, Desgranges, & Baron, 1998; Resnick et al., 2003; Tisserand et al., 2002). There are also consistent volume reductions in temporal areas such as the amygdala (Allen et al., 2005; Grieve et al., 2005; Mu, Xie, Wen, Weng, & Shuyun, 1999; Tisserand, Visser, van Boxtel, & Jolles, 2000; Wright, Wedig, Williams, Rauch, & Albert, 2006; Zimmerman et al., 2006). Ruffman et al. (in press) therefore related age-related difficulties identifying anger to changes in the orbitofrontal region, sadness to changes in the anterior cingulate cortex and temporal areas such as the amygdala, and fear to changes in the amygdala. In contrast, the relative sparing of some structures within the basal ganglia are argued to underlie the absence of deficits recognizing disgust (Calder et al., 2003; Williams et al., 2006).

Only three studies have assessed how AD affects recognition of each of the six basic emotions relative to age-matched controls (Burnham & Hogervorst, 2004; Hargrave, Maddock, & Stone, 2002; Lavenu, Pasquier, Lebert, Petit, & Van der Linden, 1999). Whilst the results for individual emotions were generally inconsistent, only deficits recognizing fear and sadness were identified in more than one study, providing some support for the notion that different emotions may be subject to differential rates of decline in AD. In terms of potential reasons for the inconsistencies, these AD studies used a variety of facial affect recognition stimuli. Since Ekman and Friesen’s (1976) Pictures of Facial Affect are the most widely used stimuli, Edwards, Jackson, and Pattison (2002) advise that facial affect recognition studies should use these stimuli to increase the comparability of their results. However, Hargrave et al. (2002) used photographs from a different stimulus set. This study also included a relatively small predominantly female control sample (n = 14), and a larger, but predominantly male AD sample (n = 22). Whilst Lavenu et al. (1999) used Ekman and Friesen’s stimuli, only four exemplars of each emotion were shown, and again, a relatively small control sample (n = 12) was used. Burnham and Hogervorst (2004) also used Ekman and Friesen stimuli, but again, a relatively small number of participants were sampled (13 AD and 13 controls). Thus, it seems likely that prior inconsistencies may reflect artefactual variance, but also substantive differences in terms of the nature and number of stimuli used.

The present study was the first to use the well validated Ekman 60 Faces Test (Young, Perret, Calder, Sprengelmeyer, & Ekman, 2002) to index facial affect identification in an AD population. The images in this measure are taken from the Pictures of Facial Affect and consist of 10 models expressing each of the six basic emotions. Further, in addition to age-matched controls, the present study was the first to also include a younger control group. This provides a unique point of comparison by assessing how difficulties decoding specific emotions vary across AD, older and younger groups. Of particular interest is whether the AD and younger groups differ with regard to the recognition of disgust, given the noted relative preservation of the basal ganglia in AD, which has been argued to underpin intact (and possibly even enhanced) disgust recognition in older adulthood (Ruffman et al., in press).

Finally, virtually all studies to date that have investigated affect recognition in relation to AD have used static stimuli. Where AD deficits have been reported in relation to other emotion cues such as auditory and paralinguistic cues (Allender & Kasznia, 1989; Bucks & Radford, 2004; Koff, Zaitchik, Montepare, & Albert, 1999; Testa, Beatty, Gleason, Orbelo, & Ross, 2001), different emotion cues were presented in isolation of one another. Thus, the final aim was to test how AD impacts on affect recognition using a more ecologically valid measure that integrates different affective cues. In addition to being of theoretical interest, assessment of this issue has potentially important practical implications since such stimuli represent a better approximation of real-life emotion recognition processes.

2. Methods

2.1. Participants

Eighty-four community dwelling adults in Sydney participated, 24 of whom met DSM-IV and NINCDS-ADRDA criteria for AD, 30 of whom were older adults matched demographically to the AD participants, and 30 of whom were younger adults. Demographic characteristics for all three groups are presented in Table 1. The AD participants were recruited via geriatricians based at hospitals in Sydney. The older control participants were either partners of the AD participants, or volunteers recruited from the general community, and did not differ significantly in age, t(52) = 0.51, p = 0.61, or years of education, t(52) = 0.51, p = 0.62, from the AD participants. Some of the younger control participants were recruited from the general community, and others were undergraduate students who took part in return for course credits. The three groups did not differ significantly in gender (50, 53 and 43% male, respectively). Exclusionary criteria for all participants were the presence of uncorrected hearing or visual loss, psychotic symptoms, and a history of substance abuse. An additional exclusionary criterion for the older control participants was a Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) score of less than 27. For the AD...
2.2. Procedure and measures

Ethics approval was obtained from Northern Sydney Central Coast NSW Health and South Eastern Sydney Area Health Service—Eastern Section. All participants gave informed consent and then completed a brief demographics form, which was then followed by the emotion and facial affect recognition measures, which were presented in a counterbalanced order. All older control and AD participants additionally completed the Australian version of the Revised Addenbrooke’s Cognitive Examination (ACE-R; Mathuranath, Nestor, Berrios, Rakowicz, & Hodges, 2002).

The ACE-R assesses six cognitive domains; orientation, attention, memory, verbal fluency, language and visuospatial ability, and thus quantifies general cognitive status. The ACE-R has been shown to have high reliability, construct validity and sensitivity to the presence of dementia (Mathuranath et al., 2000). Scores range from 0 to 100, with a score of 83 or less (out of 100) suggestive of potential cognitive deficits. The ACE-R Total score (which represents an elaboration of the MMSE) was used to provide an estimate of overall cognitive functioning (Lezak, Howieson, & Loring, 2004).

To index perceptual difficulties, and specifically, more generalized impairment recognising components of facial processing, the Benton Test of Facial Recognition (Benton, Hamsher, Varney, & Spreen, 1983) was used to index facial identity recognition. In this task participants are shown a photo of a target face, along with six other faces. In the first part (slides 1–6) the participant must identify which one of the six faces is the same person as the target face. In the second part (slides 7–13) the participant must identify which three of the six faces is the same person as the target face. The dependent measure is the number of correct identity recognitions made.

Two different measures were used to assess affect recognition. The Ekman 60 Faces Test from the FEEST (Young et al., 2002) was used to measure facial affect identification. In this computer task a total of 60 photos of faces are presented in a random order for five seconds each, with 10 photos for each of the six basic emotions from the Ekman and Friesen (1976) series (happiness, surprise, fear, sadness, disgust, anger). Participants are required to choose the label that best describes the emotion displayed by each face. The FEEST has been shown to be a reliable and valid measure of emotion recognition (Young et al., 2002).

To provide a more ecology valid index of affect recognition, the Emotion Evaluation Test from The Awareness of Social Inference Test (TASIT; McDonald, Flanagan, Rollins, & Kinch, 2002) was used. This measure is presented on video, and comprises 28 vignettes that are between 15 and 60 s long, in which a professional actor portrays one of seven basic emotional states (happy, sad, fearful, disgusted, surprised, angry, neutral). The professional actors were trained in the ‘Method’ style, which requires the actor to elicit a real emotion in him or herself. In each vignette, the actor is either engaged in an interaction without dialogue (e.g., listening on the phone with the occasional “Uh Huh”), or with dialogue using a script that is ambiguous and can therefore be interpreted in a number of ways. In some scenes there is only one actor talking, either on the telephone or directly to the camera. Other scenes depict two actors, but the instructions clearly direct the participant to focus on one of them (the “target” actor). The ability to correctly recognize emotional expression was assessed by asking participants to decide which of the basic seven categories each emotional expression represented. The TASIT is more naturalistic and ecologically valid than measures relying on static visual displays, and has been shown to have excellent test-retest, and alternate forms reliability, as well as convergent validity with other measures of social perception (McDonald et al., 2006).

3. Results

Fig. 1 shows the percentage correct recognition for AD, older and younger participants on the FEEST and the TASIT. FEEST data were analysed with a $3 \times 6$ mixed ANOVA with the between-subjects variable of group status (AD, older, younger) and the within-subjects variable of emotion type (anger, disgust, fear, sad, surprise, happy). These analyses indicated that there was a main effect of group status, $F(2, 81) = 10.9, p < 0.001, \eta^2 = 0.21$, and of emotion type, $F(5, 405) = 84.6, p < 0.001, \eta^2 = 0.51$. Further, there was an interaction between group status and emotion type, $F(10, 405) = 2.7, p = 0.003, \eta^2 = 0.06$.

To further analyze the significant main effect of group, Tukey tests were conducted. These analyses indicated that AD participants were impaired relative to both older and younger controls on the FEEST, $p = 0.005$ and $p = 0.01$, respectively, but that the younger and older groups did not differ, $p = 0.32$. Fig. 2 shows the percentage correctly recognized for each of the six emotions in the FEEST. To analyze the interaction between group and emotion type observed for the FEEST, tests of simple effects were conducted. For five of the emotions, group was a significant simple main effect: Anger, $F(2, 81) = 8.39, p < 0.001$; Sad, $F(2, 81) = 4.44, p = 0.015$; Fear, $F(2, 81) = 7.47, p = 0.001$; Surprise, $F(2, 81) = 3.39, p = 0.039$; Happy, $F(2, 81) = 6.51, p = 0.002$. The one exception was Disgust where group was not a significant simple main effect, $F(2, 81) = 1.30, p = 0.278$. The three groups, therefore, did not differ in accuracy of recognizing disgust.

Tukey tests of the five significant simple main effects (anger, sadness, fear, happiness and surprise) were then conducted. These results revealed that, relative to older adult controls, the AD group had a significantly lower percentage of correct recognition of fear ($p = 0.017$), anger ($p = 0.046$) and happiness ($p = 0.043$), and but not sadness ($p = 0.111$) or surprise
(p = 0.970). Post hoc Tukey tests of the significant simple main effects (anger, sadness, fear, happiness and surprise) also revealed that the AD group had a lower percentage of correct recognition of emotion than the younger group for all five emotions (all p’s < 0.05).

Further tests of simple effects revealed that emotion type was a significant simple main effect within each group: AD participants, F(5, 115) = 34.1, p < 0.001; older controls, F(5, 145) = 26.6, p < 0.001 and younger controls, F(5, 145) = 25.4, p < 0.001. In terms of the pattern of these significant simple effects, for the AD and older control groups there was the same order with respect to the lowest to highest percentage of correctly recognized emotions; this can be seen in Fig. 2. Thus, both AD and older controls had greatest difficulty recognizing fear, followed by anger, sadness, disgust, surprise and happiness. For younger adults, a similar order of emotion difficulty was observed, except that for this group, disgust was the second most difficult emotion to recognize, and anger was the third easiest to recognize (specifically, greatest difficulty was seen in the younger group for fear, followed by disgust, sadness, anger, surprise and happiness).

The previous analyses indicated that, relative to older adult controls, individuals with AD presented with specific deficits in the recognition of anger, fear and happiness. It should be noted that the researcher responsible for testing AD participants was a registered intern clinical psychologist who therefore had the necessary clinical expertise to make judgments relating to comprehension of tasks, and thus understand what was meant by the different emotion labels. It therefore seems unlikely that the observed facial affect recognition deficits were simply secondary to impaired semantic knowledge of emotions. However, to formally assess whether variance in emotion recognition performance was shared with variance in overall cognitive status as indexed by the ACE-R and more generalized facial recognition capacity as indexed by the Benton, a series of analyses of covariances (ANCOVAs) were conducted. For these analyses, the between subjects variable was group status (AD versus older), with either ACE-R or Benton facial recognition as the covariate. The dependent variables were the FEEST emotions that AD participants had significant difficulty with relative to age-matched controls; anger, fear and happiness. Of interest was how entry of each of these covariates impacted on the main effect of group (AD versus older controls).

The group effect sizes ($\eta^2_p$) for fear, anger and happiness (0.13, 0.08 and 0.07, respectively), were entirely eliminated after covarying for the ACE-R (all $\eta^2_p$’s < 0.01). However, covarying for the Benton had a far smaller influence on group differences in affect recognition ($\eta^2_p$’s = 0.10, 0.05 and 0.05, respectively). These data therefore suggest that whilst AD effects on emotion recognition do overlap with cognitive deficits, they are not simply attributable to changing visual perception of faces. Indeed, consistent with this possibility, whilst a main effect of group was observed on the Benton, F(2, 81) = 11.4, p < 0.001, follow-up Tukey tests indicated that although younger adults performed better relative to older adults, p = 0.005, and AD participants, p < 0.001, AD participants did not significantly differ from older adults on this measure, p = 0.376.

Subsequently it was assessed whether any of the group differences across the six target emotions reflected differences in patterns of error responses. Informal inspection of the percentage of error types in relation to each of the six target emotions (see Table 2) indicated that for five of the six target emotions (happiness, surprise, disgust, fear and anger), the mode error response was the same across the three groups (i.e., the most commonly made errors were surprise, fear, anger, surprise, and

![Fig. 2. Percentage correct for each of the six basic emotions indexed by the FEEST for the younger controls, older controls, and participants with Alzheimer’s disease (AD).](image)

<table>
<thead>
<tr>
<th>Target emotion</th>
<th>Emotion incorrectly selected (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angr</td>
<td>Anger  Sadness  Fear  Disgust  Surprise  Happiness</td>
</tr>
<tr>
<td>Younger</td>
<td>11.9  10.2  55.9  27.1  0.0</td>
</tr>
<tr>
<td>Older</td>
<td>13.6  33.0  35.2  18.2  0.0</td>
</tr>
<tr>
<td>AD</td>
<td>12.7  10.8  56.9  19.6  0.0</td>
</tr>
<tr>
<td>Sadness</td>
<td>51.6  37.5  7.8  0.0</td>
</tr>
<tr>
<td>Younger</td>
<td>51.6  37.5  7.8  0.0</td>
</tr>
<tr>
<td>Older</td>
<td>35.3  18.8  24.7  2.4</td>
</tr>
<tr>
<td>AD</td>
<td>22.0  32.6  29.5  3.3</td>
</tr>
<tr>
<td>Fear</td>
<td>14.9  81.0  1.0</td>
</tr>
<tr>
<td>Younger</td>
<td>14.9  81.0  1.0</td>
</tr>
<tr>
<td>Older</td>
<td>22.1  53.7  1.3</td>
</tr>
<tr>
<td>AD</td>
<td>17.8  56.4  3.1</td>
</tr>
<tr>
<td>Disgust</td>
<td>0.0  0.0  1.3</td>
</tr>
<tr>
<td>Younger</td>
<td>0.0  0.0  1.3</td>
</tr>
<tr>
<td>Older</td>
<td>3.5  0.0  0.0</td>
</tr>
<tr>
<td>AD</td>
<td>16.9  3.3  6.6</td>
</tr>
<tr>
<td>Surprise</td>
<td>86.7  0.0  6.6</td>
</tr>
<tr>
<td>Younger</td>
<td>86.7  0.0  6.6</td>
</tr>
<tr>
<td>Older</td>
<td>61.1  13.0  11.1</td>
</tr>
<tr>
<td>AD</td>
<td>42.6  10.6  25.5</td>
</tr>
<tr>
<td>Happiness</td>
<td>83.3  85.7  85.7</td>
</tr>
</tbody>
</table>

Table 2: Error rates for emotion recognition across the six basic emotions indexed by the FEEST for younger controls, older controls, and participants with Alzheimer’s disease (AD).
disgust, respectively). However, for the emotion of sadness, whilst younger and older adults most often mislabeled this emotion as fear, AD participants more often mislabeled this emotion as either disgust or surprise. Further, it can be seen that, relative to the younger and older adult controls, AD participants typically present with a more heterogeneous pattern of error responding across the six target emotions (i.e., they exhibit a greater confusability between the different emotions relative to the other two groups).

Following Suzuki, Hoshino, Shigemasu, and Kawamura (2007), Pearson product-moment correlations were then computed to assess whether specific error responses were correlated with accuracy on each of the six target emotions. Given the noted preservation of disgust in the AD group, of particular interest was assessment of whether misuse of the target label ‘disgust’ was correlated with accurate disgust recognition in this group. The correlation between misuse of disgust as a response label and the number of correct identifications of disgust was not significantly correlated in either the AD group ($r = −0.28, p = 0.183$) or the younger adult group ($r = 0.25, p = 0.175$). Whilst a significant association was observed in the older control group ($r = −0.40, p = 0.027$), the fact that (like the AD group) this correlation was negative, indicates that greater misuse of the disgust label was associated with fewer correct disgust identifications overall. Thus, there is no evidence for either the AD or the older control group that the preserved recognition of disgust is attributable to preferential use of the disgust label. These analyses were repeated for each of the other five target emotions. For all three groups, for none of the emotions was misuse of a specific emotion label significantly correlated with subsequent correct identification of that emotion ($r$'s ranged between 0.20 and −0.32, all $p$’s $> 0.05$). Thus, biases in the choice of labels made per se do not seem to be driving the group effects observed in the present study.

Finally, TASIT data (see Fig. 1) were analyzed with a $3 \times 7$ mixed ANOVA with the between-subjects variable of group status (AD, older, younger) and the within-subjects variable of emotion type (surprised, sad, angry, anxious, revolted, happy, neutral). These analyses indicated that there was a main effect of group status, $F(2, 81) = 13.85, p < 0.001, \eta^2 = 0.26$, and of emotion type, $F(6, 486) = 18.2, p \leq 0.001, \eta^2 = 0.18$, but that there was no interaction between group and emotion, $F(12, 486) = 1.35, p = 0.187, \eta^2 = 0.03$. Tukey tests on the main effect of group indicated that older adults were impaired relative to their younger counterparts, $p = 0.005$, and that AD participants were significantly impaired relative to younger adults, $p < 0.001$, but not older adults, $p = 0.083$.

4. Discussion

The present study is the first to simultaneously assess affect recognition in relation to older, younger and AD participants, and thus these data offer a unique point of comparison. In contrast to the clear AD deficits identifying the other five emotions from static pictures of faces, the preservation of disgust recognition in the AD group, both relative to the older and even the younger adult groups, was particularly striking. Indeed, for the contrast with younger adults, disgust was the only emotion with intact recognition in AD. Importantly, inspection of error scores indicated that this preservation was not attributable to misuse of the disgust label (i.e., biases in the choice of labels made).

It is suggested that preservation of disgust might be attributable to the relative sparing of the basal ganglia in AD. As noted previously, both the basal ganglia and the insula have been argued to be particularly implicated in recognition of disgust signals (Calder et al., 2000). However, the relative contribution of these neural substrates has been subject to some debate. The present findings, involving an AD group known to be characterized by relative preservation of the basal ganglia (Boller & Duykaerts, 2003; Braak & Braak, 1991; Delacourte et al., 1999; Hyman & Gomez-Isla, 1998), but significant atrophy in the insula (Halliday, Double, Macdonald, & Kril, 2003), point to either a more important role for the basal ganglia in disgust recognition, or that the integrity of only one of these systems is sufficient for intact recognition of disgust. Consistent with our findings and with the idea that the basal ganglia on their own are sufficient for recognition of disgust, the degree of basal ganglia (but not insula) atrophy has been shown to predict disgust recognition deficits in Wilson’s disease (Wang, Hoosain, Yang, Meng, & Wang, 2003).

Further, the basal ganglia are widely considered to represent the core site of pathology in relatively more ‘subcortical’ dementias, such as Huntington’s and Parkinson’s disease, and are preferentially targeted early in the course of these diseases. The present findings involving a group characterized by relative preservation of the basal ganglia (AD) contrast sharply with research focused on Huntington’s or Parkinson’s disorders, where decoding expressions of disgust has been shown to be disproportionately impaired (Sprengelmeyer et al., 1996), and in one study selectively impaired (Suzuki, Hoshino, Shigemasu, & Kawamura, 2006) relative to the recognition of other expressions of emotion. Importantly, Suzuki et al. (2006) study used a refined assessment technique in which the relative difficulties of different emotions were controlled. Further, a relatively selective impairment of disgust recognition has also been observed in presymptomatic Huntington’s disease gene carriers (Gray, Young, Barker, Curtis, & Gibson, 1997). The present data therefore point to the possibility of an interesting double dissociation between AD and dementias characterised by relatively greater subcortical (and specifically, basal ganglia) neuropathology.

In addition to identifying selective preservation of disgust, the present study also found significant AD deficits in decoding static facial expressions of anger, fear and happiness. Although the neural substrates that subserve decoding expressions of happiness remain relatively poorly delineated, the orbitofrontal cortex has been particularly linked to decoding expressions of anger and the amygdala to decoding expressions of fear. AD deficits for these latter two emotions (coupled with the noted preservation of disgust) may therefore directly reflect the neuropathological changes that are characteristic of AD. As noted, AD involves accelerated neuropathology in limbic regions (including the amygdala), as well as frontal neocortices, with the basal ganglia typically less affected (Boller & Duykaerts, 2003; Braak & Braak, 1991; Delacourte et al., 1999;
Hyman & Gomez-Isla, 1998). However, a clear limitation of the present study was the absence of specific information relating to neuropathological change in the AD participants tested. Thus, whilst it is suggested that the differentiated profile of affect recognition performance that was observed in the present study is consistent with neuropsychological models that highlight the role of dissociable neural substrates in recognizing specific emotions, these data should be regarded as preliminary, and further research is needed that directly maps underlying AD related neuropsychology onto affect recognition performance in this group.

Finally, in contrast to the marked AD effects on the FEEST, the present study found that individuals with AD did not differ significantly from age-matched controls on the TASIT. These data did not imply a complete absence of AD deficits on the TASIT in that there were fewer items to detect differences on the TASIT relative to the FEEST, and there was a trend showing that AD participants relative to older adults did experience greater difficulty. Thus, there is some indication that even with more emotion cues and using ecologically valid video clips rather than still images, the trend is for worse performance in the AD group relative to older adults. Nevertheless, since AD effects on the TASIT were reduced relative to AD effects on the FEEST, it is possible that deficits on more traditional measures of affect recognition over-estimate the degree of affect recognition impairment individuals with AD actually experience in day-to-day life.

Whilst such a conclusion would be extremely encouraging, and have important implications for dementia care, the FEEST and TASIT differ on a number of dimensions quite aside from ecological validity. Thus, although one possibility is that ecological validity per se is the critical distinguishing feature which explains the attenuated AD effect on the TASIT, it may instead be the contrast between dynamic and static stimuli that is key, particularly given recent models that highlight the role of dissociable neural systems for recognizing dynamic as opposed to static facial expressions. Thus, it has been proposed that whilst information about actions is processed in occipitoparietal and dorsal frontal cortices, the bilateral and anterior temporal lobes are among the critical regions responsible for linking perception of static stimuli to recognition of emotions (Adolphs, Tranel, & Damasio, 2003). Also potentially relevant is the fact that the two tasks differed on a number of stimulus dimensions, most notably the number of contextual cues (and thus the need to integrate multi-modal affective stimuli), speed of stimuli presentation (stimuli were presented rapidly in the static task but for greater duration in the TASIT), as well as the number of response options available to choose from (the TASIT included the ‘neutral’ option which was not available when completing the FEEST). One way in which future research could tease apart these competing possibilities would be to develop ecologically valid tasks that vary along each of these stimulus dimensions, and to use still images taken directly from the moving image stimuli.

Indeed, intriguingly, and also consistent with the argument that the TASIT and FEEST differ on a number of important dimensions other than just ecological validity, was the finding that whilst older relative to younger adults did not differ in terms of overall accuracy on the measure of static facial affect recognition, a significant age deficit was observed on the TASIT. This finding does not seem easily attributed to a focus on task differences that emphasizes ecological validity, particularly since there is now a considerable literature showing that deficits observed in the context of normal adult aging are often attenuated (or even reversed) in contexts where ecological validity is increased (see Henry, MacLeod, Phillips, & Crawford, 2004; Phillips & Henry, 2005). Thus, future research is needed to identify the critical task feature(s) responsible for the pattern of age and AD effects observed in the present study. The divergent pattern of results observed (significant AD effect on the FEEST but not the TASIT; significant age effect on the TASIT but not the FEEST) implies that different mechanisms may be relevant to understanding performance in these two groups.

5. Conclusions

The present data provide further important clarification about the nature of affect recognition deficits in AD, as well as in the context of normal adult aging. The major finding of the present study was that people in the early stages of AD show selective preservation in identifying disgust from static pictures of faces. Strikingly, this preservation was seen even in comparison to young healthy controls, and could not be attributed to biases in the choice of labels made. It is suggested that these data may reflect sparing of the basal ganglia in the early stages of the disorder.

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References