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Cortical processing in persistent vegetative state

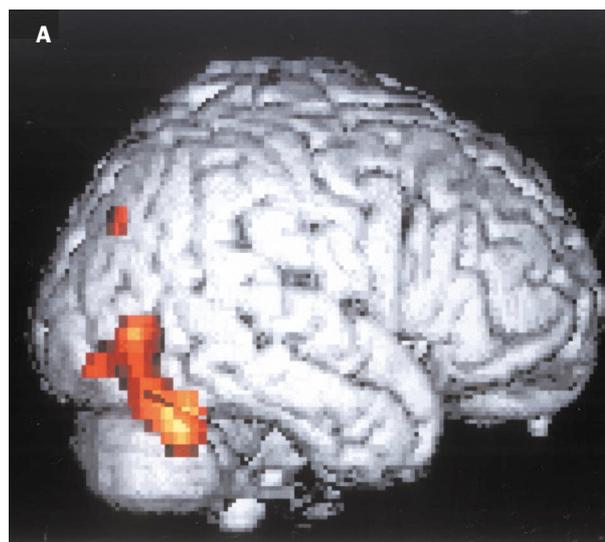
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Reductions in cerebral blood flow and glucose metabolism have been reported in patients in persistent vegetative state.¹ A few studies have suggested residual cortical activity.^{2,3} Objective assessment of residual cognitive function is difficult because motor responses may be small or inconsistent. We used positron emission tomography to study covert cognitive processing in a patient in a persistent vegetative state.

A 26-year-old woman had an acute febrile illness and became comatose. Clinical findings and examination of cerebrospinal fluid were consistent with acute disseminated encephalomyelitis. Magnetic resonance imaging showed hyperintensity in the brainstem, and small foci of hyperintensity in both thalami and in the medial right temporal lobe on T2-weighted images. 4 months after admission, she had a tracheostomy, was fed through a gastrostomy, and was doubly incontinent. Her eyes opened spontaneously and she had sleep-wake cycles. Despite repeated examination, she showed no consistent spontaneous or elicited motor responses or eye movements to suggest she could communicate. Electroencephalograms were consistent with a thalamic lesion, complicated by possible cortical ischaemia. The pons and mid-brain components of the brainstem auditory evoked responses were abnormal on both sides, but a delayed auditory oddball P300 could be detected. Functional imaging studies were undertaken to look for evidence of preserved but covert cortical processing.

Face-recognition was tested after a rapid infusion of H₂¹⁵O. Photographs of faces familiar to the patient were shown on a computer screen. Control images were generated by repixelating the same photographs to remove structure from the images. Subtraction of control from test images showed a significant focus of activation in the right fusiform gyrus (Brodmann's area 37), which spread ventrally to the most dorsal part of the cerebellum and posteriorly to include extrastriate areas 18 and 19 (figure). 2 months after this study (6 months after her illness began) she became increasingly responsive, and at the time of acceptance of this manuscript (8 months after her illness) she clearly recognised faces and used short sentences, such as "Don't like physiotherapy".

Activation patterns in this patient correlate closely with results from previous studies with similar tests.^{4,5} It is difficult



Brain area	Stereotactic coordinates			p	
	X	Y	Z	Z score (uncorrected)	
Right hemisphere					
Mid fusiform gyrus (area 37)	38	-64	0	3.90	0.001
Mid fusiform gyrus (area 37/19)	44	-66	-20	3.65	0.001
Extrastriate cortex (area 19/18)	42	-84	-12	3.36	0.001
Dorsal cerebellum	52	-58	-28	4.07	0.001

A Surface rendered normalised magnetic-resonance image

Areas of cortical activation produced by face recognition compared with control.

B Stereotactic coordinates of foci of significant activation

Face perception compared with perception of scrambled visual stimuli.

to make judgments about awareness or consciousness based on these results; however, it is clear that she not only perceived visual stimuli, but also processed them to recognise content that was not based on primary image attributes such as colour, brightness, size, or movement. Further studies may more closely correlate functional imaging with behavioural assessment, electrophysiological findings, and eventual outcome.

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