Co-registration of eye movements and event-related potentials in reading
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Introduction

- Eye-tracking is widely used to provide online measures of information processing across a variety of tasks.
- Event-related potentials (ERPs) provide online measures of neural processing across a variety of tasks.
- Combining these techniques would result in richer datasets and more natural tasks.

An example of scan patterns for normal reading and pseudo-text reading is shown.

Methods

- ICA was used to identify and remove components resulting from eye movement activity. After removal, residual EEG activity was reconstructed and analyzed for fixation-related ERPs.
- Eye movement components were identified using three criteria:
  1. Component loadings on the surface of the head were consistent with an eye movement.
  2. Source analysis localized the component to the eyes using realistic finite element method (FEM) head model obtained from each subject’s structural MRI scan.
  3. Temporal activation of the component occurred at the time of the eye movement and differed for right and left eye movements.

Results

- ERP waveforms stratified by fixation duration. Mean fixation duration is depicted with a vertical line on each ERP waveform, range is listed on the right. Note that shortly after fixation offset, the next fixation generates a large P1.

- Grand average ERP activity during the P1 interval (50 to 110 ms after word fixation onset) for test-reading (top), pseudo-text reading (middle) and the difference (bottom).

Questions

- What are the potential concerns for removing non-eye movement related activity from the EEG?
- How do eye movements affect ERP recordings?

Discussion

- Generally able to identify and remove eye-movement related artifacts from the ERP record.
- Non-eye-movement related activity was left intact by the ICA algorithm.
- The fixation's duration is significantly longer in the pseudo-text control condition (F(1,8)=40.1, MSE=373, p<.001).
- In the window of the P1 we found significantly higher amplitudes in text-reading than in pseudo-reading at all tested electrodes (all ts > 3.65, all ps < .001).

Future Work

- Source localize the fixation-related P3a/N1a to show that the next fixation's P3a/N1a is indeed coming from the same neural generators.
- Look more closely for frequency effects.
- Explore changes in the ERP waveform related to changes in fixation duration.
- Look at pre-saccadic ERP: time locked to saccadic onset. Other work has already investigated the muscular related components tied to saccade onset, but what are the cognitive components tied to saccade generation and where do they source local?