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Imaging covert cognition and consciousness

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Neuroimaging active, passive and resting state paradigms are being employed to investigate residual brain function of patients in a vegetative state/unresponsive wakefulness syndrome (VS/UWS) and minimally conscious states (MCS). Using fMRI, a patient behaviorally diagnosed as unresponsive could follow two mental imagery commands, i.e., imagine playing tennis and visit the rooms of her house. These commands were further used as communication system for a patient also diagnosed unresponsive to provide "yes"/"no" responses to simple questions. However, absence of command following does not necessarily entail absence of awareness. Aphasia problems may hinter patients from comprehending and/or responding. Alternatively, passive paradigms using external somatosensory and auditory stimulations have shown that only sensory cortices are activated in patients in VS/UWS; in contrast, patients in MCS show more widespread cortical activation including hierarchically higher-order association areas. When such experimental setups are complicated, resting state studies show that unresponsive patients' exhibit reduced global metabolism but recovery from VS/UWS does not necessarily coincide with resumption of global metabolic activity. Hence, some areas are more important than others to sustain conscious function. Indeed, patients in VS/UWS show impaired metabolism in midline and lateral frontoparietal cortices. Similarly using fMRI, posterior cingulate cortex, medial prefrontal cortex and posterior parietal cortices (areas broadly known as the default mode network) also show decreases in functional connectivity as a function of the level of consciousness. Such advances are expected to lead to medico-ethical and legal discussions, where patients' competency will potentially need to be re-established in a context of contemporary technology usage.

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