SHORT REPORT

Identification without naming: a functional neuroimaging study of an anomic patient

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Abstract

The neural correlates of identification and name retrieval have proved difficult to characterise because both occur highly automatically in normal language processing. Thus, although some evidence points to the left anterior temporal cortex (ATC) as a brain region underlying these functions, its relative role in semantic and lexical retrieval processes is still a matter of debate. Positron emission tomography (PET) was used to measure regional cerebral blood flow responses to famous and non-famous visually presented faces and buildings in a severely anomic patient and in six control subjects, while they were performing a same-different matching task. Because the patient was able to identify the stimuli that he could not name, it was possible to investigate whether the left ATC would respond when identification occurred without name retrieval. Both the patient and the controls activated the left ATC when famous stimuli were compared with non-famous stimuli. This result supports the hypothesis of a predominantly semantic function of the left ATC.

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Converging evidence indicates that the two processes of identifying and retrieving the name of a known face are accomplished serially.¹ For instance, psychological investigations have demonstrated that, whereas it is common to identify a face without temporarily being able to retrieve its name, the opposite situation, remembering a person's name without remembering to whom it belongs, seems to be extremely rare.² Consistently, neuropsychological patients can either show difficulties on famous face identification and naming—that is, prosopagnosia³ and loss of knowledge about people^{4 5}—or a deficit confined to naming only—that is, proper name anomia.⁶ Although the dissociation between identification and naming seems to be clearly established at a cognitive level, at the anatomical level it has been particularly difficult to segregate the two processes and their respective neuronal substrates. Lesion-deficit associations are subject

to the inevitable problem of poor anatomical definition, whereas functional imaging studies of healthy volunteers have not disentangled identification and naming because in normal object recognition they occur together automatically. Thus, whereas the fusiform gyrus has been consistently involved in presemantic stages of the face recognition process,⁷ the relative role of the anterior portions of the temporal cortex in identification or naming of famous people is still a matter of debate. Proper name anomia has been associated with various lesion sites in the left hemisphere,⁸ whereas the few patients with loss of biographical knowledge from both faces and names have had infectious or degenerative diseases that typically involve the ATC bilaterally.^{4–5} Functional neuroimaging studies have shown left ATC responses to be greater for (1) semantic processing of objects and words,⁹ (2) naming famous people compared with naming objects and animals,¹⁰ and (3) viewing famous faces, proper names, and buildings compared with their non-famous counterparts, when same-different judgements are made on visually presented pairs of stimuli.^{10–11} These results suggest that the left ATC is involved in retrieving specific and unique semantic associations about known items. However, the possibility that activation also reflects automatic name retrieval cannot be excluded.

The aim of our study was to investigate whether incidental identification of famous faces and buildings activated the left ATC in a severely anomic patient who retained the ability to retrieve correct semantic information about the stimuli that he could not name. The patient underwent PET while performing a same-different matching task on visually presented pairs of pictures depicting famous and non-famous faces and buildings. His results were compared with activations obtained from six control subjects. Greater activation in the left ATC for famous versus non-famous stimuli in the patient would indicate a role of this region in semantic rather than in pure lexical retrieval processes.

Case report

CLINICAL HISTORY

The patient was a 23 year old right handed man born in Pakistan, who came to the United Kingdom when aged 3. He obtained a univer-

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sity degree and at the time of illness, was studying to be an optometrist. He was admitted to the National Hospital for Neurology and Neurosurgery on 22 February 2000 with a 4 week history of progressive language difficulties, headache, and more recently somnolence and vomiting. On admission he had severe language difficulties and was dyslexic (see below). There was a mild right hemiparesis and an impairment of superficial sensation and proprioception on the right. Brain MRI showed two large cystic lesions, in the left frontal and left posterior temporoparietal regions. Brain PET data were obtained on 24 February 2000. A biopsy of the frontal lesion, performed on 28 February 2000, disclosed a malignant primitive neuroectodermal tumour (grade 4). Subsequently he developed progressive drowsiness with papilloedema and died on 13 March 2000. A postmortem study was not performed.

NEUROPSYCHOLOGICAL ASSESSMENT

The patient exhibited a significant degree of intellectual decline on the shortened version of the WAIS-R (verbal IQ=68; performance IQ=72). He was impaired on the verbal (12/25) and visual (19/25) version of the short recognition memory test.¹³ He was severely dyslexic and dyscalculic. Thus, he was unable to read any words on the National adult reading test and he was not able to score on an oral graded difficulty calculation test.¹⁴ His spontaneous speech was fluent and well articulated. Phrase length was normal; however, marked anomia was noted. On formal testing he scored only 2/30 on the graded naming test¹⁵ and 15/30 on the Oldfield picture naming test.¹⁶ However, he could provide specific semantic information about most of the stimuli that he could not name. Despite his severe oral anomia his word comprehension skills were relatively well preserved. His performance was in the normal range on a graded synonym judgement on concrete words.¹⁷ He could also retrieve defining information about 10/12 famous faces, despite being able to name only 2/12.¹⁸ His visuoperceptual abilities were normal; he obtained good scores on the unusual views test¹⁹ and on the unfamiliar face matching test.²⁰

To summarise, the patient's neuropsychological assessment showed: (1) absence of presemantic perceptual deficit, (2) preserved ability to retrieve semantic information about visual stimuli, and (3) severe anomia.

Methods

The patient and six healthy, right handed, education and age matched, native English speaking control subjects participated in the study (age range: 19–25; mean education: 14 years). All gave informed consent and the study was approved by the local hospital ethics committee.

Each subject underwent 12 PET relative perfusion scans while deciding whether two visual stimuli, displayed simultaneously as pairs in the centre of a computer screen, were the same or different. Although the task was constant, the stimuli could be famous or non-famous faces or buildings. Scrambled pic-

tures were used as controls, thus creating six different conditions each repeated twice (for details of the face stimuli and general procedure see Gorno-Tempini *et al.*¹¹ The same criteria were used for the famous buildings. The pairs were presented at a rate of one every 5 seconds, with 1 second of interstimulus interval, so that 10 pairs were seen in each scan. Subjects gave a key-press response; the right button for the same and the left button for different pairs. The patient performed exactly the same task as the control group but used his left hand (motor responses were controlled over conditions). Reaction times and accuracy were recorded.

After the PET session, the famous stimuli were shown again and subjects were asked to name them. When name retrieval was unsuccessful, the patient was asked to provide defining information, such as profession for the faces and country of origin for the buildings. When this was unsuccessful, he was asked to make a familiarity judgement.

Scans were obtained using a SIEMENS/CPS ECAT EXACT HR+ (model 962) PET scanner (Siemens/CTI, Knoxville, TN, USA) with collimating septa retracted. Participants received a 20 second intravenous bolus of $H_2^{15}O$ at a concentration of 55 Mbq/ml and a flow rate of 10 ml/min through a forearm cannula. For each subject, a T1 weighted structural MR image was obtained with a 2 Tesla Magnetom VISION scanner (Siemens, Erlangen, Germany).

Data were analysed with Statistical parametric mapping (SPM99 software from the Wellcome Department of Cognitive Neurology, London, UK: <http://www.fil.ion.ucl.ac.uk/spm>) using standardised procedures.²¹ The smoothing kernel applied was a 3D gaussian filter of 16 mm. Each subject was modelled separately using a "multisubject: condition and covariates" model.

A conjunction analysis of the main effect of fame (famous *v* non-famous faces and buildings) in the patient with the same contrast in the control group was performed. The conjunction was inclusively masked at $p < 0.01$ with the same contrasts. When considering the whole brain, we accepted a level of significance of $p < 0.05$ corrected for multiple comparisons for the entire brain volume. However, when investigating the left ATC region of interest, we performed a small volume correction on a 30 mm radius sphere centred at the peak activation of the contrast famous versus non-famous stimuli in our previous study¹¹ (coordinates of $-54, -8, -26$).

Results

BEHAVIOURAL DATA

Both the patient and the control group performed the task making less than three errors. The patient's reaction times were within 2 SD of the mean of the group of control subjects for all conditions.

On average normal subjects could name 26/28 faces and 24/28 buildings. By contrast, the patient named 6/28 faces and 5/28 buildings. However, he could provide uniquely

defining biographical information about 26/28 faces and 22/28 buildings. For instance, when presented with a picture of Princess Margaret he was unable to recall her name but he said "She is the sister of the Queen". In the familiarity decision on the two faces and six buildings he could not identify, he recognised as familiar 1/2 faces and 5/6 buildings.

ACTIVATION RESULTS

The tumour caused a considerable amount of distortion in the patient's brain and did not allow a satisfactory normalisation of the

parietal-occipital cortices and of the cerebellum. However, the lateral ATC was not involved in the pathological process. Therefore, after normalisation, the region of interest in the anterior part of the middle temporal gyrus corresponded to the same area in the normal control group (figure). This region in the left ATC was activated by both the patient and the control group (table). The conjunction analysis reached a corrected level of significance in the region of interest (see method section). In the whole brain analysis no other area reached a significant level of activation. However, the

Coronal, axial, and sagittal views of the normalised patient's structural MRI image (right column) and of the Montreal Neurological Institute standard brain (left column). The figure shows that the normalisation process gave satisfactory results in the left ATC, whereas it was not able to compensate for the dislocation of the parietal, occipital, and cerebellar regions. The superimposed activation indicates the locus of the left ATC that was activated in the contrast famous versus non-famous stimuli in both the patient and the control group.

Coordinates and Z values (in parentheses) of the conjunction and simple main effects of famous v non-famous stimuli in the patient and in the control group

Area (BA)	Conjunction		Patient		Controls	
Left anterior temporal (21/38)	-62, -8, -20	(4.4)	-66, -4, -14	(3.2)	-66, -2, -20	(3.3)
	-64, -14, -20	(4.0)	-66, -6, -18	(3.0)	-66, -14, -18	(3.2)
	-42, -10, -40	(4.1)	-36, -10, -44	(3.6)	-50, -20, -40	(3.4)
Precuneus (31)	8, -60, 20	(4.4)	12, -60, 22	(3.0)	-10, -58, 24	(3.2)

precuneus (table) has been previously found for famous versus non-famous faces.¹¹

Discussion

To date, neuropsychological and functional neuroimaging studies of normal subjects have been unable to determine whether the left ATC is necessary for semantic or lexical retrieval, or both. The present study combined the two methodologies by performing PET on an anomic patient who retained the ability to identify most of the stimuli that he could not name. We therefore investigated the neural correlates of a pathological dissociation between two processes (identification and naming) that are normally highly automatic. This allowed us to specify the function of the brain region (left ATC) that in normal subjects would respond to both. This represents a new approach to the utilisation of functional neuroimaging techniques in neuropsychological patients.

We found that our severely anomic patient, like the control subjects, activated the left ATC in response to famous relative to non-famous stimuli. This finding indicates that successful name retrieval is not necessary to elicit its activation. Normal activation in the left ATC in the patient suggests that this region is predominantly involved in retrieving appropriate semantic information about known items.

Using this approach of combining neuropsychology and neuroimaging, future studies should further elucidate the role of the ATC and of other brain regions.

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