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Interaction between spontaneous fluctuation and auditory evoked activity during wakefulness and loss of consciousness

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Objectives: Functional MRI studies have identified spontaneous fluctuations in neural activity within auditory cortices during both wakefulness and unconsciousness. The functional significance of the preserved ongoing fluctuations during loss of consciousness remains however poorly understood. We here investigated the influence of spontaneous fluctuation in the auditory resting-state network on stimulus-evoked auditory responses under propofol anesthesia, as compared to wakefulness.
Methods: Simultaneous functional MRI and EEG data were acquired in 13 healthy volunteers (6 females, mean age 23±5 SD). All subjects underwent four sessions (wakefulness, mild sedation, loss of consciousness, and recovery of consciousness) where pure tones were presented with a randomized jitter. After obtaining an auditory network template from awake states, we identified a spontaneous auditory brain activity spatial map in each condition for each subject. Sounds were then classified into two classes: ‘up’ if the tone onset occurred within the upper half spontaneous auditory activity, and ‘down’ otherwise. Data were analyzed with SPM8 and FMRIB Software Library.
Results: During wakefulness, ‘up’ tones induced stronger cerebral activation than the ‘down’ tones, in a set of areas encompassing temporal, parietal, frontal and limbic cortices. During deep sedation, the effect of spontaneous activity was restricted to primary auditory cortices only. A correlation between the influence of spontaneous fluctuations on the responses to sounds and the level of consciousness was found in parietal, frontal and occipital cortices. A consciousness-dependent effect of spontaneous activity on the processing of stimuli was also found for stimulus-induced beta band synchronisation at a latency of 200 ms after the presentation of sounds.
Conclusion: During wakefulness, spontaneous auditory cortices fluctuations elicits large differences in activation (encompassing frontoparietal cortices) and beta synchronization in late latencies. In contrast, the localized effect of spontaneous activity in primary auditory cortices during loss of consciousness is unlikely to lead to changes in awareness of auditory stimuli. Our data suggest a graded correlation between the level of consciousness and the interaction between spontaneous and stimulus evoked activity. They shed light on the lack of functional significance of fluctuations observed during loss of consciousness for the processing of auditory stimuli.