Development of high-density scalp somatosensory evoked potential recordings in macaque monkeys

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Introduction

Somatosensory evoked potential (SSEP) recordings from the scalp are commonly used in human for clinical applications. They are among others good predictor of outcome after a brain injury such as stroke. Recordings from the scalp with a high-density electrode array are also relevant for research purposes to reveal the time course of evoked topographies.

In the present pilot study, we made a transposition of this simple and minimally invasive tool to macaque monkeys, allowing repeated monitoring of the brain activity from the whole scalp surface using a multichannel electrode array. The goal was to address the general feasibility of the technique in order to use it in longer term before and after a neural lesion to investigate a possible cortical reorganisation.

Materials and methods

Experiments were conducted on one young adult macaque monkey (*Macaca fascicularis*). Recordings were performed with a customised EEG cap containing 32 electrodes regularly distributed over the scalp while the monkey was anaesthetised (2.5% sevoflurane).

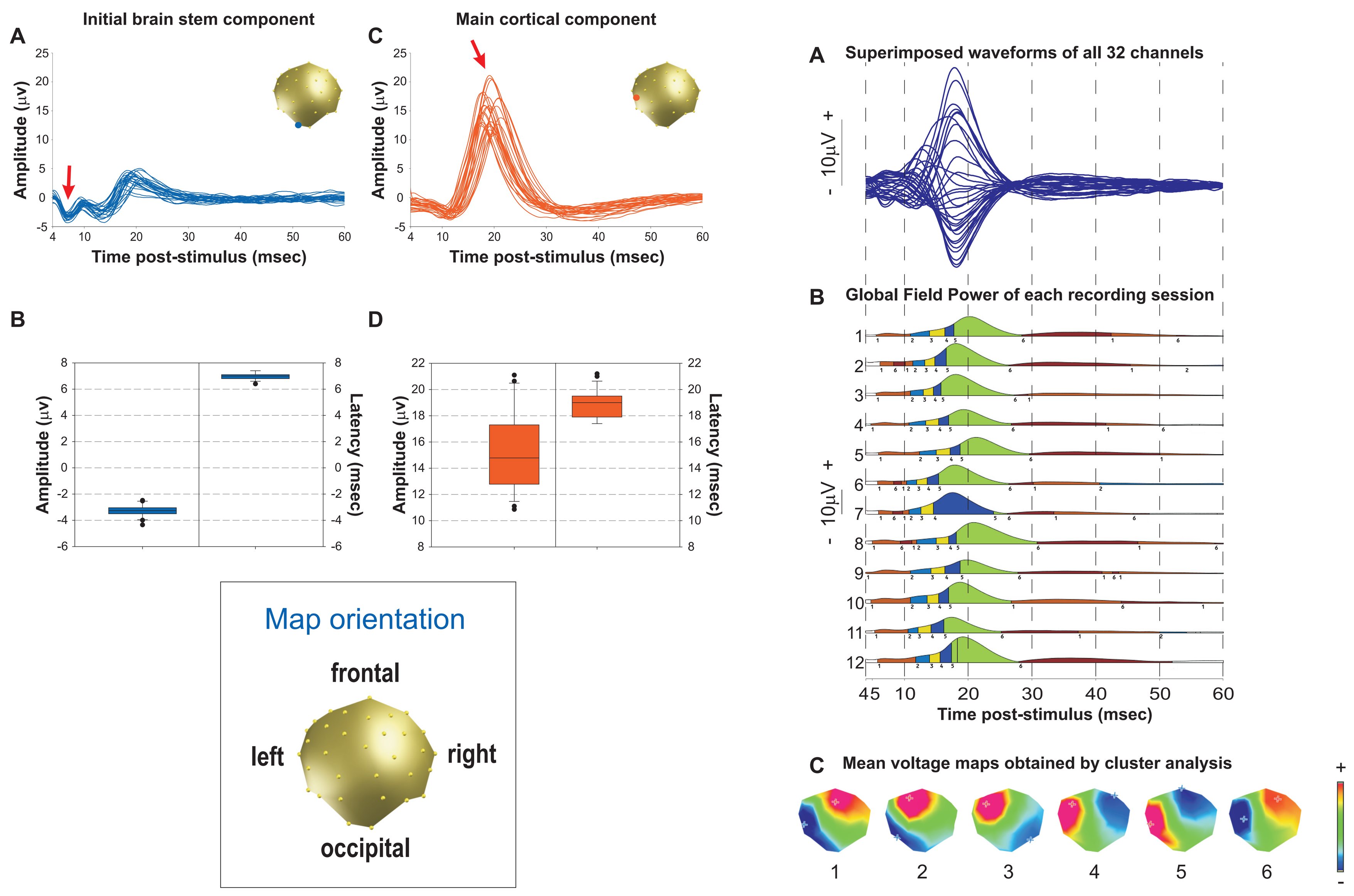
Electrical stimulations were delivered separately either to the median nerve at the wrist or to the tibial nerve at the ankle (0.5Hz repetition rate, intensity slightly above the visible motor threshold, total of 75 sweeps).

Results

1) Stability of SSEPs across different recording sessions (right median nerve SSEPs)

Conventional analysis
(27 recordings across 12 different sessions)

Topographical analysis
(only 1 recording per session, for the sake of clarity)



- The initial brain stem component is more stable in amplitude and latency across the recording sessions than the main cortical component (Panel 1).
- Although responses are somewhat variable in amplitude and latency across the different recording sessions, they are topographically very reproducible given that the main part of each recording can be summarised with a similar series of maps (Panel 1).

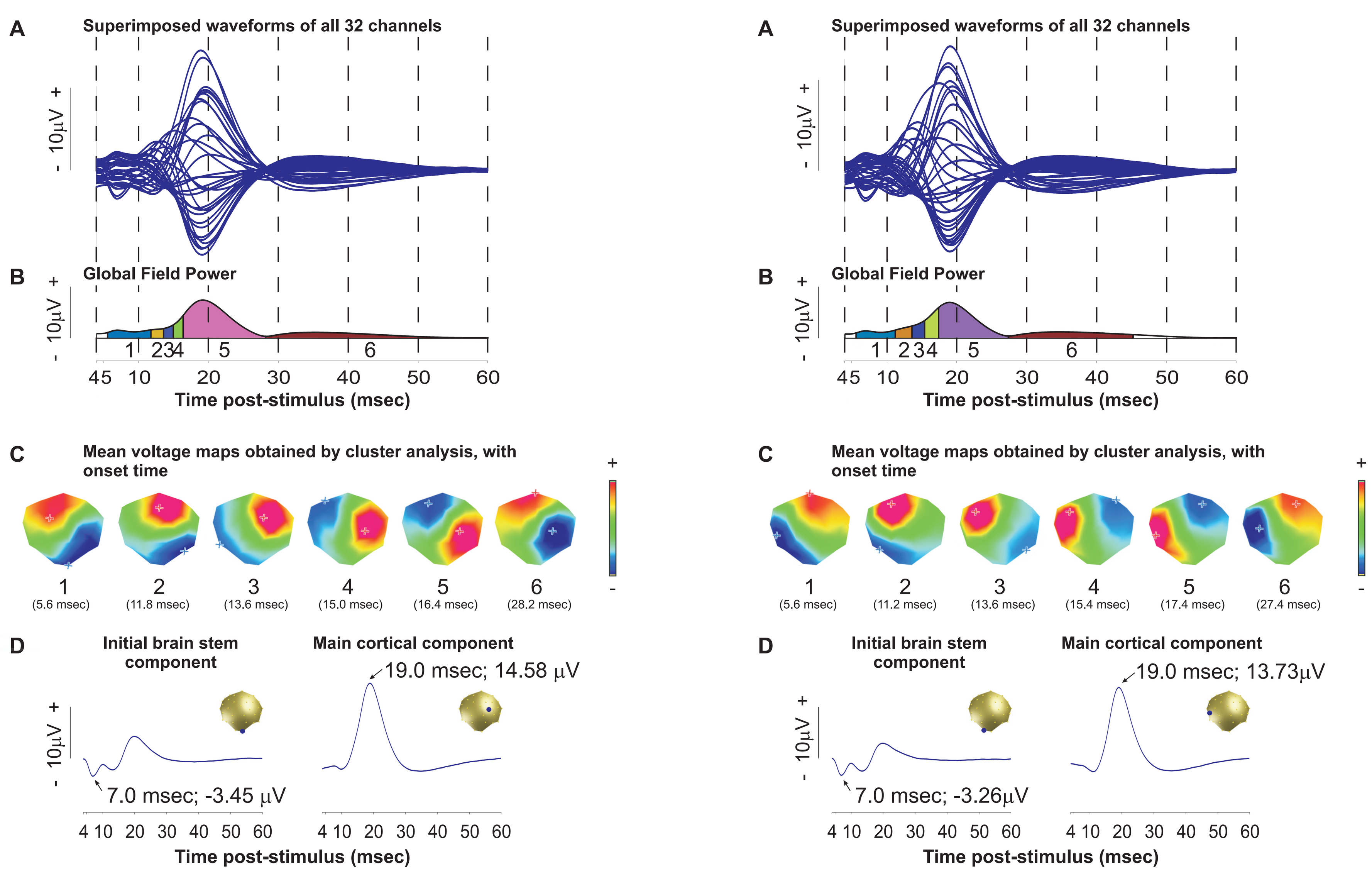
Data analysis

- Conventional analysis: study of the absolute amplitude and latency of the initial brain stem component recorded over the contralateral brain stem and the main cortical component recorded over the contralateral hand, respectively foot, representation in the sensorimotor cortex.
- Topographical analysis: cluster analysis of the voltage maps (data-driven approach revealing a series of scalp topographies reflecting the steps in information processing).

2) Median nerve SSEPs

Left median nerve stimulation
(Grand average of 19 recordings)

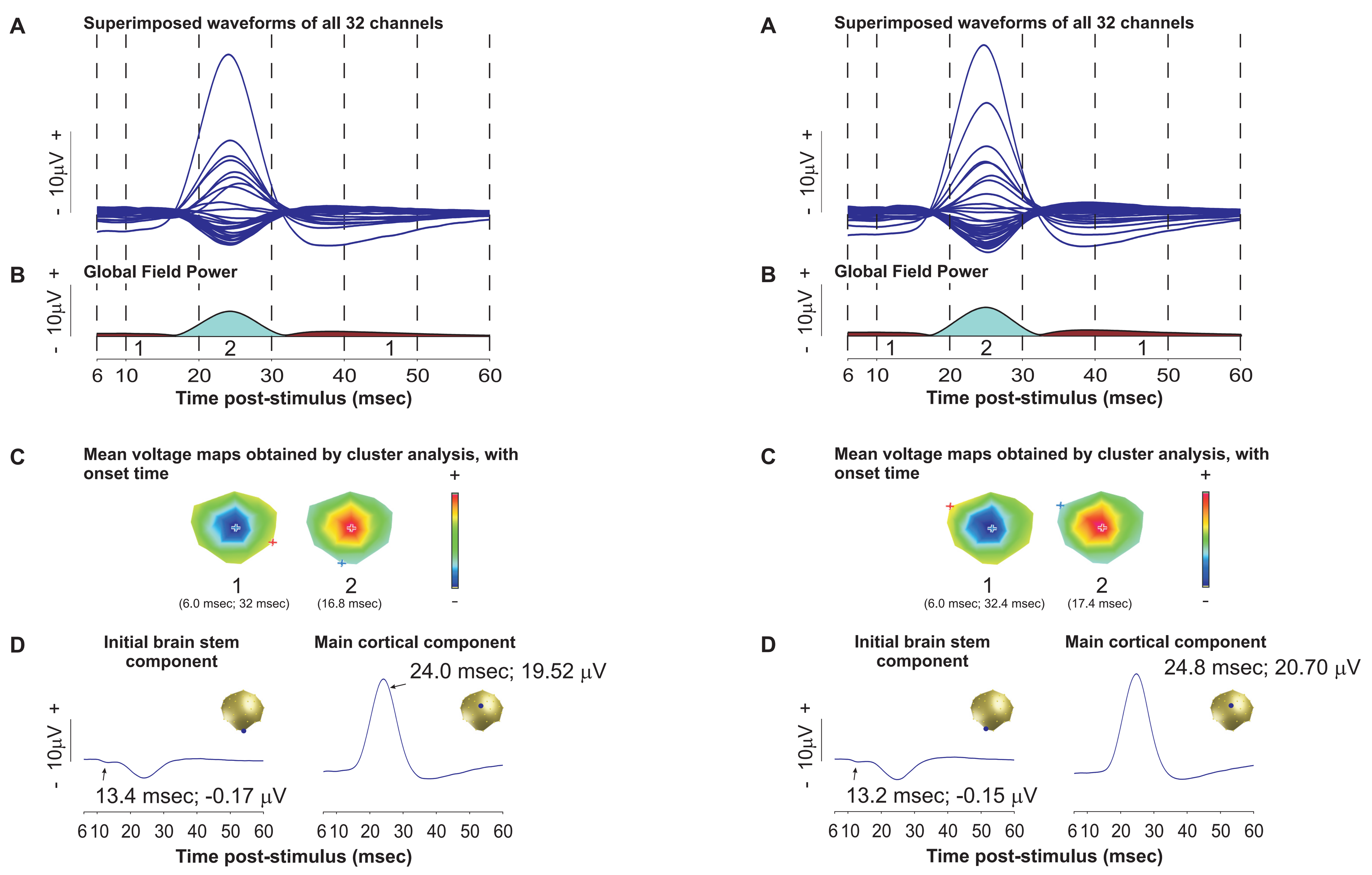
Right median nerve stimulation
(Grand average of 27 recordings)



3) Tibial nerve SSEPs

Left tibial nerve stimulation
(Grand average of 19 recordings)

Right tibial nerve stimulation
(Grand average of 23 recordings)



- As expected, responses obtained after stimulation on one side are essentially mirror images of those of the other side in relation to the antero-posterior axis (Panels 2 and 3).
- The map topography of the responses obtained after either median or tibial nerve stimulations is in line with the somatotopical organisation of the sensorimotor cortex (Panels 2 and 3).

Prospects

- Extension of this study to further animals, in parallel with behavioural tasks (modified Brinkman board task)
- Location and orientation of the generators with source location algorithms
- EEG recordings in conscious monkey to study the resting state networks

Conclusion

These preliminary data show that SSEPs can be successfully and reproducibly recorded from a high-density EEG cap in macaque monkeys. This minimally invasive method to record large-scale neuronal networks in real-time can be useful if repeated assessment of the cortical activity is desired, for example to study functional damage and recovery after a central nervous system lesion. In this case, topography of SSEPs will allow to assess the possible cortical reorganisation of neuronal networks and relate it to functional recovery. The tool we developed is very relevant in the context of promoting non-invasive approaches also in animal research.

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