Discrimination of facial identity and of emotions in Alzheimer’s Disease

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Abstract

Objective: To investigate processing of human faces identity and of emotional expressions in patients with Alzheimer’s Disease (AD).

Background: Mechanisms responsible for discriminating facial identity may be dissociated from those involved in discriminating facial expressions. Patients with prosopagnosia often have preserved capacities for processing emotional facial expressions and occasionally, patients with focal lesions may recognize human faces without being able to recognize their facial expression. Such a dissociation has not been clearly shown in groups of AD patients.

Methods: Thirty-one probable AD patients and 14 control subjects were administered tasks of discrimination of faces and of emotions.

Results: AD patients were significantly impaired in discriminating facial identities and in naming and pointing to named emotions, but were comparable to controls in discriminating facial expressions of emotion. The deficits of facial discrimination and of identification of emotions were, on the whole, correlated with the MMS and Raven scores. Discrimination of emotions was not correlated to either test, suggesting that this ability is based on cognitive processes different from those underlying the MMS and the PM47.

Conclusions: This dissociation implies two separate systems, one dedicated to discrimination of facial identities and the other to discrimination of emotions. This is compatible with the modular organization of cognitive deficits in AD and may explain the well known experience that nonverbal communication often remains effective even in patients with severe dementia.

Keywords: Alzheimers Disease; Dementia; Emotions; Facial identity; Facial expression; Prosopagnosia

1. Introduction

The human face conveys a complex set of information which contributes to the recognition of identity and emotional state, in addition to other features such as age, mood and health. Its importance for the human species may have led to the development of a specialized cognitive system. The existence of such a system has been postulated on a theoretical basis and following clinical descriptions where some patients become selectively unable to recognize familiar faces (Bodamer, 1947; Bruce and Young, 1986; Bruyer, 1993; Charcot, 1883; Ellis and Young, 1989). In addition, it has been shown that specific cerebral lesions may affect the ability to discriminate unfamiliar faces (De Renzi et al., 1968; Warrington and James, 1967).

Is there a relationship between recognition of faces and of facial emotions? Experimental data obtained from normal subjects (Strauss and Moscovitch, 1981) and from patients with focal lesions (DeKosky et al., 1980) have been used to suggest that they are related. Furthermore it has been suggested that impaired discrimination of unfamiliar faces, of emotional facial expressions as well as of emotional prosody are associated with right occipito-temporal lesions (Bowers et al., 1984; Meadows, 1974; Ross and Mesulam, 1984). Later research by the Gainesville group has shown, however, that the right hemisphere superiority for processing facial affect exists above and beyond its superiority for processing facial identity, sug-
gesting that the two functions are at least partially independent (Bowers et al., 1985).

The literature on prosopagnosia which has been rather rich in recent years tends to indicate that recognition of facial identity and emotional expressions are subserved by different neural substrates. This conclusion is based on arguments drawn from pathology (Ecoff, 1984; Parry et al., 1991) and from functional imaging studies (Sergent et al., 1994). In addition, patients with prosopagnosia often recognize normally facial emotional expressions (Bryer et al., 1983; Evans et al., 1995; Hécaen and Albert, 1978, p. 302); there are also occasional patients who can identify faces normally in the presence of a disorder of interpretation of facial expressions (Hornak et al., 1996; Rapcsak et al., 1995; Young et al., 1996).

A relatively small number of studies have dealt with the recognition of faces and emotional expressions in Alzheimers Disease (AD) and related pathology (Albert et al., 1991; Allender and Kaszniak, 1989; Bros gol et al., 1983; Evans et al., 1995; Kurucz and Feldmar, 1979; Kurucz et al., 1979). Evans et al. (1995) have described a single case with progressive prosopagnosia without loss of recognition of emotions. No histological diagnosis was available, but they suggest that their case represents a right hemisphere equivalent of semantic dementia. Other studies are more comparable to ours because they have explored, in a systematic fashion, demented patients’ ability to identify emotional expressions. Kurucz et al. (1979) described deficits in the recognition of facial emotional expressions in demented patients which did not correlate with prosopagnosia (Kurucz and Feldmar, 1979). Similarly, Bros gol et al. (1983) found that demented patients have difficulty recognizing most (but not all) facial expressions. Allender and Kaszniak (1989) found that AD patients had an impaired ability to identify facial emotions and favored the idea of a specific alteration of processes of emotional recognition. Albert et al. (1991) also found such an impairment, but noticed that this difference disappeared when AD patients’ performances were adjusted for their cognitive deficits. They therefore denied the existence of a specific process, proposing that there is no primary impairment in the perception of emotion.

We have examined the ability to discriminate unfamiliar faces and emotional expressions in a group of patients with probable AD and in controls. The stimuli were presented in such a way as to keep cognitive demands at a minimum and to separate the ability to discriminate faces from the ability to discriminate emotions. The objective of our study was to verify if these two functions are equally impaired in AD, or if a dissociation exists between them. We also wanted to determine whether impaired performance was related to overall level of cognitive functioning as measured by the MMS (Folstein et al., 1975) and Raven’s Colored Progressive Matrices known as PM47 (Raven, 1965).

2. Material and methods

2.1. Subjects

The study included 31 subjects (29 women and 2 men) with diagnosis of probable AD, hospitalized in a long-term geriatric service located 15 miles North of Paris. The diagnosis was based on the criteria of DSM-III-R (American Psychiatric Association, 1987) and on those of the ‘National Institute of Neurological and Communicative Disorders and Stroke/Alzheimer’s Disease and Related Disorders Association - NINCDS/ADRDA’ (McKhann et al., 1984). Specific laboratory tests were conducted in order to exclude syphilis and HIV infection, diabetes, thyroid disorders, Vitamin B12 and folate deficiency.

The performance of AD patients was compared to that of a group of 14 non-demented subjects (13 women, 1 man), matched in age and education. These subjects were hospitalized in the same Service for social reasons or for non-neurological problems such as orthopedic rehabilitation. A normal level of hearing and visual acuity was required for all subjects. They received no neurotropic medications during at least a month prior to the tests.

2.2. Tests

The patients and the controls were administered the Mini Mental State Examination (MMS) (Folstein et al., 1975) as well as Raven’s PM47 (Raven, 1965) in order to test overall level of functioning and verbal abilities (MMS) and non-verbal reasoning abilities (PM47).

In order to test discrimination of faces and facial expression, we used a battery of tests derived from the protocol of Bowers and Heilman (Bowers et al., 1984). The stimuli consisted of photographs of faces which in turn are drawn from the emotional faces test of Ekman and Friesen (1975). On these photographs (12.5×8.5 cm), four ‘actors’ (2 females, 2 males) represent four emotions (joy, anger, sadness and indifference). The photographs are in black and white and were presented to the subjects on cards containing, according to the test situation, one, two or four faces each.

Three test situations were used.

2.2.1. Discrimination of facial identity

First condition: same emotion. The subjects were shown 16 cards containing two photographs of a face expressing the same emotion. The task consisted of answering the question: “Is it the same or two different persons?” For eight of the pairs, the same actor (Fig. 1) appeared on the two photographs while for the other eight, the faces were those of two different actors.

Second condition: different emotions. The two photographs showed faces expressing two different emotions. The question was the same as that for the preceding
condition. For eight of the pairs, the two emotions appeared on the same face (Fig. 2), while for the other eight, the faces were those of two different actors.

2.2.2. Discrimination of facial emotion

First condition: same face. Each card included two photographs and the face of the same actor was present on both pictures. For eight pairs, the faces expressed the same emotion, for the other eight, they expressed two different emotions. Subjects answered the following question: “Is the emotion expressed in both photos the same or different?”

Second condition: different faces. The face of a different actor was present on each pair of pictures. For eight items, the two faces expressed the same emotion, for the other eight, the two emotions were different. The question was the same than for the preceding condition.

2.2.3. Identification of emotional expression

First condition: verbal. The 16 pictures representing the same actors, each expressing one of the four emotions, were presented one after the other. Subjects were asked: “Is this person happy, sad, angry or indifferent?”

Second condition: pointing. Each subject was shown a card that included four photographs of the same actor, each expressing one of the four emotions. Subjects were asked to “show (point to) the happy face, the sad face, the angry face and the indifferent one”.

2.3. Score

Each condition included 16 items and each item was scored 0 (incorrect) or 1 (correct). Therefore for each task the score ranged from 0 (worst) to 16 (best).

2.4. Statistical analysis

The analysis of variance and the Pearson correlation coefficients were calculated using the Systat statistical package (Wilkinson et al., 1992).
3. Results

Table 1 shows that the subjects were well matched for age. The level of education was also comparable consisting for the most part of elementary education. The control group had a mean MMS of 26.07 ± 1.79 and a mean PM47 of 23 ± 4.5; the mean of the AD group was 16.18 ± 1.68 for the MMS (P < 0.001) and 12.26 ± 5.03 for the PM47 (P < 0.001).

Table 1 and Fig. 3 present the results on the three conditions. The task of facial discrimination showed a statistically significant group difference (F_{1,43} = 5.78, P < 0.05; F_{1,43} = 7.59, P < 0.05) for the first (same emotion) and second condition (different emotion) respectively. In contrast, no statistically significant difference was found between the two groups for the task of emotional discrimination (F_{1,43} = 0.71 for the first condition (same face); F_{1,43} = 0.21 for the second condition (different faces)). The two groups differed significantly in their performance of identification of emotions whether a verbal response (F_{1,43} = 14.11, P < 0.01) or a pointing response was required (F_{1,43} = 7.40, P < 0.01).

Table 2 shows that the MMS and PM47 scores were closely correlated (r = 0.76, P < 0.01). The MMS scores correlated significantly to those of facial discrimination when the emotion was different, but not when the two faces represented the same emotion. They correlated significantly with the two tests of emotional identification, but not with the tests of discrimination of emotions.

The PM47 correlated significantly with the scores of

<table>
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<th>Table 1</th>
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<td>Means and standard deviations of the age, MMS and face tests</td>
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<tr>
<td>Age</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Mean standard deviation</td>
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<tr>
<td>AD patients</td>
</tr>
<tr>
<td>Mean standard deviation</td>
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</tbody>
</table>
Discrimination of facial identity when the two faces expressed the same emotion, but not when the two faces expressed different emotions.

There was a strong correlation with the two tasks of emotion identification, but not with the tasks of emotion discrimination.

### 4. Discussion

The data show that discrimination of facial identity is impaired in AD patients, while discrimination of emotional expression is preserved. Verbal identification of emotions is significantly impaired in AD patients, whether the response is requested or supplied. These findings suggest that the operations of facial discrimination and discrimination of facial expressions are distinct. There is a dissociation between mechanisms put into action when a face carries identity and when it conveys emotional information. On the other hand, the impairment of identification of emotions demonstrated by AD patients is probably related to a verbal deficit since the two subtests require a linguistic operation, either to apply a verbal label or to point in response to a verbal stimulus. A study including more complex verbal material is currently in progress and will provide a more definite confirmation of this hypothesis.

The correlation table (Table 2) reinforces the results of the ANOVA. The deficits of facial discrimination and of identification of emotions are, on the whole, correlated with the MMS and Raven scores. On the other hand, discrimination of emotions is not correlated to either of the two tests, suggesting that this ability is based on cognitive processes different from those used for the MMS and the PM47. The reason why the correlations for ‘same emotion’ and MMS and ‘different emotions’ and PM47 fell short of statistical significance may be related to the sample size.

It had been thought for some time that there are close ties between the discrimination of faces and the perception of facial emotions since both involve the human face. Several more recent studies, however, have suggested a dissociation between the two. The idea of unity or at least commonality of the two systems was indirectly suggested by developmental studies showing, for instance, that infants four to seven months of age can discriminate faces and facial expressions and perceive photographs of facial expression as faces (Oster et al., 1989). Close ties were also suggested by pathology since it is generally thought that impaired discrimination of unfamiliar faces, of emotional facial expressions as well as of emotional prosody tends to be associated with right occipito–temporal lesions (Bowers et al., 1984; Meadows, 1974; Ross and Mesulam, 1984). Experimental studies involving recognition of facial identities and emotional expressions showed right hemisphere superiority in normal subjects (Strauss and Moscovitch, 1981) and in patients with hemispheric lesions (DeKosky et al., 1980). In a later study, however, Bowers

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**Table 2**

<table>
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<tr>
<th>Test</th>
<th>PM47</th>
<th>MMS</th>
<th>PM47</th>
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</thead>
<tbody>
<tr>
<td>Discrimination of face identities</td>
<td>Same emotion</td>
<td>0.26</td>
<td>0.45*</td>
</tr>
<tr>
<td></td>
<td>Different emotion</td>
<td>0.54**</td>
<td>0.35</td>
</tr>
<tr>
<td>Discrimination of emotions</td>
<td>Same face</td>
<td>0.11</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>Different face</td>
<td>0.11</td>
<td>0.18</td>
</tr>
<tr>
<td>Identification of emotions</td>
<td>Verbal recognition</td>
<td>0.57**</td>
<td>0.55**</td>
</tr>
<tr>
<td></td>
<td>Pointing</td>
<td>0.64*</td>
<td>0.48*</td>
</tr>
</tbody>
</table>

* P<0.01; ** P<0.05.
and colleagues (Bowers et al., 1985) found that the right hemisphere superiority for processing facial affect existed independently of its role in mediating judgments of facial identity. They pointed out that the previous study (De-Kosky et al., 1980) had included only patients with lesions in the temporo–parietal regions while this time the study also included patients with anterior temporal and frontal lesions. Etcoff (1984) found that identity and emotion in faces can be selectively attended to by normal subjects and by patients with right hemisphere lesions. A study by Parry et al. (1991) found several patients with a dissociation between facial expression recognition and recognition of facial identity. More recently, some single case studies have shown a dissociation between recognition of faces and recognition of emotional expressions (Evans et al., 1995; Rapcsak et al., 1995). Sergent et al.’s (1994) PET study have confirmed that some aspects of identity and of emotions are analyzed separately in the human brain.

The present study discusses mainly ability (or inability) to discriminate unfamiliar faces, which may be different from the ability to recognize familiar faces. In an earlier study, Warrington and James (1967) found that patients with right hemisphere lesions were impaired in recognizing well-known and previously unknown faces. Further studies, however, have suggested that recognition of familiar faces has a greater implication of verbal factors and of semantic memory, and might even be left-hemisphere dominant (Bruyer et al., 1983; Sergent and Bindra, 1981).

The few systematic investigations of face and facial emotions discrimination in dementia have yielded different results and interpretations. The studies of Kurucz et al. are difficult to interpret because their patients with “organic brain syndrome” included some subjects with diagnosis of schizophrenia or major affective disorders (Kurucz and Feldmar, 1979; Kurucz et al., 1979). Allender and Kaszniak (1989) found that AD patients were impaired in their ability to correctly associate the name of an emotion with its appropriate facial expression and in their ability to correctly match the emotional tone of a sentence with a line drawing of a face expressing that emotion, but there was no attempt to have subjects match faces or emotional expressions. The tests used by Allender and Kaszniak have a strong verbal component and the poor performance of their AD patients may in all likelihood be explained by the linguistic deficits that accompany the disease: We therefore do not agree that the findings of Allender and Kaszniak indicate a specific deficit of emotional processing in AD.

In the present experiment, we used tasks that had been used by Albert et al. (1991). These authors found a significant impairment of AD patients in all these tasks. In particular the tasks of discrimination of facial identity and of facial emotion were performed poorly by AD patients. Albert et al. did not demonstrate the dissociation shown by our data and we have no ready explanation for this discrepancy. However, when the test scores of Albert et al.’s patients were adjusted for the cognitive abilities of the subjects, the tasks of discrimination of facial expression no longer differentiated the AD group from the controls. Their conclusion that there is no primary impairment in the perception of emotion in AD is in complete agreement with our own interpretation.

A few recent papers indicate the possibility of a dissociation opposite to ours. Rapcsak et al. (1995) report the case of a 72-year old man who, following an infarct involving the right inferior and middle temporal gyri, was selectively impaired in naming and pointing to emotional facial expressions while remaining able to discriminate unfamiliar faces and to utter right judgments about gender, race and age. Young et al. (1996) described a 51-year old woman who underwent a partial bilateral amygdalotomy for intractable seizures. The amygdalas were only partially destroyed (the destruction spared 75% on the left and 96% on the right) and the lesions extended to other areas including parts of the anterior commissure, lateral putamen and external capsule on the left as well as parts of the right frontal lobe. Post-operatively, the patient was impaired in recognizing facial expressions, but performed normally on tasks requiring matching of facial identities. In a study of 23 patients with frontal lobe damage, Hornak et al. (1996) report two patients with intact face discrimination abilities and with severe impairment at facial expression identification.

These findings compared to our data constitute a double dissociation which in turn strongly indicate that the tasks of facial recognition and of recognition of facial expressions involve two distinct mechanisms, a conclusion similar to that reached by Ellis (1986) and by Calder et al. (1996).

Can the mechanisms responsible for recognition of emotional expressions be localized? Sergent et al.’s (1994) PET study indicated that processing of facial identity is performed predominantly in the ventro–mesial region of the right hemisphere (particularly the lingual gyrus) while processing of emotional expressions did not engage the ventro–mesial region, but activated the right lateral occipital gyrus and the posterior part of the cingulate cortex. However, when the two experimental conditions were subtracted from one another, the CBF changes in these areas were no longer significant.

It is often difficult to establish the precise location of the lesions of patients with isolated facial expression recognition deficits. Heilman and his colleagues (Bowers et al., 1985) were probably the first to hypothesize the implication of right frontal and temporal areas. Young et al. (1993) have reported selective impairment of facial expression analysis following posterior lefthemisphere lesions. Rapcsak et al. (1995) patient had right inferior temporal lobe lesions. In Hornak et al.’s cases, the lesions appeared related to ventral frontal lobe structures while Young et al.’s patient had damage that extended from the amygdala to the frontal regions. It could be argued that these areas
were spared in our AD patients, explaining our results of preserved recognition of emotions. The amygdala is an area well-known to be affected even in the earliest phases of AD (Cuénod et al., 1993), but the area typically affected corresponds mainly to the lateral amygdaloid nuclei (Brady and Mufson, 1990), while the patient reported by Young et al. (1995) had damage confined to the basal nuclei. More in general, the pathology of AD which tends to affect temporal and parietal areas can contribute to the disorder of visual processing expressed in our study by failure to discriminate facial identities. The frontal lobes structures which may be related to emotional processing are frequently less impacted by AD.

While these anatomical considerations are important, other factors may also be involved in the dissociation between faces and emotional expressions recognition. Following Sergent and colleagues (Sergent et al., 1994; Sergent and Signoret, 1992), we suggest that this dissociation is also related to the fact that emotions are perceptually easier to recognize than most other properties conveyed by a face, perhaps with the exception of race (Sergent et al., 1994). Emotions are categorical in nature and Ekman has indicated that there are no more than seven basic emotions; hence the net representing emotions is probably much more defined than the net representing identities. A facial expression is much easier to draw whereas much more complex drawings are needed to convey a facial identity. The cognitive requirements associated with the processing of facial identity and emotion are also different since recognizing facial identity requires complex visual processing, episodic and (in the case of famous faces) semantic (biographical) memory. Memory is not required in recognizing facial emotions and visual processing is probably less complex because the necessary information is more salient and more readily accessible. Even in patients reported to have a clear-cut impairment in recognition of emotions, performance is above chance (Young et al., 1993), suggesting that more than one cerebral area is involved and that a disturbance in recognition of emotions may be more easily compensated for by the spared cortical areas. These various factors may explain why the few cases with normal recognition of faces, but impaired recognition of emotions are for the most part single case reports.

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