The study is important on several accounts. First, it suggests that the role of the amygdala in recognition of emotion may not be restricted to the visual modality. Despite having normal hearing, patient DR, who has some damage to the left amygdala and minimal damage to the right, was impaired at recognizing emotional prosody in words, emotions in nonverbal sounds, and in recognizing sentence prosody and tone of voice. Together with results regarding the visual modality, and with a recent functional imaging study showing that the amygdala is activated by aversive odors, Scott et al.'s findings suggest a multimodal role for the amygdala in the recognition of emotions. Also, it may not be a coincidence that patient DR has primarily left-sided amygdala damage, and that Zaid and Pardo obtained especially strong activation in the left amygdala; perhaps it will turn out that the two amygdalae are not functionally symmetric with regard to emotional processing.

Scott et al. also found that DR's impairment of auditory emotion recognition was largely confined to the emotions of fear and anger, a result which parallels extant findings in the visual and olfactory modalities. As far as auditory stimuli are concerned, it is worth noting in this context that our patient SM, who has focal and complete bilateral amygdala damage, has relatively greater difficulty recognizing fear, as compared to other emotions, although in general, SM does not evidence the same degree of emotion recognition impairment in the auditory modality as she does in the visual. Additionally, we have found that patients with left temporal lobectomies that include the amygdala tend to have poor auditory recognition of fear, again suggesting the possibility of an asymmetric role for the amygdala in emotional processing.

An intriguing issue raised in the Scott et al. study concerns recognition of identity. DR was unable to recognize the identities of speakers from hearing voices, but she is also entirely normal in fact, not only does SM recognize normally the amygdala will turn out to have a role in the recognition of identity, via the auditory modality or any other. To begin with, there is no indication that patient SM has any defect in recognising familiar faces or familiar voices in fact, not only does SM recognize normally previously learned faces and voices, but she also exhibits normal in her ability to learn new faces and voices. Second, patient DR is unimpaired in her ability to recognize previously learned faces. The voice recognition defect in DR may be attributable to her general impairment in using intonation patterns as the authors suggest, or to other factors. In any event, this finding should not be taken as evidence that the amygdala is important for identity recognition. Finally, an interesting question that arises in this context is whether a double dissociation between identity recognition and emotional expression recognition is possible in the auditory modality, as it is in the visual. This issue deserves investigation.

Scott et al. link their findings to the hypothesis that the amygdala is involved in the appraisal of danger and the emotion of fear, as suggested by LeDoux, Damasio, and others. The findings add to the growing and remarkably consistent evidence that the amygdala's role in emotional processing is focused on aversive, negatively valenced emotions. Characterizing the amygdala as a 'fear detector' would be an oversimplification, but the consistency of the evidence regarding negatively-valenced emotions, from both animal and human studies, is impressive.

Response from Young and Aggleton

We are in agreement with most of the points Tranel makes, and we recognize the important contributions to this topic made by his group. As he states, it is intriguing that DR's surgery was more extensive in the left than the right amygdala. Further grounds for thinking that the possibility of a differential contribution of the left amygdala should be entertained come from the PET and fMRI findings with neurologically normal individuals, where amygdala activation to fearful facial expressions was greater on the left side. Moreover, Young et al. found in their study of people with unilateral cortical injuries that although people with right hemisphere lesions were often impaired at recognizing expression and identity from the face, individuals who were selectively impaired at recognizing expression whilst remaining able to recognize identity all came from the group with left hemisphere lesions.

Where we differ from Tranel is in the precise implications of this type of work. Tranel argues that it supports the idea that the amygdala is critical for the pairing of cross-modal sensory information with interoceptive information concerning somatic (body) states, and that the amygdala's role in emotional processing is focused on aversive, negatively valenced emotions. We think matters are more complicated. It seems to us that, whilst Tranel's view may turn out to give a correct account of conditioning and declarative knowledge relative to the amygdala and hippocampus in humans Science 269, 1115-1118


Adolphs, R. et al. (1994) Impaired recognition of emotion in facial expressions following bilateral damage to the human amygdala Nature 372, 669-672


Young, A.W. et al. (1995) Face processing impairments after amygdalothalamic Brian 118, 352-364

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characterization of the amygdala's role in some aspects of emotion, existing evidence suggests that it plays a more specific part in the recognition of emotions signalled by other people. The literature on recognition of emotion after amygdala damage is as yet far from extensive, but when deficits are noted they typically link the amygdala to recognition of fear and (to a lesser extent) anger. However, fear and anger do not exhaust the range of negative emotions.

Consider, for example, the emotion of disgust. Recognition of seen disgust was not impaired for Adolphs et al.'s patient SM2, and recognition of heard disgust was not impaired for DR. DR was noted to be slightly poor at recognizing seen disgust, but this impairment was less severe than her problems with fear or anger, and a second patient with bilateral amygdala damage, SE, showed no problems in recognizing disgust. So there is no compelling reason to link the recognition of fear and anger with the other's disgust to the amygdala, yet it is a strongly valenced negative emotion whose recognition involves linking externally observable information (seen face, heard voice) to introductory information about bodily states - primarily bad tastes.

Importantly, differentially severe impairments of disgust recognition have recently been demonstrated in Huntington's disease. Although people with symptomatic Huntington's disease show widespread problems in the recognition of emotion, Sprengelmeyer et al. found that for tests of facial and vocal expression recognition disgust was recognized only at chance level, and was significantly more severely affected than any other emotion. Further work with people who presented for genetic testing has shown that recognition of disgust is affected in clinically pre-symptomatic individuals who are carriers of the gene for Huntington's disease (Gray, J.M., Young, A.W., Barker, W.A. and Curtis, A., unpublished).

Neuropsychological studies are thus beginning to uncover double dissociations between the recognition of negative emotions, with recognition of disgust affected by some other type of brain injury (for which the critical lesion has yet to be determined - obvious candidate structures include orbitofrontal cortex, ventral striatum and regions of temporal cortex in proximity to the amygdala). We find this pattern surprising, because one of the most obvious effects of cytotoxic lesions of the monkey amygdala is a willingness to eat novel or unusual foods. This may indicate a potential difference between the amygdala's function in monkeys and humans, or that (in our view more likely) it may imply that the amygdala's role in the recognition of emotions expressed by others differs in interesting ways from its more general contribution to the learning of emotion-related stimuli.

Further work on the different types of appraisal involved in these emotions may provide a fruitful line of enquiry: displays of emotion by other people make an important contribution to our moment to moment evaluation of what is significant in our environment. A useful idea could be that the amygdala's contribution is to recognition of those emotions expressed by others which carry clear signals of the presence of physical danger requiring an immediate response (primarily fear and anger), and that it is less involved in the recognition of emotional responses indicating the presence of noxious stimuli and risk of contamination (disgust).

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Spiders walking 180° away from the lure, and walking past the start of the incorrect route. The spiders appeared to 'scan' the environment prior to leaving the starting platform and frequently abandoned incorrect routes at very early stages, despite not being able to see the lure at that stage of the route. This paper is interesting because, although the complex scanning behaviour is clearly a key factor in the performance of this task, the precise mechanisms involved in selecting and navigating the correct route remain to be determined.

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