

INTRODUCTION

- Pain arises from the integration of sensory and cognitive processes in the brain, resulting in specific patterns of neural oscillations that can be characterized by measuring electrical brain activity
- Current source density (CSD) estimation from low-resolution brain electromagnetic tomography (LORETA) and its standardized (sLORETA) and exact (eLORETA) variants, is a common approach to identify the spatiotemporal dynamics of the brain sources in physiological and pathological pain-related conditions [1].
- Even though there are several studies on the field, reliable data on the variability of CSD estimations is lacking.

AIM

To assess the test-retest reliability of current source density estimates during experimental tonic muscle pain.

METHODS

- 21 healthy subjects (25.0 ± 2.6 years; 14 women)
- 2 session (separated 7 ± 2 days)

Data acquisition:

- Continuous EEG using 64 channels
- VAS:
 - 0 = no sensation at all
 - 5 = pain detection threshold.
 - 10 = maximal pain
- Stimulation paradigm, 3 minutes of :
 - VAS-3: non-painful tonic cuff pressure
 - VAS-7: painful tonic cuff pressure
 - REEG: Resting EEG

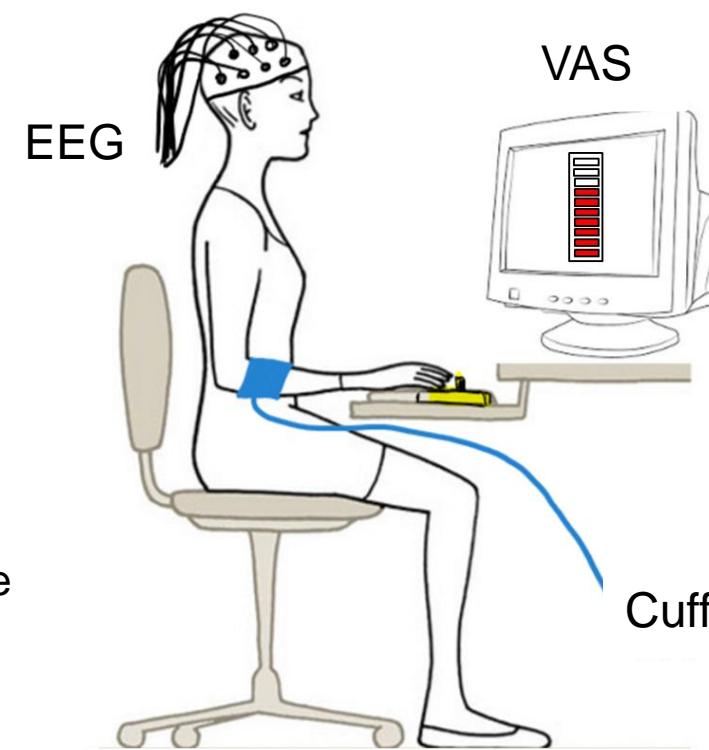


Figure 1: Experimental setup.

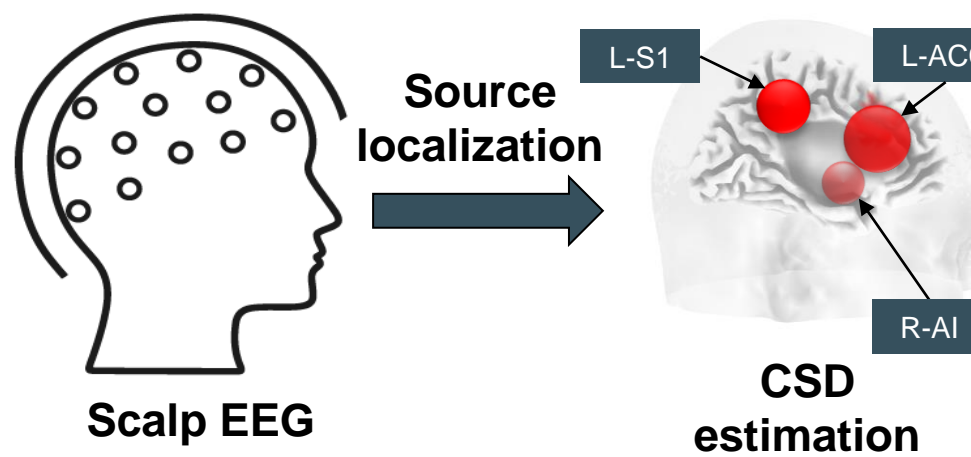


Figure 2: eLORETA CSD was extracted in this regions of interest (ROIs)

- Left anterior cingulate cortex (L-ACC)
- Left primary somatosensory cortex (L-S1)
- Right anterior insula (R-AI)

METHODS

Data analysis and statistics

Bland–Altman (BA) analysis was used to assess the between-session reliability of CSD estimations [2]. BA analysis consists of :

- Plots with the differences vs. the average of repeated measurements.
- Limits of agreement (LoA) express the mean difference (bias) ± 1.96 times the standard deviation of the differences between measurements.
- Reliability of CSD was calculated during REEG, VAS-3 and VAS-7 for theta, alpha, and gamma bands in the regions L-ACC, L-S1, and R-AI.
- Hypothetical sample size estimation was calculated for parallel (Np) and crossover (Nc) study designs for VAS-7

RESULTS

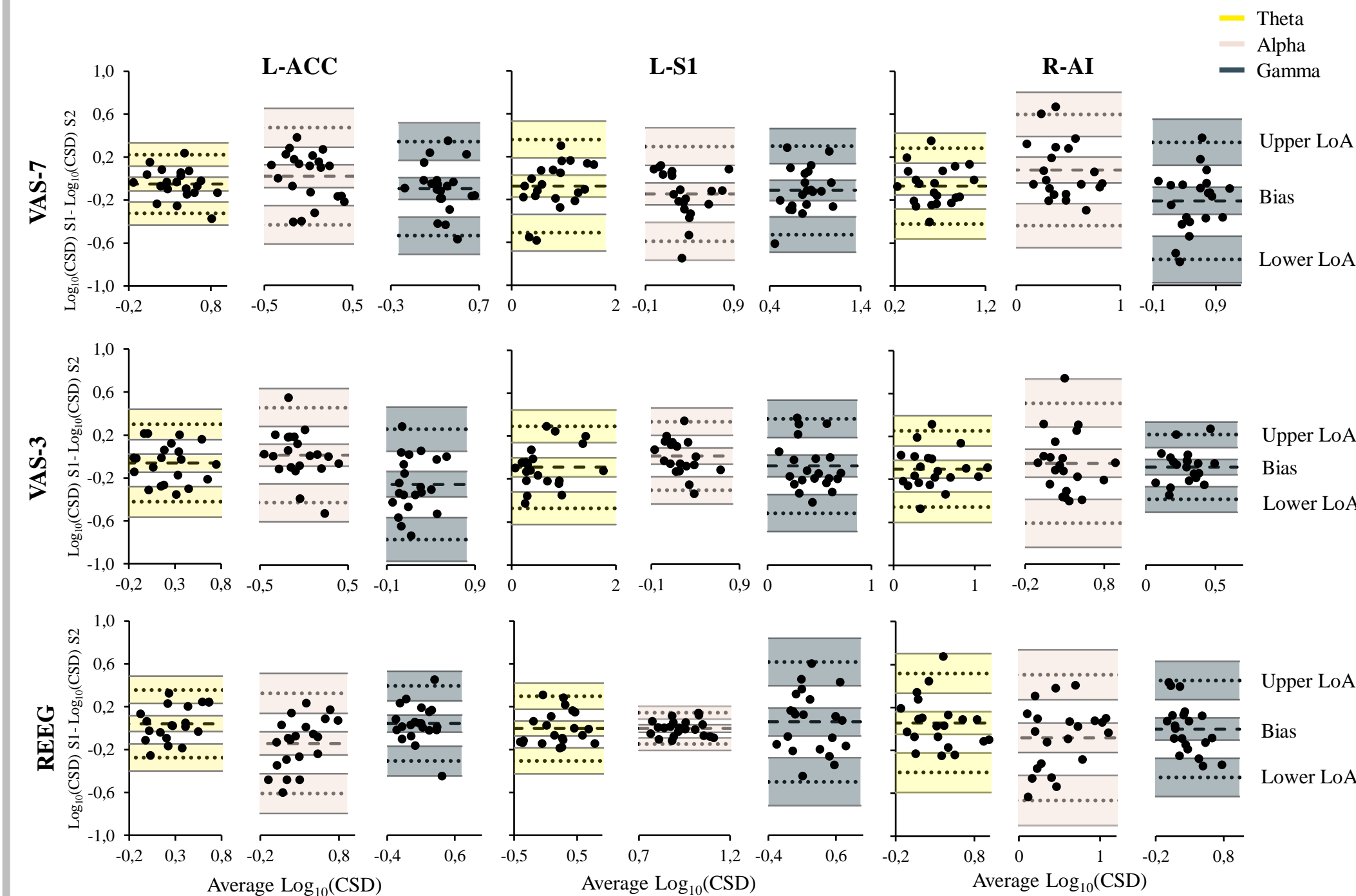


Figure 3: BA plots of the difference between S1 and S2 of the \log_{10} CSD. The dashed line indicates the bias between sessions and the dotted lines indicate LoA

RESULTS (CONT.)

Table 1: Hypothetical sample size calculation for Nc and Np in a VAS-7 like experiment design as a function of the effect size. Despite some of the values are lower than 10 participants, the minimum suggested sample size for a group should not be less than that.

Effect size (Log-CSD)		ACC			L-S1			R-AI		
		θ	α	γ	θ	α	γ	θ	α	γ
±0.05	Nc	61	166	156	153	159	138	102	218	242
	d_z	0.33	0.20	0.21	0.25	0.21	0.29	0.28	0.17	0.21
	Np	446	409	305	1129	426	273	384	457	705
±0.10	d	0.17	0.18	0.21	0.13	0.18	0.29	0.20	0.17	0.17
	Nc	15	42	39	38	40	34	25	54	61
	d_z	0.66	0.39	0.42	0.50	0.42	0.58	0.56	0.35	0.42
±0.25	Np	111	102	76	282	107	68	96	114	176
	d	0.34	0.35	0.43	0.26	0.36	0.58	0.40	0.34	0.35
	Nc	2	7	6	6	6	6	4	9	10
±0.25	d_z	1.65	0.98	1.06	1.26	1.04	1.45	1.39	0.87	1.05
	Np	18	16	12	45	17	11	15	18	28
	d	0.86	0.88	1.07	0.65	0.90	1.46	1.01	0.85	0.87

CONCLUSIONS

- LORETA CSD estimations are equally reliable for within-session comparisons among all conditions, regions and frequencies. Estimations during REEG at L-S1 in the alpha band were more reliable than the rest of estimations.
- Bland Altman plots showed no clear signs of heteroscedasticity in the CSD estimation between sessions. This was expected because CSD data were log-transformed, and in most cases, log-transformation will address heteroscedasticity.
- BA plots revealed that there is no clear sign of systematic bias during REEG, VAS-3 and VAS-7 (except in the R-AI during VAS-7 and the L-ACC during VAS-3 both in the gamma band). This is evident because the CI 95% of the bias did not overlap the zero- \log_{10} (CSD) difference between sessions (except in the two aforementioned cases).
- Hypothetical sample size calculation revealed that the number of participants to sufficiently power the study seems to be independent of the ROI and frequency band.

REFERENCES

- [1] Hansen, T. M., Mark, E. B., Olesen, S. S., Gram, M., Frøkjær, J. B., & Drewes, A. M. (2017). Characterization of cortical source generators based on electroencephalography during tonic pain. *Journal of Pain Research*, 10, 1401.
- [2] Bland, J.M., Altman, D.G. (1999). Measuring agreement in method comparison studies. *Stat. Methods Med. Res.* 8, 135–160.