**Motivation**

The ABR (Auditory Brainstem Response) is widely used as a tool to assess the integrity of the first stages of the auditory system, clinically and in human and animal research. The measured signal is tiny relative to noise, and requires averaging over many trials. Furthermore, responses from different auditory processing sites are overlapped and are distinguishable only by their latency. Multichannel recording and analysis may overcome these limits.

**The DSS Algorithm**

Denoising Source Separation (DSS) finds the optimal linear combination of sensor or electrode waveforms, specific to some criterion (Särelä & Valpola 2005; also known as Common Spatial Patterns, CSP, Koles et al 1990). Here, the criterion to be optimized is repeatability over trials (de Cheveigné & Simon 2007).

**Methods**

- 32+8 channel EEG system (Biosemi).
- Electrode layout: standard International 10/20 + additional electrodes (e.g. nasion, inion, mastoid, periocular).
- Stimuli: Clicks, alternating polarities, 2000 repeats, 70 dB nH, Sennheiser HD250 headphones, 11-25/s, ICI designed to avoid 1/50Hz (line noise), 1/10 Hz (alpha).
- Analysis:
  - Denoising Source Separation (DSS) finds the optimal linear combination of sensor or electrode waveforms, specific to some criterion (Särelä & Valpola 2005; also known as Common Spatial Patterns, CSP, Koles et al 1990). Here, the criterion to be optimized is repeatability over trials (de Cheveigné & Simon 2007).
  - In Matlab:
    - $c_0 = x_1'x_1 + x_2'x_2$;
    - $c_1 = x_1'x_1$;
    - $[V, D] = \text{eig}(c_0, c_1)$; $V = \text{real}(V)$; $D = \text{real}(D)$;
    - $[\lambda, \text{idx}] = \text{sort} (\text{diag}(D), \text{"descend"})$; $V = V(:, \text{idx})$;
    - $z_1 = x_1V$;
    - $z_2 = x_2V$;

**Human**

- Standard ABR vs multichannel:
- DSS 1
- DSS 2
- DSS 3

**Mouse**

- Human magnetic:
  - ABR measured with 120-channel magnetometer (Adachi et al 2010)
  - 2 electrodes parallel to each other on midline, 1 over bulla ipsilateral to speaker, 1 over nape of neck, click, 1000 rep, 80 dB:
  - 50 dB:

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