HEEG virtual electrodes for synchrony measures

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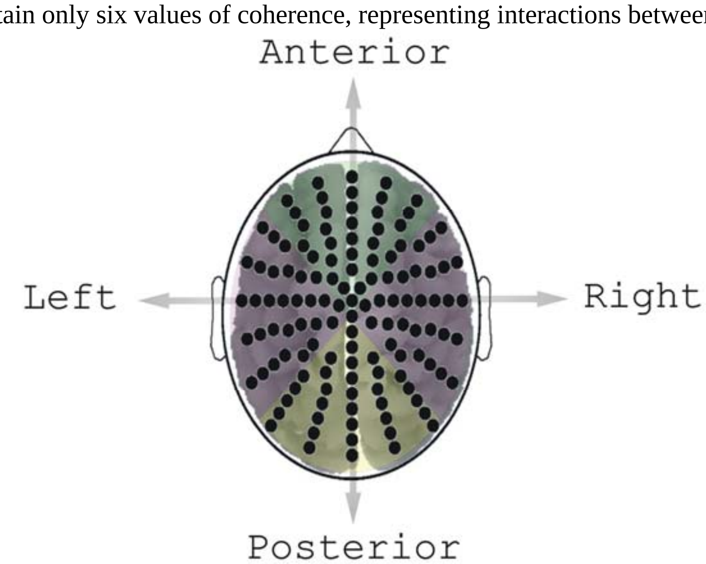
Word Count: 495 (500 Limit)

Introduction

EEG signal is very complex, especially when high density array are used. The resulting high density electroencephalography (HEEG) combines an efficient time resolution, with a good spatial resolution. However, because EEG measures electrical activity propagated through the brain tissues and the scalp, volume conduction effect of broad current sources tend to blur the recorded data: EEG channels usually record a mixture of signals. This is a key issue when one wants to investigate synchronization of brain activity. Local increases or decreases of synchrony can be due to either truly synchronous signals, or to mixed signals with a common source. We suggest a method to quantify synchrony if HEEG while narrowing the contribution of volume conduction effects: we compute "virtual electrodes" measuring synchrony over vast brain zones. This method was already applied with success on EEG data from patients in the early stage of Alzheimer's disease (1,2) and for steady-state visual evoked responses (3).

Methods

We recorded HEEG (128 electrodes, Biosemi system, 2048 Hz sampling rate, 50 Hz notch filter) during one minute, in resting condition with eyes closed. From this record, 5 seconds of artifact-clean signal was extracted. Magnitude squared coherence was computed for all 128 pairs of electrodes (>8000 pairs). We then regrouped these values depending on spatial location of electrodes into four groups of 32 electrodes (**Fig.1**). Hence, for each pair of zone, we compute the average of 1024 values of coherences (32 times 32 pairs). We finally obtain only six values of coherence, representing interactions between each zone.



Results

We grouped the 128 electrodes pairs into eight bins by distance, which showed clearly (**Fig.2**) a classical volume conduction effect: closer electrodes have significantly higher synchrony, whereas farther electrodes have significantly lower synchronies, whatever the frequency range. After coherence values were grouped into four zones, the distance from one zone to another ("bottom" zone is closer to "right" or "left" zone than "top" in **Fig.1**) had no effect on coherence measure.

Conclusion

We demonstrated how electrode grouping reduces the effects of local volume conductions between close electrodes. It is very unlikely that broad sources could convey synchronous activity between these zones; therefore it is obvious that volume conduction is severely reduced with this method.

The scientific interest of such a method is very limited with the design presented here. The four zones were chosen according to mathematical convenience, and for a simpler of demonstration. However, if one wants to apply this method to EEG investigations, the choice of zones should be guided either by *a priori* knowledge (known effect, or conventional locations); or with a posteriori evaluation using for instance independent component analysis to located brain areas featuring distinct EEG sources (4). Finally, removing border electrodes between each zone might also improve the reduction of volume conduction effect.

References
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