

Emotion perception and interpersonal behavior in epilepsy patients after unilateral amygdalohippocampectomy

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Aim of this study was to examine the relation between perception of facial expressions and interpersonal behavior in epilepsy patients after unilateral amygdalohippocampectomy (AH). Nine patients with unilateral amygdalohippocampectomy and 14 controls completed a forced-choice emotional recognition task, in which morphed facial emotional expressions were shown at different emotional intensities, and a self-report questionnaire of interpersonal behavior. Face perception and depressive symptoms were also taken into account. Compared to normal controls, patients were less sensitive in the recognition of fearful and disgusted facial expressions, in line with previous reports. These impairments were only minimally correlated with self-report interpersonal behavior. In all, unilateral damage to the amygdala and medial temporal lobe results in subtle emotion recognition impairments, but these deficits do not appear to extend to self-reported impairments in everyday interpersonal behavior. Further studies need to explore in more detail the effects of these subtle recognition problems on daily social intercourse.

Key words: amygdalohippocampectomy, emotion, epilepsy, interpersonal behavior, neuropsychology, social cognition

Studies in epilepsy patients after amygdalohippocampectomy (AH) and neuroimaging studies in healthy participants have revealed that the amygdala and structures in the anterior and medial temporal lobes are important for the recognition of emotions from facial expressions, especially fear (Morris et al. 1996, Adolphs et al. 2003, Brierley et al. 2004). Clinically, emotion perception deficits may be relevant in that the ability to recognize facial expressions in others is an important social skill that is crucial for complex interpersonal interactions and that may be important in order to infer what others think, feel or what their intentions might be (Smith and Scott 1997). However, the assessment of social cognition in chron-

ic epilepsy patients undergoing temporal lobectomy is not yet standard clinical practice (Kirsch 2006). Furthermore, the relationship between emotion perception and everyday interpersonal behavior has been scarcely studied in psychiatric patients (Mueser et al. 1996), but data on post-surgical epilepsy patients are lacking altogether.

Most studies on emotion perception have used static displays of intense emotions rather than dynamic and more subtle expressions. It has been found that motion improves the perception of facial expressions (Biele and Grabowska 2006) and dynamic presentation of emotional facial expressions enables the use of different emotional intensities, which may help to overcome possible ceiling effects in mildly impaired patients (Montagne et al. 2007a), and as such may be more ecologically valid. Also, it has been suggested that processing static and dynamic facial expression displays may

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Received 21 September 2007, accepted 11 February 2008

rely partly on distinct neural systems. For example, a patient with extensive bilateral amygdala lesions has been reported to be able to recognize emotions from dynamic facial expressions, but failed to recognize emotions from static images (Adolphs et al. 2003). The aim of the present study was to investigate the perception of dynamic emotional expressions in epilepsy patients after unilateral amygdalohippocampectomy and to relate this ability to their everyday social behavior as measured with a self-report questionnaire.

A convenience sample of nine post-surgical patients with resections of the medial temporal cortex for the treatment of drug-resistant mesial temporal lobe epilepsy were recruited from Epilepsy Centre Kempenhaeghe, Heeze, the Netherlands (see Table I). MRI revealed that all resections were unilateral, restricted to the medial temporal lobe and included the amygdala (4 left hemisphere and 5 right hemisphere patients). None of the patients were medication-free at the time of testing, but all reported a reduction in seizure frequency or were seizure free. In addition, fourteen healthy volunteers with no history of epilepsy or other neurological impairment were included and served as controls. No statistical difference in age ($t_{24}=0.32$), sex distribution (Mann-Whitney $U=81.0$) or handedness ($U=77.0$, assessed by self-report, i.e. indicating the preferred hand for most everyday activities) were present between both groups. The control group had a higher education level ($U=24.5$, $P<0.001$) than the patients.

The Emotion Recognition Task (ERT) was included, which measures perception of facial expressions at different intensity levels and has been validated in various neurological and psychiatric patient populations (see Montagne et al. 2007a for an overview). The task consists of short video clips in which always a neutral face (i.e., using colored pictures of faces from four different actors, two males and two females) gradually changed into one of six basic emotions (anger, disgust, fear, happiness, sadness and surprise) with different end-points of emotional intensity (varying from 20% emotional intensity to the 100% full expression). The task starts with the video clips with the lowest emotional intensities (0–20%), gradually increasing until all intermediate steps were shown (0–100%). After the presentation of each video clip, participants were asked to judge which emotion was shown on the face by making a forced choice between one of the six emotions displayed as verbal labels on the computer screen with no time restriction. Raw data were converted into a sensitivity measure, i.e. the mean end point (percentage of emotional intensity) after which a particular emotion was consistently recognized correctly.

As an index of the participants' social behavior and skills, the Scale for Interpersonal Behavior (SIB) (Arrindell et al. 2001) was used. This self-report questionnaire was developed and validated for the independent assessment of both distress associated with self-assertion in a variety of social situations and the likelihood of engaging in

Table I

Demographic variables, intelligence level, depressive symptoms and face perception ability for the patients with amygdalohippocampectomy and the controls (mean \pm SEM)		
	Patients ($n=9$)	Controls ($n=14$)
Age	37.1 (3.4)	36.4 (3.4)
Sex (m:f)	2:7	3:11
Handedness (left:right:mixed)	2:6:1	0:14:0
Education level (1–7)	5.0 (0.3)	6.5 (0.1)
NART-IQ	94.1 (4.5)	107.6 (3.3)
BDI-II	5.6 (2.4)	3.1 (1.1)
Benton Test of Facial Perception	22.6 (0.8)	23.1 (0.7)
Time after surgery (in months)	18.3 (5.8)	–
Age of epilepsy onset (in years)	19.9 (12.8)	–
Duration of epilepsy (in years)	18.1 (10.4)	–

(BDI-II) Beck Depression Inventory – Second Edition; (NART) National Adult Reading Task

a specific social response. The SIB consists of 50 items which all had to be evaluated on two separate five-point Likert scales; one for the degree of discomfort experienced (Distress) and the other for the probability of engaging in a specific assertive behavior in various situations (Performance). Factor analysis (Arrindell et al. 2001) has yielded four subscales: Negative Assertion (display of negative feelings), Insecurity (expression of and dealing with personal limitations), Initiating Assertiveness (social assertiveness and expressing one's own opinion) and Positive Assertion (praising others and the ability to deal with compliments or praise).

The Dutch version of the National Adult Reading Test (NART) was included as an estimate of premorbid intellectual functioning, since intelligence may contribute to emotion perception ability. The short form of the Benton Test of Facial Perception was administered to account for possible impairments in general perception of neutral faces. Because depressive symptoms have been shown to be related to emotion perception (Montagne et al. 2007b), the Beck Depression Inventory – II (BDI-II) was used to account for possible mood differences between the two groups (see Lezak et al. 2004 for a detailed description of these tests). All tasks were presented in a fixed order to account for possible order effects.

Results demonstrated no group differences on the Benton Test of Facial Perception ($t_{24}=0.06$) and the BDI-II ($t_{24}=1.54$). The controls obtained a slightly higher NART-IQ score than the patients ($t_{24}=2.66$, $P<0.05$), in accordance with their somewhat higher education level. Figure 1 shows the results for the sen-

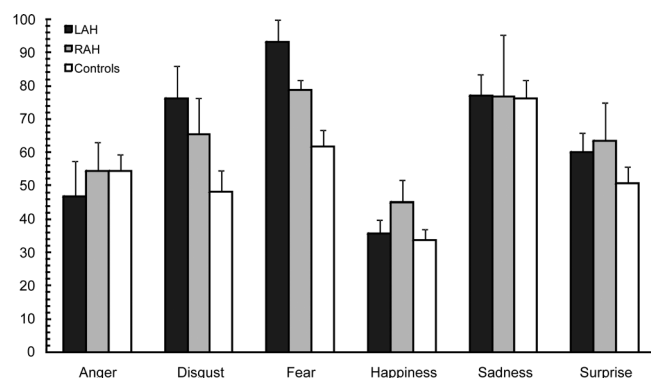


Fig. 1. Mean sensitivity (percentage emotional intensity needed in order to correctly recognize the emotion) \pm SEM for all six emotions on the Emotion Recognition Task for the left (LAH) and right (RAH) amygdalohippocampectomy patients and the control group

sitivity measure of the ERT for the left and right hemisphere patients and the controls. Due to the small sample size of the patient group, left and right hemisphere patients were taken together in all statistical analyses. The patients needed more intense expressions than the controls in order to correctly recognize the emotions fear ($t_{16}=2.7$, $P=0.02$) and disgust ($t_{21}=2.3$, $P=0.03$), but performed similar to the controls on the other emotion types (all t -values <1.4).

Table II summarizes the results for the SIB; no differences between the patients and controls were found on any of the subscales (all t -values <1.6). Correlational analyses between the SIB and the emotions on the ERT (Pearson's r) only revealed significant correlations between the Surprise sensitivity measure and the Performance measure of the subscales Negative Assertion ($r=-0.45$, $P=0.04$), Insecurity ($r=-0.48$, $P=0.03$) and Positive assertion ($r=-0.45$, $P=0.04$).

The present study showed that amygdalohippocampectomy patients required higher intensity levels of emotional expression to recognize fearful and disgusted faces correctly compared to healthy controls. This finding was not due to a general deficit in face perception or to depressive symptoms. The results on fear perception are in agreement with previous research

Table II

Mean scores (\pm SEM) for the subscales of the Scale for Interpersonal Behavior (for both the Distress and Performance indices)

	Patients ($n=9$)		Controls ($n=14$)	
	Mean	SEM	Mean	SEM
Distress				
Total	89.2	10.1	83.1	4.4
Negative	29.6	3.3	30.3	1.7
Assertion	22.8	2.9	19.3	0.9
Insecurity	18.4	2.9	15.6	1.1
Initiating	12.8	1.6	12.5	0.84
Assertiveness				
Positive	149.3	9.1	166.4	6.8
Assertion	38.4	2.4	43.1	2.6
Performance	46.9	3.3	52.6	2.0
Total	27.1	2.0	29.1	1.3
Negative	24.0	1.7	26.9	1.2

showing disproportionate impairments in the perception of fear in patients with lesions of the amygdala and surrounding structures (Calder et al. 2001, Schmolck and Squire 2001, Adolphs et al. 2003). Deficits in the recognition of disgust are generally due to dysfunction of the insular cortex (Calder et al. 2001), but activation of the amygdala has also been linked to disgust recognition (Costafreda et al. *in press*). While the neurosurgical lesions in the amygdalohippocampectomy patients obviously did not extend to the insular cortex, previous studies in chronic temporal-lobe epilepsy patients have demonstrated that the insular cortex may also play a role in the origin of the seizures (Isnard et al. 2000) and may thus be dysfunctional in our group as well. Moreover, there is evidence for hemispheric lateralization of emotion perception (Kucharska-Pietura and Klimkowski 2002). Although our sample was unfortunately too small to investigate lateralization differences statistically, visual inspection of the data shows that patients with lesions of the left amygdala tended to perform worse on the perception of the emotions fear and disgust compared to patients with right amygdala lesions. This is in agreement with previous positron emission tomography data also showing more involvement of the left amygdala during perception of fearful faces (Morris et al. 1996). However, a recent meta-analysis demonstrated that lateralization of the amygdala in relation to emotion perception may be predominantly related to the type of information that is presented, i.e. lingual information being processed by the left amygdala and visually presented masked stimuli by the right amygdala (Costafreda et al. *in press*). Since our stimuli were neither verbal in nature nor masked, it could also be argued that lateralization effects are not to be expected in the current setup. Future studies should examine this in more detail.

We observed no differences between amygdalohippocampectomy patients and controls on a measure of interpersonal behavior. In addition, only a minimal correlation was found between the emotion perception ability and Scale for Interpersonal Behavior, that is, between difficulties in recognizing the emotion surprise and the degree of negative feelings, the frequency of expressing and dealing with personal limitations, and the amount of praising others and the ability to deal with compliments or praise. Thus, emotion perception ability does not necessarily relate to interpersonal behavior as rated by the patient. This discrepancy may also be due to the fact that patients with amygdalohip-

pocampectomy have limited insight into their own subjective states and behavior, as most patients are unaware of their emotion recognition deficits, which make subjective reports regarding interpersonal competence of limited value. This is in agreement with a previous study (Reynders et al. 2005) showing that deficits in the perception of fearful facial expressions in temporal-lobe epilepsy patients without amygdalohippocampectomy were not related to the response on items related to social function as part of a quality of life questionnaire. Clearly, this indicates that sensitive neurocognitive tasks are necessary in order to reveal subtle impairments in emotion recognition in small groups or individual patients after unilateral brain damage and that self-report questionnaires do not suffice.

It should be noted that some studies have found relations between social behavior and emotion perception in other patient groups. For example, in patients with chronic schizophrenia a positive correlation was found between abilities in facial expression recognition and social competence in a role playing test and social adjustment as rated by hospital staff (Mueser et al. 1996). Others have found impairments in facial expression identification that were related to observed social behavioral problems in patients with lesions of the orbital frontal cortex (Hornak et al. 1996). Future studies on social cognition in post-surgical epilepsy patients should also include third-party ratings of the patients' emotional behavior to investigate whether objective behavioral measures are perhaps related to objective measures of emotion perception. It was not the aim of the current study to investigate changes in emotion perception compared to the pre-operative status, although it would be interesting to compare pre- and post-surgical assessment of social-cognitive functions in epilepsy patients to unravel the underlying etiology in more detail.

In sum, the present results support previous studies showing subtle impairments in emotion recognition after unilateral amygdalohippocampectomy, specifically fear and disgust. Although these deficits did not extend to self-reported problems in daily social intercourse, neurocognitive tests measuring aspects of social cognition, such as emotion perception, may be a valuable addition to the neuropsychological assessment of pre- or post-operative epilepsy patients.

The authors would like to thank Mrs. R. Nouwens for her help in recruiting the participants.

REFERENCES

- Adolphs R, Tranel D, Damasio AR (2003) Dissociable neural systems for recognizing emotions. *Brain Cogn* 2003: 61–69.
- Arrindell WA, Bridges KR, Van der Ende J, St. Lawrence JS, Gray-Shellberg L, Harnish R, Rogers R, Sanderman R (2001) Normative studies with the Scale for Interpersonal Behaviour (SIB): II. US students: a cross-cultural comparison with Dutch data. *Behav Res Ther* 39: 1461–1479.
- Biele C, Grabowska A (2006) Sex differences in perception of emotion intensity in dynamic and static facial expressions. *Exp Brain Res* 171: 1–6.
- Brierley, B, Medford N, Shaw P, David AS (2004) Emotional memory and perception in temporal lobectomy patients with amygdala damage. *J Neurol Neurosurg Psychiatry* 75: 593–599.
- Calder AJ, Lawrence A, Young AW (2001) Neuropsychology of fear and loathing. *Nature Rev Neurosci* 2: 352–363.
- Costafreda SG, Brammer MJ, David AS, Fu CHY (in press) Predictors of amygdala activation during the processing of emotional stimuli: a meta-analysis. *Brain Res Rev* doi:10.1016/j.brainresrev.2007.10.012
- Hornak J, Rolls ET, Wade D (1996) Face and voice expression identification in patients with emotional and behavioural changes following ventral frontal lobe damage. *Neuropsychologia* 34: 247–261.
- Isnard J, Guenot M, Ostrowsky K, Sindou M, Mauguier F (2000) The role of the insular cortex in temporal lobe epilepsy. *Ann Neurol* 48: 614–623.
- Kirsch HE (2006) Social cognition and epilepsy surgery. *Epilepsy Behav* 8: 71–80.
- Kucharska-Pietura K, Klimkowski M (2002) Perception of facial affect in chronic schizophrenia and right brain damage. *Acta Neurobiol Exp (Wars)* 62: 33–43.
- Lezak MD, Howieson DB, Loring DW (2004) *Neuropsychological Assessment*, fourth ed. Oxford University Press, Oxford, UK.
- Montagne B, Kessels RPC, De Haan EHF, Perrett DI (2007a) The Emotion Recognition Task: a paradigm to study the perception of facial emotional expressions at different intensities. *Percept Mot Skills* 104: 589–598.
- Montagne B, Nys GMS, Van Zandvoort MJE, Kappelle LJ, De Haan EHF, Kessels RPC (2007b) The perception of emotional facial expressions in stroke patients with or without depression. *Acta Neuropsychiatrica* 19: 279–283.
- Morris JS, Frith CD, Perrett DI, Rowland D, Young AW, Calder AJ, Dolan RJ (1996) A differential neural response in the human amygdala to fearful and happy facial expressions. *Nature* 383: 812–815.
- Mueser KT, Doonan R, Penn DL, Blanchard JJ, Bellack AS, Nishith P, DeLeon J (1996) Emotion recognition and social competence in chronic schizophrenia. *J Abnorm Psychol* 105: 271–275.
- Reynders HJ, Broks P, Dickson JM, Lee CE, Turpin G (2005) Investigation of social and emotion information processing in temporal lobe epilepsy with ictal fear. *Epilepsy Behav* 7: 419–429.
- Schmolck H, Squire LR (2001) Impaired perception of facial emotions following bilateral damage to the anterior temporal lobe. *Neuropsychology* 15: 30–38.
- Smith CA, Scott HS (1997) A componential approach to the meaning of facial expressions. In: *The Psychology of Facial Expression* (Russel JA, Fernández-Dols JM, Eds). Cambridge University Press, New York, NJ, p. 229–254.