
Effective connectivity of the right fusiform face area through concurrent intracerebral electrical stimulation and frequency-tagged visual presentation

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Abstract

The neural basis of human face recognition has been extensively studied for decades. The key role of several face-selective brain regions in the ventral occipito-temporal cortex (e.g., in the fusiform gyrus and inferior occipital gyrus) has been established, but the functional organization of the cortical face network remains largely unknown.

To define the effective connectivity of this network, we apply direct electrical stimulation (DES) through intracerebral electrodes (SEEG) and combine it with fast periodic visual stimulation (FPVS). Electrodes implanted intracerebrally in drug-resistant epilepsy patients allow us to stimulate a local node of the network and record the functional activity of other implanted regions, with high spatial and temporal resolution.

We describe this original combination of techniques in one case: CJ, a right-handed 43-year-old woman with refractory focal epilepsy, excellent face recognition ability, and key implantations in face-selective regions of the right lateral fusiform gyrus (latFG; ‘FFA’) and bilateral ventral anterior temporal cortex (vATL). This specific patient is of note as it constitutes the first case of transient face identity recognition impairment induced by focal stimulation of the right FFA (Volfart et al., in prep). CJ was presented with 60-second sequences of natural images of familiar faces alternating at a 6Hz rate, while focal stimulation (1,2mA at 55Hz) was applied to the face-selective right latFG for 10s.

During stimulation, we found a reduction of significant 6Hz responses to famous faces not only locally (right latFG), but also in remote face-responsive electrodes of the right and left vATL. As these electrophysiological effects represent an explicit modulation of responses to familiar faces, they suggest functional connectivity between these areas. Interestingly, the stimulations that led to significant electrophysiological effects were also associated with the clearest behavioural impairment: during these stimulations, the patient was not able to recognize the famous faces displayed on the screen.

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Although these results concern only one patient, this original combination of techniques appears to be effective and its application on a wide sample of individual brains could provide key information regarding the connectivity of well-defined functional brain networks.

Keywords: face recognition, cortical face network, effective connectivity, SEEG, FPVS, direct electrical stimulation