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Do I know you? Face perception and memory in patients with selective amygdalo-hippocampectomy

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Abstract

In 1968, Milner (Neuropsychologia 6 (1968) 191) demonstrated a face-memory impairment in patients with right, but not left, temporal-lobe excisions. Because all the removals included lateral and inferior temporal neocortex together with amygdala, parahippocampal gyrus and varying amounts of hippocampus, a combined-lesion effect could not be ruled out. We therefore examined the contribution of right temporal structures to recognition of previously unfamiliar faces by repeating Milner's original study, testing patients who had undergone selective amygdalo-hippocampectomy (AH), in addition to those with anterior temporal-lobectomy (TL). The paradigm involved selecting 12 previously studied faces from an array of 25 photographs. The Mooney Closure Faces Test was also administered. Subjects included 29 AH patients (14 left (LAH) and 15 right (RAH)) and 59 TL patients (30 L and 29 R) who were categorized further based on extensive (18 LTH and 21 RTH) or minimal (12 LTh and 8 RTh) hippocampal encroachment. Twenty age- and education-matched normal control subjects (NC) were also tested. For the face-memory task, one-way ANOVA revealed a strong group effect ($P < 0.001$), and post-hoc tests confirmed that both the RTH and RAH groups recognized fewer faces than the NC and LAH groups; the RAH group also differed from the LTh, LTH and RTh groups. No group differences were found for the closure test. Our findings suggest that right medial temporal-lobe structures are critically involved in the retention, but probably not in the perception, of new faces.

Keywords: Anterior temporal lobectomy; Epilepsy; Hippocampus; Mooney Closure Faces Test; Recognition memory; Right medial temporal lobe

1. Introduction

Faces are especially difficult to describe, yet somehow our brains manage to distinguish and remember countless faces that we meet in a lifetime. There is by now considerable evidence indicating that the non-dominant right temporal lobe is preferentially involved in remembering faces and other patterned visual stimuli that are hard to verbalize [e.g., 9,10,14,18,23,36,37,40]. In particular, distinguishing between new and previously viewed photographs of faces has been shown to rely upon the integrity of the right temporal lobe [3,5,6,23,30]. Milner [23] demonstrated an impairment in the retention of previously unfamiliar faces after anterior temporal resections from the right hemisphere, but not from the left or from large frontal lesions of either hemisphere. The deficit was more pronounced when there was also damage to the hippocampal region, but because the removals all included lateral and inferior temporal neocortex, it was not possible to dissociate the medial, inferior and lateral temporal contributions to face memory. In contrast, other investigators [4,13] have found only mild deficits on face recognition in groups of patients tested prior to temporal lobectomy, despite the fact that all these patients had unilateral hippocampal sclerosis. Also, in contrast to the results of postoperative testing [3–5,13,23,30], the mild preoperative deficits were found in both the right- and left-sided groups. Furthermore, Baxendale reported that patients with cortical dysgenesis, in addition to hippocampal sclerosis, performed more poorly than subjects with abnormality confined to the hippocampal formation. In support of this position, Aggleton and Shaw [1], in their reanalysis of cases reported in the literature, claim that

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amnesic patients with bilateral anoxic damage limited to the hippocampal structures show only mild deficits or near-normal performance on the Warrington Recognition Memory Test for faces [42]. Thus, these findings from preoperative studies and amnesic patients argue for a contribution from the temporal neocortex to the recognition of newly learned faces.

Further evidence of an important role of the right temporal-lobe structures in memory for faces comes from a study of patients with Alzheimer's disease, using structural neuroimaging and a recognition memory paradigm. Cahn et al. [6] measured the volume of the hippocampus, the temporal horn and the temporal cortex in each hemisphere in patients with Alzheimer's disease and correlated each of these volumes with performance on the Warrington Recognition Memory Test. They found that recognition memory for previously unfamiliar faces correlated significantly with the volume of both the right hippocampus and the right temporal cortex; the volume of the right temporal horn did not predict performance on the face memory task, nor did any of the left-hemisphere volumes.

The present study explored the medial temporal contribution to face memory by examining recognition memory for recently seen photographs of previously unfamiliar faces in groups of patients who had undergone either anterior temporal lobectomy or the relatively new surgical procedure of selective amygdalo-hippocampectomy. As the name implies, selective amygdalo-hippocampectomy is a removal primarily from the medial temporal region. By comparing the performance of these groups with that of groups of patients with anterior temporal lobectomy, where the removal either largely spares or invades the hippocampal zone, the unique contribution to face memory from the medial temporal region can be examined.

The right hemisphere appears to play a predominant role, not only in memory for faces, but also in perception of faces [11,19,24,33,38,42,44]. Consistent with this right-hemisphere predominance, mild impairments in face perception have also been found in groups of patients with right anterior temporal lobectomy [19,24] using the Mooney Closure Faces Test [29], in which subjects must visually organize a percept of a face from degraded images. These perceptual impairments probably resulted from the damage to inferolateral temporal cortex in these patients because preliminary results showed normal performance on this closure task in three patients with right selective amygdalo-hippocampectomy [25]. We decided to confirm this observation by testing a larger group of patients with unilateral selective amygdalo-hippocampectomy. Demonstrating normal face perception in this patient population and deficient face perception in the groups with right anterior temporal lobectomy would have several implications. First, such results would imply that the right anterolateral temporal neocortex has an important role in face perception, whereas the medial temporal region is not crucial for this cognitive function. A second implication would be that the remaining lateral and inferior temporal neocortex was functioning normally after the selective amygdalo-hippocampectomy procedure.

2. Methods

2.1. Subjects

The subjects were 20 neurologically normal volunteers and 88 patients of the Montreal Neurological Hospital. The patients had each undergone a unilateral excision from the temporal lobe for the relief of medically intractable focal epilepsy or low-grade tumour, and they had returned for postoperative neuropsychological evaluation, either 3 months after surgery or in long-term follow-up, 1–13 years later. All such patients who agreed to participate were tested. Excluded from the sample was any patient who showed evidence of bilateral or right-sided speech representation, as demonstrated by preoperative intracarotid sodium amobarbital tests [26,41]. Excluded also were those patients whose Full-Scale IQ rating on the revised Wechsler Adult Intelligence Scale [43] was below 75, or who showed radiological or electrographic evidence of damage extending outside the lobe of resection.

Patients were classified into one of six groups according to the surgeon's operation report. There were 29 patients who had undergone selective amygdalo-hippocampectomy, 14 in the left hemisphere (LAH) and 15 in the right (RAH). In this procedure, a narrow corridor is made through the first or second temporal gyrus or through the floor of the superior temporal sulcus. Through this corridor, the surgeon removes the medial structures, including most of the amygdaloid nuclei and the anterior 2–3 cm of the hippocampal formation along with the surrounding structures of the parahippocampal gyrus, while sparing the rest of the lateral and inferior temporal neocortex [34]. Magnetic resonance images (depicted in Fig. 1 bottom row), show the typical extent of removal in the RAH procedure, as practised at the Montreal Neurological Hospital. The remaining 59 patients had each received a unilateral anterior temporal lobectomy, which usually included the polar cortex, most of the amygdaloid nuclei, together with varying amounts of the hippocampal formation, the parahippocampal gyrus and the lateral neocortex. The temporal-lobectomy group was further subdivided by side and then by extent of hippocampal excision. The hippocampal excision was said to be small or large, based on whether or not it exceeded 1.5 cm of hippocampus removed; 39 patients had a large