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# Normal recognition of emotional similarity between facial expressions following bilateral amygdala damage

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**Abstract**

Bilateral damage to the amygdala in humans has been previously linked to two deficits in recognizing emotion in facial expressions: recognition of individual basic emotions, especially fear, and recognition of similarity among emotional expressions. Although several studies have examined recognition of individual emotions following amygdala damage, only one subject has been examined on recognition of similarity. To assess the extent to which deficits in recognizing similarity among facial expressions might be a general consequence of amygdala damage, we examined this ability in two subjects with complete bilateral amygdala damage. Both subjects had previously demonstrated entirely normal recognition of individual facial emotions. Here we report that these two patients also are intact in their ability to recognize similarity between emotional expressions. These results indicate that, like the recognition of individual basic emotions in facial expressions, the recognition of similarity among emotional expressions does not have an absolute dependence on the amygdala. © 1999 Elsevier Science Ltd. All rights reserved.

*Keywords:* Amygdala; Facial emotion; Expression; Similarity; Recognition

## 1. Introduction

Several recent neuropsychological studies have investigated the role of the amygdala in the recognition of emotion in human facial expressions. The first of these studies described patient S.M., a 30-year old female with nearly complete bilateral destruction of the amygdala through calcification resulting from congenital Urbach-Wiethe disease [2]. In that initial report, two facial emotion processing deficits were identified in S.M. The first was an impairment in recognizing specific emotions in facial expressions, particularly fear. This deficit was revealed by her inability to recognize the emotion fear in a task that involved judging the intensity of individual basic emotions in facial expressions. The second deficit involved the ability to recognize similarity between different facial expressions of emotion that normal subjects rate as similar. When shown two facial expressions and asked to rate their emotional similarity, S.M. gave abnormally low similarity ratings to pairs of expressions that normal subjects judge as similar, such as anger and disgust or fear and surprise. Further analysis indicated that S.M. gave abnormal similarity ratings because she could only recognize the most dominant or prototypical emotion in each facial expression, in contrast to normal subjects who can recognize that a given facial expression can contain a blend of different intensities of different emotions [17]. From these data, Adolphs et al. [2] concluded that the amygdala may be indispensable to recognizing individual basic emotions in facial expressions (especially fear) and in recognizing similarity between different facial expressions.

Following upon this initial report, several neuropsychological studies have investigated deficits in recognizing individual basic emotions in facial expressions in

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patients with bilateral amygdala damage [4,6,22,23]. These studies have generally supported the link between bilateral amygdala damage and facial emotion deficits involving fear and other negative emotions, although such deficits are not invariably present [3,9]. Neuroimaging studies have also provided evidence that the amygdala has an important role in the perception of fearful, angry, and happy facial expressions [4,12,13,21].

In contrast to the extensive scrutiny that the relation between amygdala damage and deficits in recognizing individual basic emotions in facial expressions has received, however, no studies have investigated S.M.'s other deficit, the inability to recognize similarity between different facial expressions of emotion. It is important to examine the nature of this deficit further in other patients with bilateral amygdala damage for two reasons. First, it is not known to what extent this facial emotion deficit is general to other cases of bilateral amygdala damage besides S.M. Secondly, it is unclear whether the two facial emotion recognition deficits that S.M. exhibited are separate or whether they simply reflect different aspects of the same underlying deficit.

The current study investigated these issues in two postencephalitic patients, E.P. and G.T. [9], each of whom have complete bilateral amygdala lesions. We assessed the ability of E.P. and G.T. to recognize similarity between emotional expressions using the same task that Adolphs et al. [2] used previously with patient S.M. In addition to collecting these new data, we conducted a reanalysis of the raw facial emotion recognition data from a previous study with these patients [9], using multidimensional scaling (MDS) techniques to address the same issue in a different way. In an MDS plot, facial expressions of emotion that a subject perceives as similar are represented as close together, whereas expressions that are perceived as dissimilar are represented as far apart. Patient S.M. exhibited an abnormal MDS plot that indicated that she failed to perceive normally the similarity between different facial expressions of emotion [2]. We compared the MDS plots generated for E.P. and G.T. to those obtained previously for S.M. and normal control subjects to examine whether E.P. and G.T. would be normal or abnormal on this additional measure.

E.P. and G.T. are notable in that they have been shown previously to exhibit normal recognition of specific facial emotions, including fear, despite complete bilateral lesions to the amygdala [9]. Thus, if E.P. and G.T. are impaired on recognizing similarity between different facial expressions, this would imply both that the similarity-recognition deficit is not unique to S.M. and also that this ability is dissociable from the ability to recognize specific emotions in facial expressions, suggesting that the two facial emotion deficits that S.M. previously exhibited are in fact separate. Conversely, if both E.P. and G.T. can recognize similarity between emotional expressions normally, this would indicate that the deficit that S.M. exhibited in this ability does not generalize to all cases of bilateral amygdala damage and would demonstrate that this ability does not have an absolute dependence on the amygdala, paralleling the findings of the previous report that examined the ability of these two patients to recognize specific emotions in facial expressions [9].

## 2. Method

### 2.1. Subjects

Two males who survived herpes simplex encephalitis (E.P. and G.T., aged 73 and 59 respectively) participated in the study. Both patients have complete bilateral lesions of the amygdala confirmed by MRI, as described in previous case reports [2,18]. E.P.'s bilateral amygdala damage extends rostrally to the temporal pole and caudally to include the hippocampal formation. There is also severe atrophy of the entorhinal, perirhinal, and parahippocampal cortices. G.T.'s damage extends through the anterior 7.0 cm of the left temporal lobe and through the anterior 5.0 cm of the right temporal lobe. The lesion includes bilaterally the amygdaloid complex, hippocampus, entorhinal, perirhinal, and parahippocampal cortices as well as the inferior, middle, and superior temporal gyri. There is also bilateral damage in insular cortex, medial and orbital frontal cortex, and cingulate gyrus.

Both patients are profoundly amnesic due to their medial temporal lobe damage but have IQ scores in the normal range (Wechsler Adult Intelligence Scale-Revised [19]; Verbal IQ = 98 and 88, Performance IQ = 111 and 99, Full Scale IQ = 103 and 92, respectively). The severity of the amnesia is documented by their zero scores on several tests of anterograde amnesia [10,14,18]. Their mean scores were 106, 57, 66, 55, and 53 on the five indices of the Wechsler Memory Scale-Revised [20] (Attention-Concentration, Verbal Memory, Nonverbal Memory, General Memory, and Delayed Memory). These 5 indices yield means of 100 in the normal population (S.D. = 15) and minimum scores of 50. E.P. and G.T. are also anomic (Boston Naming Test [11] score = 42 and 18 out of 60, respectively; normal score > 50), and E.P. has some behavioral evidence of frontal-lobe dysfunction.

### 2.2. Materials and procedure

#### 2.2.1. Facial expression similarity task

The ability of E.P. and G.T. to recognize similarity between facial expressions of emotion was assessed