**EEG findings in MCI.** Reduced delta power during resting state EEG has been identified in patients with MCI (Liddell et al., 2007). Furthermore, in the study, individuals with MCI demonstrated a significant positive correlation between delta power and immediate memory recall. Liddell et al. (2007) proposed that these findings suggest that delta power may be linked to memory decline in MCI, indicating that it could serve as a sensitive indicator of prodromal or early cognitive decline. However, other studies have shown increased delta power in MCI patients compared to healthy controls, particularly in frontal and centroparietall regions (Adler, Bramesfeld & Jajcevic, 1999; Moretti, Zanetti, Binetti & Frisoni, 2012). A decrease in beta power has been found in individuals with mild AD (Hogan, Swanwick, Kaiser, Rowan & Lawlor, 2003).

***EEG in MCI and AD***

**D'Atri et al. (2021): https://doi.org/10.1016/j.isci.2021.102386**

The hallmark of the resting state EEG in patients with AD is the slowing of cortical rhythms, consisting of increased low-frequency (0.5-7.0 Hz) and decreased high-frequency activity (Babiloni et al., 2015; Jeong, 2004). Similar EEG features affect mild cognitive impairment (MCI) subjects, a condition being prodromal to AD in more than half of cases (Babiloni et al., 2006; Galluzzi et al., 2001; Petersen et al., 2001; Scheltens et al., 2002). The EEG slowing correlates with the functional, structural, and cognitive changes in the disease progression (Babiloni et al., 2006; Claus et al., 2000; Jelic et al., 1996) and has been considered an EEG expression of the neurodegenerative process (Dringenberg, 2000).

Results: The waking EEG activity recorded in the evening hours displayed significant differences at the prefrontal and right frontotemporal sites for the delta band and at the right occipital derivation only for the alpha band. Prefrontal delta power was significantly higher in the AD compared to the HC group, while the right frontotemporal delta activity increased in the AD compared to both the HC and MCI groups. As expected, the occipital alpha power was reduced in the AD and MCI groups compared to the HC group. In the morning EEG, the three groups showed differences only in the delta band with a prevalence of the delta activity in AD compared to both HC and MCI groups. On the other hand, the EEG activity of the MCI group differed from that of HC only at the frontal sites. Greater EEG slowing was associated with worse cognitive impairment, as indicated by lower MMSE scores.

**Liu, Wang, Xin, Wang, Jiang & Meng, 2024: https://doi.org/10.1186/s12877-024-05041-x**

**Commented [JH1]:** EEG in AD and MCI

**Commented [JH2]:** The EEG index that showed the strongest correlation with cognitive deterioration is the synthetic index of the EEG slowing during REM sleep. This result confirms previous findings (Montplaisir et al., 1996), and it also suggests that this composite index may be better suited as a disease marker than others based on cortical activity in a single frequency band measured during REM and NREM sleep or resting state, as well as than the same index evaluated during wakefulness.

**Commented [JH3]:** @article{d2021eeg, title={EEG alterations during wake and sleep in mild cognitive impairment and Alzheimer's disease}, author={D'Atri, Aurora and Scarpelli, Serena and Gorgoni, Maurizio and Truglia, Ilaria and Lauri, Giulia and Cordone, Susanna and Ferrara, Michele and Marra, Camillo and Rossini, Paolo Maria and De Gennaro, Luigi}, journal={Iscience}, volume={24}, number={4}, year={2021}, publisher={Elsevier} }

**Commented [JH4]:** EEG in cognitive impairment (MCI)

**Commented [JH5]:** @article{liu2024relationship, title={The relationship and pathways between resting-state EEG, physical function, and cognitive function in older adults}, author={Liu, Hairong and Wang, Jing and Xin, Xin and Wang, Peng and Jiang, Wanting and Meng, Tao}, journal={BMC geriatrics}, volume={24}, number={1}, pages={463}, year={2024}, publisher={Springer} }

Studies have found that EEG signals in older adults with cognitive impairment exhibit specific characteristics, such as a basic rhythm slowdown, manifested by an increase in low-frequency band (delta, theta) power and a decrease in high-frequency band (alpha, beta) power [8, 9]. Slowing of alpha power may be an early sensitive indicator of the brain transitioning from normal physiological function to aging or its pathological state [10], while increased theta power may have a good predictive effect on cognitive decline [11].

In individuals with cognitive impairment, acute exercise effects include decreased delta and theta power and increased beta1 power [18, 20]; longterm exercise appears to result in decreased delta [18, 20, 21] and theta rhythm power [19, 21], and increased alpha and beta rhythm power [18, 20, 22].

The left frontal area, located at the front of the brain, is associated with advanced cognitive functions, decision-making, problem-solving, and personality traits. It plays a role in executive functions, emotional regulation, and modulation of social behavior.

The severity of cognitive impairment is positively correlated with increased theta activity, and an increase in theta waves in EEG serves as a good predictor of cognitive decline [36].

As the activation level of the frontal lobe cortex increases, theta wave power decreases, leading to improved cognitive function. A decrease in theta wave power was observed after both single and prolonged exercise [17].

**Finnigan & Robertson, 2011**: https://doi.org/10.1111/j.1469-8986.2010.01173.x

We address the degree to which resting EEG bandpower is associated with cognitive performance in 73 healthy older adults (aged 56–70). Relative theta (4–6.5 Hz) power was significantly correlated with immediate and delayed verbal recall, attention, and executive function measures. Relative delta and alpha power and peak alpha frequency did not correlate with any cognitive measures. These data indicate that high resting theta power in healthy older adults is associated with better cognitive function and may be a marker of healthy neurocognitive aging.

In summary, these outcomes indicate that high resting-state theta power in older adults is associated with relatively greater cognitive impairment; whereby such impairment either may already exist, be developing, and/or may (be predestined to) subsequently manifest or increase (this is from introduction).

Across 73 healthy older adults, relative resting theta power was significantly correlated with performance on numerous cognitive tests, which assess verbal memory, attention, or executive function.

**Commented [JH6]:** 8. Lejko N, Larabi D I, Herrmann C S, et al. Alpha Power and Functional Con-
nectivity in Cognitive decline: a systematic review and Meta-analysis [J]. J
Alzheimers Dis. 2020;78:1047–88.
9. Garrido-Chaves R Perezv, Zapater-Fajarí M, et al. EEG markers and subjec-
tive memory complaints in young and older people [J]. Int J Psychophysiol.
2022;182:23–31.

**Commented [JH7]:** 10. Babiloni C, Ferri R, Noce G et al. Abnormalities of Cortical Sources of Resting
State Alpha Electroencephalographic Rhythms are Related to Education
Attainment in Cognitively Unimpaired Seniors and Patients with Alzheimer's
Disease and Amnesic Mild Cognitive Impairment [J]. Cerebral cortex (New
York, NY: 1991), 2021;31(4):2220-37

**Commented [JH8]:** 11. Musaeus C S, Engedal K, Høgh P, et al. EEG Theta Power is an early marker of
Cognitive decline in Dementia due to Alzheimer's disease [J]. J Alzheimer's
Disease: JAD. 2018;64(4):1359–71.

**Commented [JH9]:** 18. Amjad I, Toor H, Niazi I K, et al. Therapeutic effects of aerobic exercise on EEG parameters and higher cognitive functions in mild cognitive impairment ...

**Commented [JH10]:** 20. Amjad I, Toor H, Niazi I K, et al. Xbox 360 Kinect Cognitive games improve ...

**Commented [JH11]:** 18. Amjad I, Toor H, Niazi I K, et al. Therapeutic effects of aerobic exercise on EEG ...

**Commented [JH12]:** 20. Amjad I, Toor H, Niazi I K, et al. Xbox 360 Kinect Cognitive games improve ...

**Commented [JH13]:** 21. Styliadis C, Kartsidis P, Paraskevopoulos E, et al. Neuroplastic effects of com- ...

**Commented [JH14]:** 19. Hong S G, Kim J H, Jun TW. Effects of 12-Week Resistance Exercise on Elec- ...

**Commented [JH15]:** 21. Styliadis C, Kartsidis P, Paraskevopoulos E, et al. Neuroplastic effects of com- ...

**Commented [JH16]:** 18. Amjad I, Toor H, Niazi I K, et al. Therapeutic effects of aerobic exercise on EEG ...

**Commented [JH17]:** 20. Amjad I, Toor H, Niazi I K, et al. Xbox 360 Kinect Cognitive games improve ...

**Commented [JH18]:** 22. Jiang H, Chen S, Wang L et al. An investigation of limbs Exercise as a treat- ...

**Commented [JH19]:** 36. Babiloni C, Visser P J, Frisoni G, et al. Cortical sources of resting EEG rhythms in ...

**Commented [JH20]:** 17. Pedroso R V, Lima-Silva A E, Tarachuque P E, et al. Efficacy of Physical Exercise ...

**Commented [JH21]:** EEG in cognitive impairment (older adults)

**Commented [JH22]:** @article{finnigan2011resting, title={Resting EEG theta power correlates with cognitive performance in healthy older adults}, author={Finnigan, ...

**Lejko, Larabi, Herrmann & Aleman, 2020: https://doi.org/10.3233/JAD-200962**

We have therefore decided to take the first step by focusing on the alpha band for three main reasons.

First, alpha is the most prominent rhythm during quiet wakefulness [33]. Second, it has large amplitudes ranging from 10 to 50 V [34]. This is in contrast to theta, beta, and gamma waves, which have smaller amplitudes at rest [34–36], and can be best identified using tasks with many repetitions. This makes measuring alpha activity in research and clinical practice highly feasible, as it does not require people with cognitive decline to perform challenging and tiresome tasks.

Lastly, lower power and synchronization of alpha oscillations have consistently been associated with neurodegenerative dementias, especially AD [29, 37–39]. These decreases were found to correlate with lower cognitive scores [40, 41], higher atrophy of the hippocampus [42] and higher amyloid burden [43], as well as with genetic susceptibility for AD [44, 45]. Though alpha activity in other neurodegenerative dementias is less well-researched, there is evidence of lower alpha power in people with dementia due to Lewy body disorders [46–49]. Alpha power and synchronization are therefore an important part of the changes in the EEG spectrum associated with cognitive decline.

**Babiloni et al. (2011): https://doi.org/10.3233/JAD-2011-0051**

It has been reported that a positive ERP peaking 600 ms after the zerotime of stimuli to be encoded (P600) was reduced in patients with AD and mild cognitive impairment (MCI), particularly in those MCI patients who subsequently converted to AD [7, 8]. Furthermore, a positive ERP peaking 300 ms after the zerotime of oddball stimuli (P300) was reduced in amplitude in AD patients [5, 9], even during its early stages [10].

When compared to the resting state EEG rhythms of healthy normal elderly (Nold) subjects, AD patients showed an amplitude increase of widespread delta and theta sources and an amplitude decrease of posterior alpha (8–13 Hz) and/or beta (13–30 Hz) sources [45, 55, 56, 76–78]. The observation of these abnormalities of the EEG rhythms could allow discrimination among different dementia diagnoses, for instance a marked decline of posterior slow-frequency alpha power shows peculiar features in mild AD subjects when compared to cerebrovascular dementia, fronto-temporal dementia and normal elderly subjects with similar cognitive impairment.

Furthermore, pathological increased amplitude of the theta sources characterized cerebrovascular dementia patients [56].

**Commented [JH23]:** EEG in AD (alpha)

**Commented [JH24]:** @article{lejko2020alpha, title={Alpha power and functional connectivity in cognitive decline: a systematic review and meta-analysis}, author={Lejko, Nena and Larabi, Daouia I and Herrmann, Christoph S and Aleman, Andre and {\'C}ur{\v{c}}i{\'c}-Blake, Branislava}, journal={Journal of Alzheimer's disease}, volume={78}, ...

**Commented [JH25]:** 33] Britton JW, Frey LC, Hopp JL, Korb P, Koubeissi MZ, Lievens WE, Pestana-Knight EM, St EL (2016) ...

**Commented [JH26]:** [34] Herrmann CS, Demiralp T (2005) Human EEG gamma oscillations in neuropsychiatric disorders. Clin Neuro- ...

**Commented [JH27]:** [34] Herrmann CS, Demiralp T (2005) Human EEG gamma oscillations in neuropsychiatric disorders. Clin Neuro- ...

**Commented [JH28]:** 29] Jeong J (2004) EEG dynamics in patients with Alzheimer's disease. Clin Neurophysiol 115, 1490-1505 ...

**Commented [JH29]:** 40] Babiloni C, Binetti G, Cassetta E, Dal Forno G, Del Percio C, Ferreri F, Ferri R, Frisoni G, Hirata K, Lanuzza B, ...

**Commented [JH30]:** [42] Babiloni C, Frisoni GB, Pievani M, Vecchio F, Lizio R, Buttiglione M, Geroldi C, Fracassi C, Eusebi F, Ferri ...

**Commented [JH31]:** [43] Michels L, Muthuraman M, Anwar AR, Kollias S, Leh SE, Riese F, Unschuld PG, Siniatchkin M, Gietl AF, Hock C ...

**Commented [JH32]:** [44] Babiloni C, Benussi L, Binetti G, Bosco P, Busonero G, Cesaretti S, Dal Forno G, Del Percio C, Ferri R, Frisoni G, ...

**Commented [JH33]:** [46] Andersson M, Hansson O, Minthon L, Ros´en I, Londos E (2008) Electroencephalogram variability in dementia with ...

**Commented [JH34]:** EEG in MCI and AD

**Commented [JH35]:** @article{babiloni2011resting, title={Resting state cortical rhythms in mild cognitive impairment and Alzheimer's disease: ...

**Commented [JH36]:** [7] Olichney JM, Morris SK, Ochoa C, Salmon DP, Thal LJ, Kutas M, Iragui VJ (2002) Abnormal verbal event ...

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**Commented [JH38]:** Polich J, Corey-Bloom J (2005) Alzheimer's disease and P300: review and evaluation of task and modality. Curr ...

**Commented [JH39]:** [45] Dierks T, Jelic V, Pascual-Marqui RD, Wahlund L, Julin P, Linden DE, Maurer K, Winblad B, Nordberg A (2000) ...

**Commented [JH40]:** 56] Babiloni C, Binetti G, Cassetta E, Cerboneschi D, Dal Forno G, Del Percio C, Ferreri F, Ferri R, Lanuzza B, Miniussi C, ...

Despite the evidence of abnormal cortical rhythms in MCI and AD subjects, EEG analysis alone is unable to allow a diagnosis of disease.

The hypothesis of some strict relationships between brain activity in MCI and AD subjects implies the prediction of similar features of resting state EEG rhythm in MCI and AD subjects as a function of genetic risk factors.

**Farina et al., 2020**: **https://doi.org/10.1016/j.neuroimage.2020.116795**

Among the most promising EEG markers are reduced alpha power and increased theta power, as well as increased theta band functional connectivity (Cassani et al., 2017; Hatz et al., 2015; Musaeus et al., 2018). EEG ratios, such as theta/gamma and high alpha/low alpha, have also been suggested as promising markers (Moretti et al., 2012, 2009).

Similar to AD models, the best features for distinguishing aMCI from healthy ageing were increased theta and delta power in left temporo-parietal electrodes, while the best predictor of control status was increased frontal beta2 power. Theta and beta1 power also discriminated aMCI from AD participants; that is, higher theta in left frontal and right parietal electrodes was associated with AD status, and higher temporo-parietal beta1 power was associated with aMCI status.

The EEG markers highlighted here are consistent with the neurophysiological changes typically associated with AD; specifically, increases in slow wave activity (i.e., delta and theta) and decreases in fast wave activity (i.e., alpha and beta), which are thought to reflect loss of cholinergic innervations as the disease progresses (Cassani et al., 2018; Musaeus et al., 2018). Theta power was the best overall predictor of patient status, in line with the suggestion that increased theta is one of the first changes to occur in AD (Musaeus et al., 2018). Differences in theta were most pronounced at temporo-parietal sites, where connectivity between electrodes was increased in AD and aMCI. AD participants were distinguished from aMCI participants by increased theta in frontal and parietal electrodes, likely reflecting widespread changes that occur at advanced stages (Fraga et al., 2013). Higher delta power in left temporo-parietal areas was also indicative of patient status, though to a lesser degree, consistent with evidence that delta changes occur later (Roh et al., 2011). As expected, healthy ageing was associated with higher alpha power, both in amplitude (temporo-parietal areas) and connectivity (with frontal electrodes), and beta power, which was increased in controls relative to patients, and in aMCI relative to AD.

**Commented [JH41]:** EEG in MCI and AD

**Commented [JH42]:** @article{farina2020comparison, title={A comparison of resting state EEG and structural MRI for classifying Alzheimer’s disease and mild cognitive impairment}, author={Farina, Francesca R and Emek-Sava{\c{s}}, DD and Rueda-Delgado, L and Boyle, Rory and Kiiski, Hanni and Yener, G{\"o}rsev and Whelan, Robert}, journal={Neuroimage}, volume={215}, pages={116795}, year={2020}, publisher={Elsevier} }

**Fröhlich, Kutz, Müller & Claudia Voelcker-Rehagen (2021):** **https://doi.org/10.3389/fnagi.2021.675689**

Compared with healthy older adults, patients with Alzheimer's disease show decreased alpha and beta power as well as increased delta and theta power during resting state electroencephalography (rsEEG). Findings for mild cognitive impairment (MCI), a stage of increased risk of conversion to dementia, are less conclusive. Results indicate no rsEEG power differences between healthy individuals and those with MCI.

Thus, the hypotheses that MCI is characterized by lower alpha and beta power as well as stronger delta and theta power during EC could not be confirmed in our sample. This is not in complete agreement with prior findings of changes in the rsEEG in patients with MCI. For the rest with EC, it was shown that alpha and beta powers were reduced and theta and delta powers were either elevated or reduced in MCI compared with healthy OA (Koenig et al., 2005; Babiloni et al., 2006b, 2010; Kwak, 2006; Ya et al., 2015). In fact, when specifying former studies, each study only showed some of the listed changes, but the overlap between results was often not great even though similar parameters were studied.

**Commented [JH43]:** EEG in MCI and AD

**Commented [JH44]:** @article{frohlich2021characteristics, title={Characteristics of resting state EEG power in 80+-year-olds of different cognitive status}, author={Fr{\"o}hlich, Stephanie and Kutz, Dieter F and M{\"u}ller, Katrin and Voelcker-Rehage, Claudia}, journal={Frontiers in aging neuroscience}, volume={13}, pages={675689}, year={2021}, publisher={Frontiers Media SA} }

**Caravaglios et al., 2023**: **https://doi.org/10.1177/15500594221110036**

Amnesic-MCI had: i) increased delta/beta activity in the superior frontal gyrus and decreased alpha1 activity in the paracentral lobule (ie, default mode network); ii) greater delta/theta/alpha/beta in the superior frontal gyrus (i.e, attention network); iii) lower alpha in the left superior parietal lobe, as well as a lower delta/theta and beta, respectively in post-central, and in superior frontal gyrus(ie, attention network).

- ➔ Not that much about power, but other things

**Commented [JH45]:** EEG in MCI

**Commented [JH46]:** @article{caravaglios2023eeg, title={EEG resting-state functional networks in amnestic mild cognitive impairment}, author={Caravaglios, G and Muscoso, EG and Blandino, V and Di Maria, G and Gangitano, M and Graziano, F and Guajana, F and Piccoli, T}, journal={Clinical EEG and neuroscience}, volume={54}, number={1}, pages={36--50}, year={2023}, publisher={SAGE Publications Sage CA: Los Angeles, CA} }

**Özbek, Fide & Yener, 2021**: **https://doi.org/10.1016/j.clinph.2021.05.012**

Compared to healthy controls individuals with early-onset Alzheimer's disease (EOAD) showed an increase in slow frequency bands and a decrease in fast frequency bands. Frontal alpha/theta power ratio is the best discriminating value between EOAD and young HC with the sensitivity and specificity greater than 80% with area under the curve (AUC) 0.881.

This study is the first to report that resting-state EEG power can be a promising marker for diagnostic accuracy between EOAD and healthy controls.

Additionally, our study showed that resting-state alpha/theta power ratio can accurately discriminate between individuals with EOAD and healthy controls.

**Commented [JH47]:** EEG in AD (early-onset AD)

**Commented [JH48]:** @article{ozbek2021resting, title={Resting-state EEG alpha/theta power ratio discriminates early-onset Alzheimer's disease from healthy controls}, author={{\"O}zbek, Ya{\u{g}}mur and Fide, Ezgi and Yener, G{\"o}rsev G}, journal={Clinical Neurophysiology}, volume={132}, number={9}, pages={2019--2031}, year={2021}, publisher={Elsevier} }

**Perez, Duque, Hidalgo & Salvador, 2024:**

https://doi.org/10.1016/j.biopsycho.2024.108823

Over the years, a substantial body of research has amassed compelling evidence pointing to a progressive alteration in brain electrical activity in neurodegenerative disorders such as MCI or AD. This alteration is characterized by an increase in theta power and a decrease in beta power, followed in subsequent stages by a decrease in alpha power and an increase in delta power (Gouw et al., 2017; Jeong et al., 2021; Prichep et al., 2006).

In Iliadou's study, the MCI group exhibited a significant increase in overall delta power compared to the SCD group, highlighting distinctive spectral alterations. Moreover, in their spectral analysis comparing SCD and MCI, Sibilano et al. (2023) identified higher spectral power in the delta band that was associated with the clinical progression from SCD to MCI. Iliadou et al. (2021) observed lower spectral power in theta in SCD compared to individuals with MCI. Sibilano et al. (2023) utilized rsEEG to discriminate between SCD and MCI, identifying the delta and theta bands as discriminating the most between SCD and MCI. We identified six articles that reported alterations in alpha power in individuals with SCD compared to those with MCI and healthy control groups. Iliadou et al. (2021) observed a decrease in alpha spectral power in individuals with SCD compared to those with MCI. Individuals with SCD exhibited decreased alpha1, compared to the healthy control group, and increased alpha2 in the left temporal, central, and parietal cortex compared to those with MCI, as reported in the study by Mazzon et al. (2018). Iliadou et al. (2021) observed a decrease in beta spectral power in individuals with SCD compared to those with MCI. Additionally, Mazzon et al. (2018) identified a decrease in beta power in the left frontal regions when comparing the SCD group to the MCI group.

Overall, individuals with SCD exhibited a pronounced increase in theta spectral power compared to healthy controls, whereas those with MCI showed a further increment compared to individuals with SCD, indicating alterations across the MCI continuum. Similar alterations across the MCI continuum were observed in alpha spectral power.

Specifically, individuals with SCD displayed decreased alpha spectral power compared to healthy controls, but higher levels than in individuals with MCI. However, this trend is inconsistent because two studies reported increases, rather than decreases, in this band in both SCD and MCI. Additionally, findings for the delta and beta frequency bands are rather inconclusive, given that half of the studies did not identify significant effects within these bands. In the studies that did observe effects, an increase in delta was noted in individuals with SCD compared to healthy controls, as well as in individuals with MCI compared to

**Commented [JH49]:** EEG in SCD

**Commented [JH50]:** @article{perez2024eeg, title={EEG Frequency Bands in Subjective Cognitive Decline: A Systematic Review of Resting State Studies}, author={Perez, Vanesa and Duque, Ar{\'a}nzazu and Hidalgo, Vanesa and Salvador, Alicia}, journal={Biological Psychology}, pages={108823}, year={2024}, publisher={Elsevier} } individuals with SCD. The findings related to beta band activity are also unclear. Whereas one study reported an increase in beta band activity when comparing SCD and healthy controls, an examination of the MCI continuum reveals a tendency towards decreased beta band activity in individuals with MCI compared to those with SCD.

Furthermore, studies contrasting SCD and MCI reveal that rsEEG abnormalities persist and intensify as cognitive decline progresses. Our review revealed the following evidence: 1) increased delta power in individuals with SCD compared to both healthy controls and people with MCI, although these findings were not consistently reported across all the studies; 2) a progressive increase in theta frequency bands in individuals with SCD compared to healthy controls, which intensified when comparing MCI to SCD; 3) a decrease in the alpha frequency band in individuals with SCD compared to healthy controls, with this decrease being more pronounced in those diagnosed with MCI compared to SCD. However, this trend was not observed in two studies that compared individuals with SCD to healthy controls and individuals with MCI, respectively. In these studies, unexpected increases, rather than decreases, in alpha and beta frequency band spectral power were reported in the SCD groups compared to healthy controls, and in the MCI groups compared to the SCD groups; 4) a decrease in beta band activity was only noted in studies that compared MCI with SCD. Conversely, the other two studies reported increases in the frequency of this band.

**Jelic, Shigeta, Julin, Almkvist, Winblad & Wahlund (1996):**
**https://doi.org/10.1159/000106897**

A significant difference between the AD group and groups with objective and subjective memory disturbances was found for delta, theta, and alpha relative power. AD group significantly higher theta relative power in all investigated regions, and significantly lower alpha relative power in all investigated regions, in relation to the rest of the study population. For delta relative power, a lower level of significance ($p<0.05$) was observed in the left and right temporal and parieto-occipital, and left frontal regions. No significant difference was found for beta relative power in the groups studied, but a tendency towards higher values was observed in frontal regions in groups with objective memory disturbance and subjective memory complaints, as well as an increase in the left and right temporal and perieto-occipital regions in the AD group. A significant difference was found between the AD group and the other groups for mean frequency in the 4- to 20- Hz range in all regions, except for the left temporal region where the AD group was significantly different compared to controls and the

**Commented [JH51]:** EEG in AD and MCI / objective and subjective decline

**Commented [JH52]:** @article{jelic1996quantitative, title={Quantitative electroencephalography power and coherence in Alzheimer's disease and mild cognitive impairment}, author={Jelic, Vesna and Shigeta, Masahiro and Julin, Per and Almkvist, Ove and Winblad, Bengt and Wahlund, Lars-Olof}, journal={Dementia and Geriatric Cognitive Disorders}, volume={7}, number={6}, pages={314--323}, year={1996}, publisher={S. Karger AG Basel, Switzerland} } group with subjective memory disturbances. There was no significant difference in the mean frequency between AD patients and the group with objective memory disturbances in that region. All 4 spectral ratios were significantly lower in all investigated regions in the AD group. Significantly lower temporoparietal alpha band coherence was found in the AD group. A tendency towards a decrease in temporofrontal coherence was observed in the AD group. No significant differences between the groups with subjective or objective memory impairment when compared to the controls. The lack of clear qEEG changes in the present study in subjects with MCI can have at least two explanations. 1. Group is heterogeneous and, according to some follow-up studies, only a proportion of them will show further cognitive decline and develop manifest disease (4,9). 2. Some of these subjects have preclinical AD with pathology still restrictred to medial temporal lobes, which cannot be detected as changes in EEG power.

**Claus et al. (2000):** https://doi.org/10.1159/000017219

Slowing on the electroencephalogram (EEG) in patients with Alzheimer's disease (AD), compared to normal control subjects, evidenced by increase of theta activity and decrease of beta or alpha power, is a uniform finding in previous studies [1–5].

More impairment in overall cognitive function was most strongly reflected in loss of parieto-occipital and fronto-central alpha activity.

Detailed analysis of cognitive domains in relation to localized EEG values also revealed most consistently associations with decrease in alpha activity. Lower temporal and parietal rCBF were significantly associated with lower parieto-occipital alpha activity, while presence of leukoaraiosis was significantly associated with lower relative beta activity and higher absolute delta and theta activity.

General level of cognitive function, assessed in several previous studies with the MMSE, is most consistently related to alpha activity on EEG in AD patients [8, 13, 16 17, 46], in agreement with our findings. However, also correlations between overall cognitive function and delta and theta activity were observed in our study and in previous reports [13–16].

Alpha power as strongest correlate of cognitive domains finds support in the study of Jelic et al. [19], where visuospatial functions were strongly related to alpha power in left parieto-occipital and right temporal regions. In the study by Jelic et al. [19] measures of frontal lobe function, including attention and abstraction, were significantly related to fronto-central theta activity. We also found that, in addition to alpha activity, fronto-central theta activity was selected as a significant predictor of performance in attention and abstraction.

**Commented [JH53]:** EEG in cognitive impairment in AD

**Commented [JH54]:** @article{claus2000determinants, title={Determinants of quantitative spectral electroencephalography in early Alzheimer's disease: cognitive function, regional cerebral blood flow, and computed tomography}, author={Claus, JJ and Ongerboer de Visser, BW and Bour, LJ and Walstra, GJM and Hijdra, A and Verbeeten Jr, B and Van Royen, EA and Kwa, VIH and Van Gool, WA}, journal={Dementia and geriatric cognitive disorders}, volume={11}, number={2}, pages={81--89}, year={2000}, publisher={S. Karger AG Basel, Switzerland} }

**Commented [JH55]:** 88 Dement Geriatr Cogn Disord 2000;11:81–89 Claus/Ongerboer de Visser/Bour/Walstra/ Hijdra/Verbeeten/Van Royen/Kwa/
van Gool
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13 Dierks T, Frolich L, Ihl R, Maurer K: Correla-tion between cognitive brain function and elec-

**Commented [JH57]:** 13 Dierks T, Frolich L, Ihl R, Maurer K: Correla-
tion between cognitive brain function and elec-trical brain activity in dementia of Alzheimer type. J Neural Transm 1995;99:55–62.
14 Elmstahl S, Rosen I, Gullberg B: Quantitative EEG in elderly patients with Alzheimer's dis-ease and healthy controls. Dementia 1994;5:

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blad B, Wahlund LO: Quantitative electroen-cephalography power and coherence in Alz-heimer's disease and mild cognitive impair-ment. Dementia 1996;7:314–323

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blad B, Wahlund LO: Quantitative electroen-cephalography power and coherence in Alz-heimer's disease and mild cognitive impair-ment. Dementia 1996;7:314–323

Interestingly, our relative beta activity, but also absolute theta and delta activity, were significantly related to leukoaraiosis on CT. This analysis may demonstrate that increase of absolute theta and delta power is sometimes less clearly reflected in the relative power values.

This is probably due to the fact that theta and also delta power determine the main part of the total power. As, for instance, theta or delta increases, the total power more or less increases proportionally. An increase in theta or delta may then be reflected by the absolute power, rather than by the relative EEG values. The preclinical finding that beta activity is found in subcortical or lower cortical structures [51–53] may either suggest that neuronal function of these brain structures is compromised by the presence of leukoaraiosis or that leukoaraiosis results in disconnection of subcortical and cortical structures.

Thus, the results suggest that leukoaraiosis in AD patients is related to slowing of the EEG, evidenced mainly by increase of theta and loss of beta activity.

In conclusion, alpha activity may be closely associated with cognitive function and rCBF, while beta and theta activity are related to lower cortical or subcortical changes. Our study therefore suggests that the EEG bands reflect differential pathophysiologic changes in AD.

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1988;448:272–286

**Duffy, McAnulty & Albert (1995): https://doi.org/10.1093/cercor/5.3.215**

**Commented [JH61]:** EEG in AD

**Commented [JH62]:** @article{duffy1995temporoparietal, title={Temporoparietal electrophysiological differences characterize patients with Alzheimer's disease: a split-half replication study}, author={Duffy, Frank H and MCAnulty, Gloria B and Albert, Marilyn S}, journal={Cerebral Cortex}, volume={5}, number={3}, pages={215--221}, year={1995}, publisher={Oxford University Press} }

These results demonstrate that there are significant and topographically consistent alterations in qEEG in mild to moderately impaired AD patients. The qEEG differences between patients and controls were bet reflected by increased theta, decreased beta, and reducted amplitude in the long-latency VER and AER. Spectral findings were basically the same for both absolute and relative measures.

By EEG spectral analysis, theta was increased and beta decreased for the AD patients (abstract).

**Wada, Nanbu, Jiang, Koshino, Yamaguchi & Hashimoto (1997): https://doi.org/10.1016/0006-3223(95)00651-6**

**Commented [JH63]:** EEG in AD

**Commented [JH64]:** @article{wada1997electroencephalographic, title={Electroencephalographic abnormalities in patients with presenile dementia of the Alzheimer type: quantitative analysis at rest and during photic stimulation}, author={Wada, Yuji and Nanbu, Yuko and Jiang, Zheng-Yan and Koshino, Yoshifumi and Yamaguchi, Nariyoshi and Hashimoto, Takuma}, journal={Biological psychiatry}, volume={41}, number={2}, pages={217--225}, year={1997}, publisher={Elsevier} }

Compared with the normal controls, the AD patients had a significantly lower alpha-2 and beta band power in the resting EEG as well as a significant increase in delta and theta band power.

In addition, our patients were found to have a significantly lower EEG power for the alpha-2, beta-1 and beta-2 bands in the resting condition. These findings are in general agreement with those of earlier studies showing that AD patients had background EEG slowing with a reduction in alpha and fast activity (Liddell 1958; Swain 1959; Horie et al 1990; Miyauchi et al 1989, 1994).

Topographic analyses of the resting EEG showed a significant increase in delta band power at the frontal regions. This finding is consistent with that of previous EEG studies both with visual inspection (Liddell 1958; Swain 1959) and with significant probability mapping (Miyauchi et al 1989, 1994), in which delta activity was observed predominantly at the frontal areas.

Previous studies showed the relationships between cognitive impairment and EEG abnormalities in AD patients (Johannesson et al 1979; Sulkava 1982) although these studies evaluated EEG by visual inspection. Although in our AD patients the MMS score was positively correlated with alpha and beta band power of the resting EEG, no significant correlations were found with delta or theta band power.

**Schreiter-Gasser, Gasser & Ziegler (1993) : https://doi.org/10.1016/0013-4694(94)90144-9**

The degree of dementia is strongly reflected by an increase of power in the delta frequency band, accentuated on the left hemisphere, as well as a decrease of alpha activity. Longer duration of disease is associated with a decrease of power in the alpha frequency band, earlier age at onset with an additional increase of power in the theta frequency band. Visual EEG evaluation correlates highly with the degree of dementia, in contrast to visually assessed CCT. The quantitative EEG shows a surprising power in reflecting stages of Alzheimer's disease and indeed the most striking associations occurred between the degree of dementia and delta power. Correlations of absolute delta power with MMSE scores ranged typically from 0.6 to 0.9 at different locations. The delta band is by far the best indicator for the degree of dementia. The theta band, which best separated patients from controls (Schreiter-Gasser et al. 1993), separates poorly different stages of dementia. This can be explained by the fact that theta activity is greatly increased already in mild to moderate cases. In the delta band, on the other hand, mild to moderate cases are intermediate between severe cases and controls. Thus, progression of Alzheimer's disease goes along with gradual increase of delta power. This is in general agreement with the literature (Cohen et al. 1985; Penttilfi et al. 1985; Soininen and Partanen 1988; Soininen et al. 1991), but the relationships are more clear-cut in our Study. This may be attributed to using absolute rather than relative power and also to LOG artifact correction.

**Commented [JH65]:** EEG in dementia and AD (what's the difference?)

**Commented [JH66]:** @article{schreiter1994quantitative, title={Quantitative EEG analysis in early onset Alzheimer's disease: correlations with severity, clinical characteristics, visual EEG and CCT}, author={Schreiter-Gasser, Ursula and Gasser, Theo and Ziegler, Peter}, journal={Electroencephalography and clinical Neurophysiology}, volume={90}, number={4}, pages={267--272}, year={1994}, publisher={Elsevier} }

**Commented [JH67]:** Craniale Computertomographie

**Elmståhl, Rosen & Gullberg (1994): [https://doi.org/10.1159/000106706](https://doi.org/10.1159/000106706)**

The control subjects showed increasing theta activity with age but the EEG changes did not correlate significantly with psychometric features. The AD patients showed highly significant increases in delta and theta activity and decreases in beta activity compared with controls. Our finding of a steadily increasing relative theta power with age is in accordance with earlier studies [20, 21], but at variance with other studies which indicate a continuous decline in delta and theta activity with age [10, 22].
Not only theta power but also delta power is significantly increased. This is most likely due to the fact that our patient sample is one o f late-onset AD in a rather advanced stage. In studies of the progress of the FEG with increasing severity of AD theta power is increased, fol lowed by a decrease in beta power and later by an increase in delta power and a decrease in alpha power (3. 25]. Our group of elderly institutionalized patients had obviously reached a stage of marked delta power increase.
The topographical analysis showed a widespread in crease in delta and theta power over most cortical areas, whereas the decrease in beta power was more restricted to posterior temporoparietal areas. Delta waves are consid ered to reflect primarily abnormalities of connections between subcortical and cortical areas whereas the beta power decrease is considered to reflect cortical degenerative changes [26, 27]. The results of our study would therefore indicate a profound derangement of subcortical function in combination with degeneration of posterior cortical areas.

**Dierks, Frölich, Ihl & Maurer (1994):** [https://doi.org/10.1007/BF01271469](https://doi.org/10.1007/BF01271469)

Summarizing the present investigation, we demonstrated a) an increase of dipole strength in the slow frequency bands, b) a more anterior equivalent dipole of alpha- and beta-activity, and c) a slowing of the EEG with increasing cognitive deterioration. The results support the assumption that cognitive decline in dementia can be assessed by measuring the electrical activity of the brain.

**Kuskowski, Mortimer, Morley, Malone & Okaya (1993): [https://doi.org/10.1016/0006-3223(93)90108-P](https://doi.org/10.1016/0006-3223(93)90108-P)**

Log-absolute EEG power in the alpha bandwidth (8–12 Hz) was found to be correlated with the computed rate of MMSE decline. This association was present for electrode sites across all regions of the scalp and remained significant when the effects of current cognitive severity

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**Commented [JH69]:** EEG in AD

**Commented [JH70]:** @article{elmstaahl1994quantitative, title={Quantitative EEG in elderly patients with Alzheimer's disease and healthy controls}, author={Elmst{\aa}hl, S{\"o}lve and Ros{\'e}n, Ingmar and Gullberg, Bo}, journal={Dementia and Geriatric Cognitive Disorders}, volume={5}, number={2}, pages={119--124}, year={1994}, publisher={S. Karger AG Basel, Switzerland} }

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27 Gloor P, Ball G. Schaull N: Brain lesions that ...

**Commented [JH75]:** EEG in dementia

**Commented [JH76]:** @article{dierks1995correlation, title={Correlation between cognitive brain function and electrical brain activity in dementia of Alzheimer type}, author={Dierks, T and Fr{\"o}lich, L and Ihl, R and Maurer, K ...

**Commented [JH77]:** EEG in AD

**Commented [JH78]:** @article{kuskowski1993rate, title={Rate of cognitive decline in Alzheimer's disease is associated with EEG alpha power}, author={Kuskowski, Michael A and Mortimer, James A and Morley, Gerald K an ...

**Commented [JH79]:** Mini Mental State Examination were partialled out. These data suggest that a quantitative EEG measure (absolute alpha power) is related to the rate of cognitive decline in patients with Alzheimer's disease.

The data presented here suggest that a quantitative EEG measure (absolute alpha power) is correlated with the rate of cognitive decline in patients with AD. This association was present for electrode sites across all regions of the scalp and remained significant when the effects of current cognitive severity were partiailed out.

**Dringenberg (2000): https://doi.org/10.1016/S0166-4328(00)00261-8**

The generalized slowing of the neocortical EEG is a characteristic symptom in AD and refers to a reduction in desynchronized, activated EEG patterns that are replaced by deactivated, synchronized activity. Typical EEG changes in AD include a loss of beta (13–30 Hz) activity, a decrease in power and mean frequency of alpha activity (8–12 Hz), and increased power in the theta (4–7 Hz) and delta (B4 Hz) bands [21,39,71,74].

Also, alpha EEG coherence decreases while delta coherence increases in patients with clinically probable AD [56]. These quantitative EEG changes provide a sensitive index of the cognitive status of AD patients; McAdam and Robinson [59] reported a positive correlation of 0.79 between EEG abnormalities and the severity of dementia in a population of demented pa-tients, and Pentilla¨ et al. [71] noted a significant positive correlation between occipital peak (alpha) frequency and neuropsychological test scores in AD patients (i.e. lower frequency was associated with lower test scores).

Some EEG changes, such as the increase in theta power, occur together with the earliest signs of cognitive deterioration, while others are associated with more advanced cognitive decline (e.g. increased delta power [71,74]). The close relation between EEG slowing and the severity of cognitive symptoms suggests that a disruption of processing in cortical networks contributes importantly to the behavioral disorganization present in AD.

**Babiloni et al. (2006): https://doi.org/10.1016/j.clinph.2005.09.019**

In the present study, low-band (8–10.5 Hz) alpha sources in parietal, occipital, temporal, and limbic areas had an intermediate magnitude in MCI subjects when compared to mild AD and Nold subjects. Furthermore, magnitude of these five EEG sources showed positive linear and non-linear (i.e. correlations with MMSE score (global cognitive level) across all Nold, MCI, and mild AD subjects as a single group. These results suggest that the global neurophysiological variables (posterior cortical rhythmicity) were linearly and not linearly

**Commented [JH80]:** EEG in AD

**Commented [JH81]:** @article{dringenberg2000alzheimer, title={Alzheimer's disease: more than a 'cholinergic disorder'—evidence that cholinergic--monoaminergic interactions contribute to EEG slowing and dementia}, author={Dringenberg, Hans C}, journal={Behavioural brain research}, volume={115}, number={2}, pages={235--249}, year={2000}, publisher={Elsevier} }

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tive analysis of occipital EEG in different stages of Alzheimer's disease. Electroencephalogr Clin Neurophysiol 1985;60:1–6.

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tive analysis of occipital EEG in different stages of Alzheimer's disease. Electroencephalogr Clin Neurophysiol 1985;60:1–6.
[74] Prichep LS, John ER, Ferds SH, Reisberg B, Almas M, Alper
K, Cancro R. Quantitative EEG correlates of cognitive deterio-ration in the elderly. Neurobiol Aging 1994;15:85–90.

**Commented [JH87]:** EEG in MCI AD and normal old (Nold)

**Commented [JH88]:** @article{babiloni2006sources, title={Sources of cortical rhythms change as a function of cognitive impairment in pathological aging: a multicenter study}, author={Babiloni, Claudio and Binetti, Giuliano and Cassetta, Emanuele and Dal Forno, Gloria and Del Percio, Claudio and Ferreri, Florinda and Ferri, Raffaele and Frisoni, Giovanni and Hirata, Koichi and Lanuzza, Bartolo and others}, journal={Clinical neurophysiology}, volume={117}, number={2}, pages={252--268}, year={2006}, publisher={Elsevier} } correlated with global clinical and cognitive status (MMSE score) across the shadow region between physiological and pathological aging.

The present results extend in spatial detail previous EEG evidence showing a decrease of alpha power in MCI compared to normal subjects (Frodl et al., 2002; Grunwald et al., 2001; Huang et al., 2000; Jelic et al., 1996; 2000).

Furthermore, they complement previous evidence of early atrophy signs in limbic, precuneus, and posterior cingulate areas of MCI subjects (Baron et al., 2001; Callen et al., 2001).

In our MCI group, the alpha findings paralleled those in occipital delta (2–4 Hz), which had an intermediate magnitude compared to mild AD and Nold subjects. Furthermore, magnitude of these EEG sources showed negative linear and non-linear correlations with MMSE score (global cognition) across all subjects. These results are compatible with previous EEG evidence showing increased slow rhythms in MCI compared to normal controls (Grunwald et al., 2001; Jelic et al., 2000; Prichep et al., 1994; Wolf et al., 2003). Furthermore, previous evidence have shown that the increase of slow EEG rhythms in AD is secondary to progressive cortical hypoperfusion (Brenner et al., 1986; Dossi et al., 1992; Kwa et al., 1993; Niedermeyer, 1997; Nobili et al., 1998; Passero et al., 1995; Rae-Grant et al., 1987; Stigsby et al., 1981; Steriade et al., 1994; Rodriguez et al., 1999a; Young, 1987). From a physiological viewpoint, delta rhythms have been intensively studied during slow wave sleep. These rhythms are then replaced by fast (beta and gamma) cortical oscillations induced by the depolarizing effects of meso-pontine cholinergic neurons acting on thalamocortical neurons and by the depolarizing effects of nucleus basalis cholinergic neurons acting on cortical neurons (Steriade, 2003). Therefore, it can be speculated that the increment of delta oscillations in MCI and AD subjects might be related to loss of hippocampal and posterior cortical neurons, which are impinged by cholinergic inputs. Indeed, it has been demonstrated that early degeneration in mesial temporal cortex of MCI and AD subjects can affect functional connectivity between hippocampal formation and tempor-oparietal cortex (Killiany et al., 1993). Furthermore, a bilateral reduction of gray matter volume in the hippocampal formation and entorhinal cortex of AD subjects was correlated with an increment of delta rhythms in posterior cortex (Fernandez et al., 2003).

In the present study, the theta sources in parietal, occipital, temporal and limbic areas had a stronger magnitude in mild AD subjects than MCI and Nold subjects. These results extend in spatial detail previous EEG evidence showing an increase of theta power in mild AD compared to normal subjects (Coben et al., 1983; Huang et al., 2000; Mattia et al., 2003; Ponomareva et al., 2003).

The results of the present study showed that cortical sources of EEG rhythms changed across Nold, MCI, and mild AD subjects, as a function of the global cognitive level.
This was true for occipital delta and alpha 1 sources in parietal, occipital, temporal, and limbic areas, which had an intermediate magnitude in MCI subjects compared to mild AD and Nold subjects and were correlated with MMSE score across all subjects.

**Jeong (2004): https://doi.org/10.1016/j.clinph.2004.01.001**

Since Hans Berger, the discoverer of the electroencephalogram (EEG), first observed pathological EEG sequences in a historically verified AD patient (Berger, 1931, Berger, 1932), a large number of studies about the EEG of AD have been performed. The hallmark of EEG abnormalities in AD patients is slowing of the rhythms and a decrease in coherence among different brain regions. An increase in theta and delta activities and a decrease in alpha and beta activities are repeatedly observed (Brenner et al., 1986, Coben et al., 1983, Coben et al., 1985, Giaquinto and Nolfe, 1986), and a reduced coherence of the alpha and beta bands is frequently found (Dunkin et al., 1994, Leuchter et al., 1987, Locatelli et al., 1998).
Furthermore, these abnormalities are correlated with the severity of the disease (Hughes et al., 1989, Kowalski et al., 2001). For the last 2 decades, the EEG has been utilized as a useful tool for diagnosing dementias.
There is a good correlation between the degree of the EEG abnormality and cognitive impairment (Brenner et al., 1988; Erkinjuntti et al., 1988; Johannesson et al., 1979; Kaszniak et al., 1979; Liddle, 1958; Merskey et al., 1980; Obrist et al., 1962; Rae-Grant et al., 1987; Roberts et al., 1978; Soininen et al., 1982; Wiener and Schuster, 1956).
It is of clinical interest to find that the EEG abnormality is associated with cognitive deficits. A good correlation is found between EEG spectral measures and cognitive deterioration scores, such as the Folstein (Mini-mental) score (Brenner et al., 1986; Elmsta˚hl et al., 1994; Filipovitch et al., 1989; Leuchter et al., 1987; Leuchter et al., 1993; Schreiter-Gasser et al., 1994; Strijers et al., 1997), the global deterioration score (Helkala et al., 1991; Passero et al., 1995; Prichep et al., 1994), and a composite neuropsychological test score (Penttila¨ et al., 1985). There are, however, some studies reporting only a weak correlation or no correlation between EEG changes and the cognitive decline in AD (Hughes et al., 1989; Prinz and Vitiello, 1989).

**Babiloni (2015): https://doi.org/10.1016/j.ijpsycho.2015.02.008**

**Commented [JH89]:** EEG in AD and cognitive impairment

**Commented [JH90]:** Here more information about delta, theta, beta and alpha waves in AD

**Commented [JH91]:** @article{jeong2004eeg, title={EEG dynamics in patients with Alzheimer's disease}, author={Jeong, Jaeseung}, journal={Clinical neurophysiology}, volume={115}, number={7}, pages={1490--1505}, year={2004}, publisher={Elsevier} }

**Commented [JH92]:** EEG in MCI and AD
EEG introduction, why it's great to use

**Commented [JH93]:** Good paper!

**Commented [JH94]:** @article{babiloni2016brain, title={Brain neural synchronization and functional coupling in Alzheimer's disease as revealed by resting state EEG rhythms}, author={Babiloni, Claudio and Lizio, Roberta and Marzano, Nicola and Capotosto, Paolo and Soricelli, Andrea and Triggiani, Antonio Ivano and Cordone, Susanna and Gesualdo, Loreto and Del Percio, Claudio}, journal={International Journal of Psychophysiology}, volume={103}, pages={88--102}, year={2016}, publisher={Elsevier} }

Resting state EEG power density differed between AD patients and amnesic MCI subjects, who were considered to be at high risk of suffering from prodromal AD. There was an "intermediate" power density of low-frequency alpha rhythms (8–10.5 Hz) in the parietal and occipital regions in MCI compared to mild AD and Nold subjects (Babiloni et al., 2006b). Furthermore, maximum alpha and beta power density shifted more anteriorly in AD patients compared to Nold and MCI subjects (Huang et al., 2000). Moreover, longitudinal studies have shown that increased delta or theta power density, decreased alpha and beta power density, and slowing of mean EEG frequency were in some way predictors of the progression from MCI to dementia at about 1-year follow-up (Huang et al., 2000; Jelic et al., 1996, 2000; Grunwald et al., 2001; Kwak, 2006; Rossini et al., 2006). High power density of the posterior alpha rhythms also predicted a stable global cognitive function in MCI subjects at 1-year follow-up (Babiloni et al., 2010a).

n the MCI subjects, the EEG markers of disease progression included an increase of the power density at the theta and delta rhythms in the temporal and occipital regions as well as a decrease of the power density at beta rhythms in temporal and occipital regions (Jelic et al., 2000).

In the AD patients with global cognitive impairment, hippocampal atrophy was associated with increased power density at delta and theta rhythms in the temporal and parietal regions (Helkala et al., 1996), in line with recent magnetoencephalographic (MEG) evidence (Fernandez et al., 2003).

Furthermore, a volume decrement of hippocampus was related to the decreased power density at alpha rhythms in the temporal, parietal, and occipital regions in MCI and AD subjects (Babiloni et al., 2009b).

Furthermore, the global delta and alpha power density was related to the total amount of atrophy of cortical gray matter in the amnesic MCI and in the AD subjects, as revealed by MRI voxel-to-voxel volumetry of lobar brain volume; the higher the total gray matter volume, the lower the global delta power density and the higher the global alpha power density (Babiloni et al., 2012).

The power density of the resting state eyes-closed EEG rhythms was repeatedly found to be correlated to cognitive status in MCI and AD subjects. It has been shown that the posterior alpha power density was positively correlated to the subjects' global cognitive status, as measured by ADAS-cog in the MCI or AD subjects; namely, the lower the alpha power density, the lower the cognitive status (Luckhaus et al., 2008). This relationship can be extended to the cognitive health condition. Furthermore, the posterior delta and alpha power density was correlated to the MMSE score in the Nold, MCI and AD subjects; namely, the lower the alpha power, the higher the delta power and the lower the cognitive status (Babiloni et al., 2006b).

It has been shown that in the MCI subjects, the markers of disease progression included an increase of the power density at theta and delta rhythms in the temporal and occipital lobes as well as the reduction of the beta power density in the temporal and occipital lobes (Jelic et al., 2000).

AD patients were characterized by an increase of theta and delta power density and by a reduction of the alpha and beta power density in the parieto-occipital lobes (Coben et al., 1985). Furthermore, half of the AD patients showed an increase of the theta and delta power density in the temporal-occipital lobe (Soininen et al., 1989).