Previous studies showed that event related EEG delta coherence increased upon application of cognitive load in healthy young subjects. The decrease of delta coherence in Alzheimer’s disease patients was reported in comparison to healthy controls during cognitive load. However, when the stimulation was just visual sensory no differences between healthy controls and Alzheimer patients were found (Başar et al. 2010, Güntekin et al. 2008). The present study aims to analyze event related delta coherence in patients with Parkinson’s disease with and without cognitive deficits during application of visual oddball paradigm.

Methods: 10 patients with cognitively normal Parkinson’s disease, 14 patients with mild cognitive impairment (mild cognitive impairment or dementia) Parkinson’s disease and 10 age matched healthy controls were included in the study. EEG was recorded at 32 electrode sites upon application of visual oddball paradigm. The intra-hemispheric event related delta (1–3.5 Hz) coherence was analyzed for target stimulation and for F3, TP3, F4, TP4, P3, P4, O1, O2, C3, C1, C2, P3, P4, C1, C2, O1, O2, electrode pairs.

Results: The results of the present study showed that both patient groups of Parkinson’s disease had lower values of delta coherence than healthy controls in the range of 28%–56%. This difference was significant between healthy controls and cognitively impaired Parkinson’s disease patients (p < 0.05). This difference was mostly significant over F3, TP3, F4, TP4, P3, P4, C3, C1, O1, O2, electrode pairs (p < 0.05 for all electrode pairs).

Conclusions: Both patient groups of Parkinson’s disease had lower values of event related delta coherence than healthy controls. Cognitively impaired patient group has the lowest values among all three groups. These results could show dementia or mild cognitive impairment in Parkinson disease had negative effects on the functional connectivity of the brain.

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Delta and theta oscillatory activity in human information processing

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Oscillatory dynamics of the brain provide a valid representation of mental processing. The complexities of the human mind can be represented by a limited number of frequencies because the functional meaning of a given oscillatory component vary according to a host factors that include: (1) enhancement, attenuation, blocking, duration, latency, time-locking, phase-locking and frequency-locking of the oscillations, (2) the topology that the oscillation is recorded from and, (3) the coherency function between different neural structures. The alpha and beta oscillations have been studied ever since Berger discovered them in 1929. The gamma oscillation is being studied since its discovery by Adrian in 1942. A review paper on the delta oscillations and the multiple functions that it represents has been possible only recently. Theta oscillation is even more complex. The role of the theta oscillation on the navigatory behavior earned O’Keefe and co-workers the Nobel Prize. Among the other mental processes that the theta component represents are selective attention, memory consolidation and episodic memory. The functional significance of the oscillations does not depend on only the oscillation-related variables. Among the many other variables is the developmental level of the subject. The study of the changes in the delta and theta responses in aging does not only have a scientific value but also provide norm values for field studies. Currently, the level that basic science on oscillatory dynamics has reached justifies its application to neuropsychiatric disorders. Amplitudes of low frequency and high-frequency spontaneous oscillations, amplitude of evoked and event-related oscillations, and coherency decrement in selective brain areas point to a set of potential biomarkers for AD and for the progression from the healthy state to mild cognitive impairment. Electroencephalography is an unexcelled technique with respect to temporal resolution but not to spatial resolution. Functional magnetic resonance imaging, on the other hand, offers a high spatial resolution. Future studies on brain’s cognitive processing may also make use of the equally noninvasive MRG for defining the regions that the oscillatory components are recorded from.

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Delta and theta oscillatory activity in physiological aging, mild cognitive impairment and Alzheimer Type Dementia

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Alzheimer’s disease (AD) is the most common neurodegenerative disease and mild cognitive impairment (MCI) is considered as its prodromal stage. There is a need to develop an efficient, low-cost and non-invasive biomarker with high resolution for the diagnosis and monitoring of MCI. Due to being non-invasive and low-cost analyses with a high temporal resolution, electrophysiological methods such as sensory-evoked and event-related oscillations are considered to be particularly useful in screening and monitoring of cognitive impairments. The term “sensory-evoked” indicates responses elicited upon simple sensory stimulation, whereas “event-related” indicates responses elicited upon a cognitive task. In addition, coherence measures reflect connectivity deficits in sensory and/or cognitive networks. In our previous studies, altered sensory-evoked and event-related brain oscillations were demonstrated in physiological aging, MCI and AD patients. Physiological aging causes widespread reductions in event-related delta responses and selective decreases in frontal theta responses. Moreover, event-related delta and theta responses were found to be associated with age negatively. AD patients showed increased sensory-evoked theta responses over posterior regions and decreased event-related delta responses in fronto-central regions. AD patients also demonstrated intact sensory-evoked coherences in all frequency bands and decreased event-related coherences in delta, theta and alpha frequency ranges. Moreover, event-related oscillations and coherences appeared to be sensitive to treatment effects, as higher theta event-related phase-locking and higher alpha event-related coherences were found in cholinergically treated AD patients compared to untreated patients. There was an electrophysiological continuum of event-related delta responses among healthy elderly, MCI, and AD and delta responses were significantly reduced in AD and MCI patients compared to controls during both auditory and visual cognitive tasks. MCI patients showed lower delta responses compared to healthy elderly, particularly in fronto-central areas and a positive correlation was observed between frontal delta responses and frontal volume in all MCI and healthy subjects as a whole group. One year follow-up of these MCI patients revealed that progressive MCI patients’ frontal delta responses were significantly reduced at baseline compared to stable