

Event-Related EEG Dynamics During Short-Term Memory

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In this study, we investigated EEG dynamics occurring during a variation of the Sternberg task. By clustering event-related patterns of EEG spectral activity change across subjects, we show that in frontal, motor, parietal and occipital areas, letters marked to be memorized or ignored elicit different patterns of EEG power changes and that spatially and spectrally distinct activity patterns also occur before and following a memory probe. Each trial consisted of a sequence of eight letters, centrally presented (SOA 1400 ms), 3-7 of which were marked to be memorized (by their color, black). The remainder of the letters were of a different color (green), indicating they should be ignored. Following presentation of the letter sequence, subjects viewed a fixation point for 2-4 s, then responded to a presented probe letter by pressing either of two response buttons to indicate whether or not the probe had been among the letters to be memorized. Applied to the 71-channel EEG data, Independent Component Analysis (ICA) extracted 15-25 components per subject whose spatial projections strongly resembled projections of single equivalent dipoles. A novel clustering algorithm used spatial ICA to find common patterns of event-related change in spectral power across components and subjects. In some resulting clusters of components with occipital and parietal projections, power at alpha and beta frequencies *increased* during presentations of 'Ignore' letters, while *decreasing* during 'Memorize' letters. In midline frontal components, a ~13-Hz activity increase appeared 500 ms after onset of 'Memorize' letters. In these same components, (5-8 Hz) theta power progressively increased across the sequence (1→7) of 'Memorize' letters, though the same trend did not occur at 13 Hz. During the Maintenance period, two distinct activity-defined component clusters were found. One, localized predominantly to the right parietal and occipital areas, produced high alpha (9-12 Hz) power at the beginning of the Maintenance period that decreased before the Probe letter. The second, localized near the left motor cortex, was characterized by a maintained suppression of the mu rhythm (~10 and ~20 Hz). Presentation of the Probe letter was also accompanied by several patterns of spectral perturbation, each one appearing in a relatively discrete area of cortex. EEG rhythms produced by local partial synchronization of extra-cellular field activity in compact cortical domains may act to promote or inhibit information inflow and/or outflow in the involved cortical domains to regulate attention, association and memory.