

NIC Technical Document # 9

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**Evaluating Results of ICA applied to Real EEG Data:
Seeding the blink template gives superior results**

Introduction

FastICA, fixed vs. random seeds.

-3 runs with random seeds

-1 run with fixed seed = identity matrix

-1 run with fixed seed = blink template

allowing for some refinement of solution for first (fixed) column of mixing matrix

Metrics for choosing a “good” run with multiple random seeds

Methods

-input = blinky but otherwise “clean” data:

-omit bad samples (with saturated observations)

-detect and interpolate bad channels for each “segment” (defined as contiguous 200ms intervals from beginning to end of file)

-baseline or mean correct data prior to ICA?

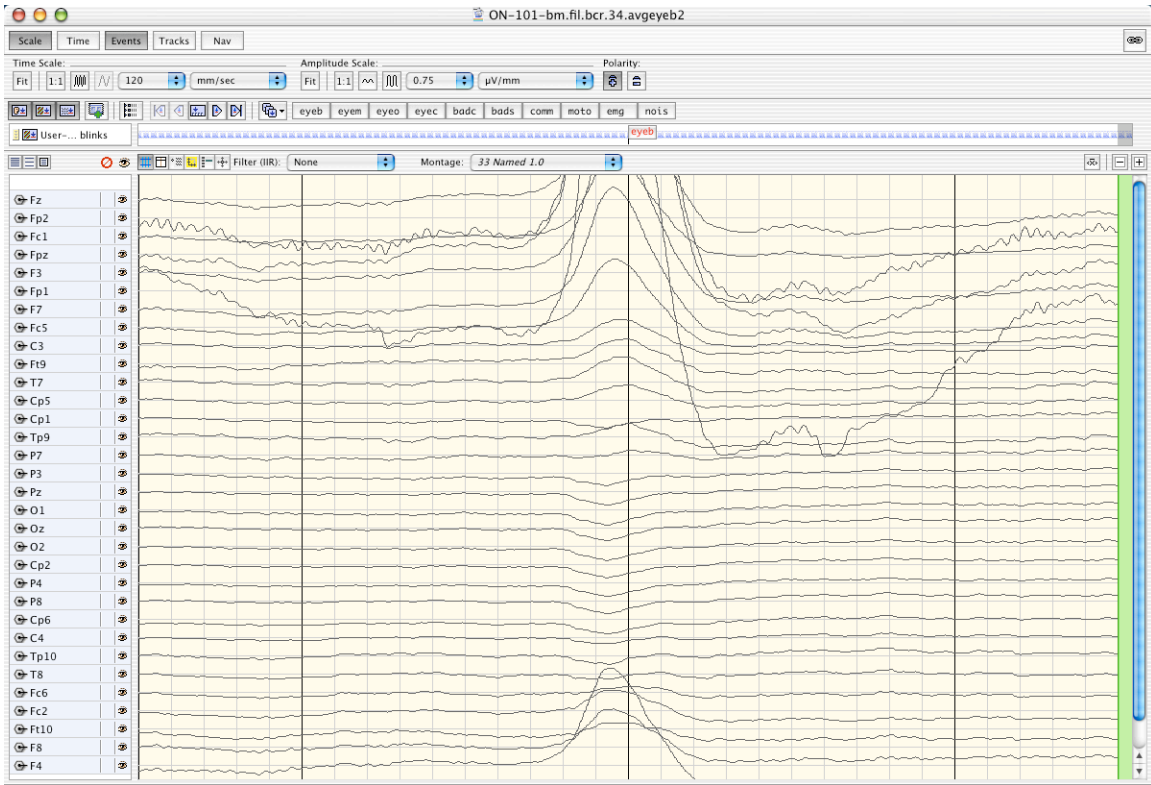


Figure 1. Blink-averaged data before ICA.

Results

[FastICA with blink template seed gave very good results.]

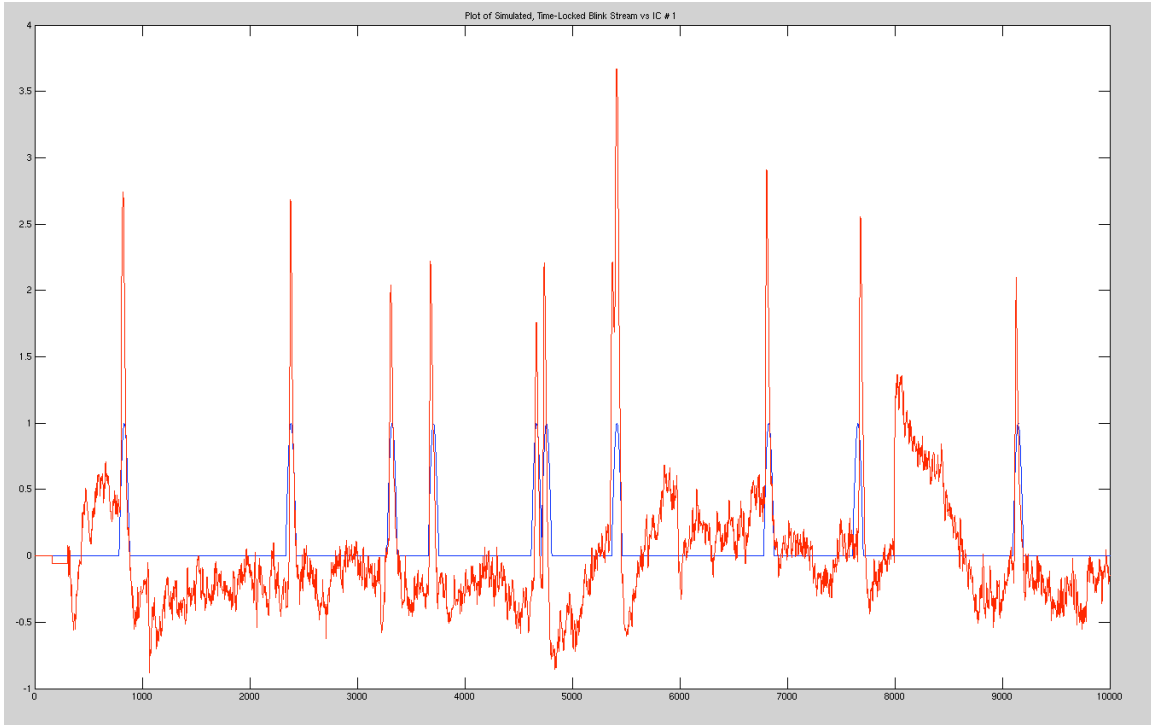


Figure 2. Simulated blink stream overlaid with independent component #1.

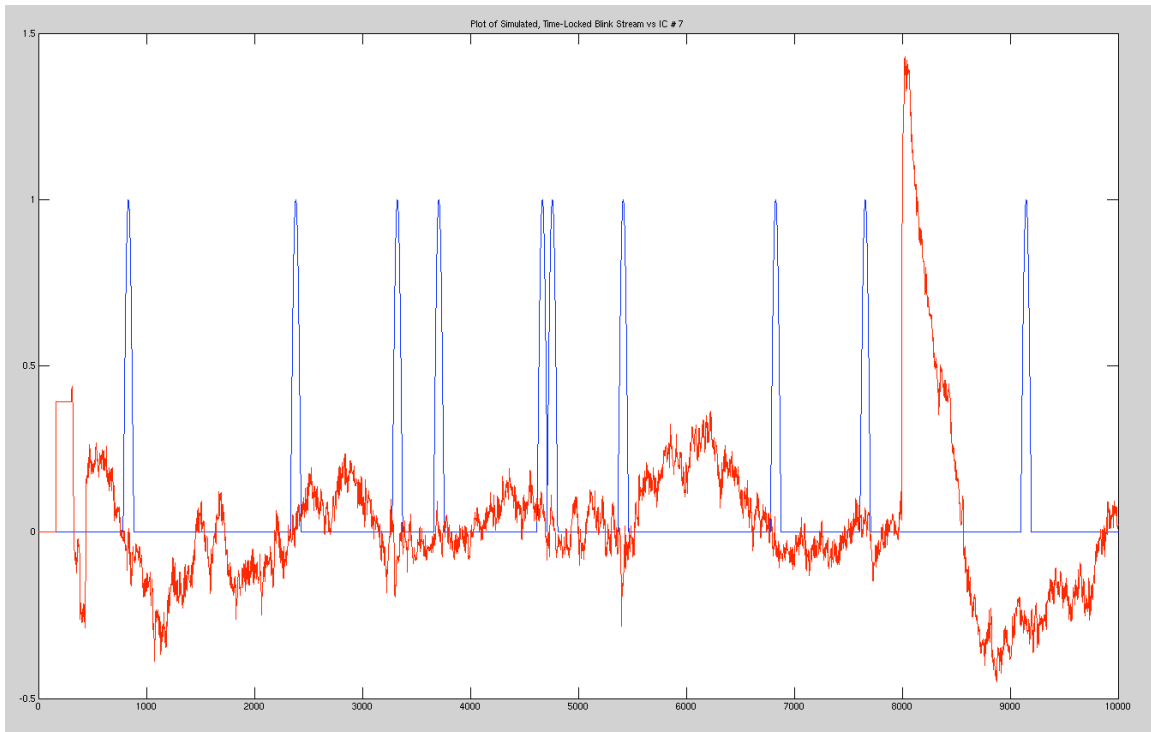


Figure 3. Simulated blink stream overlaid with independent component #7.

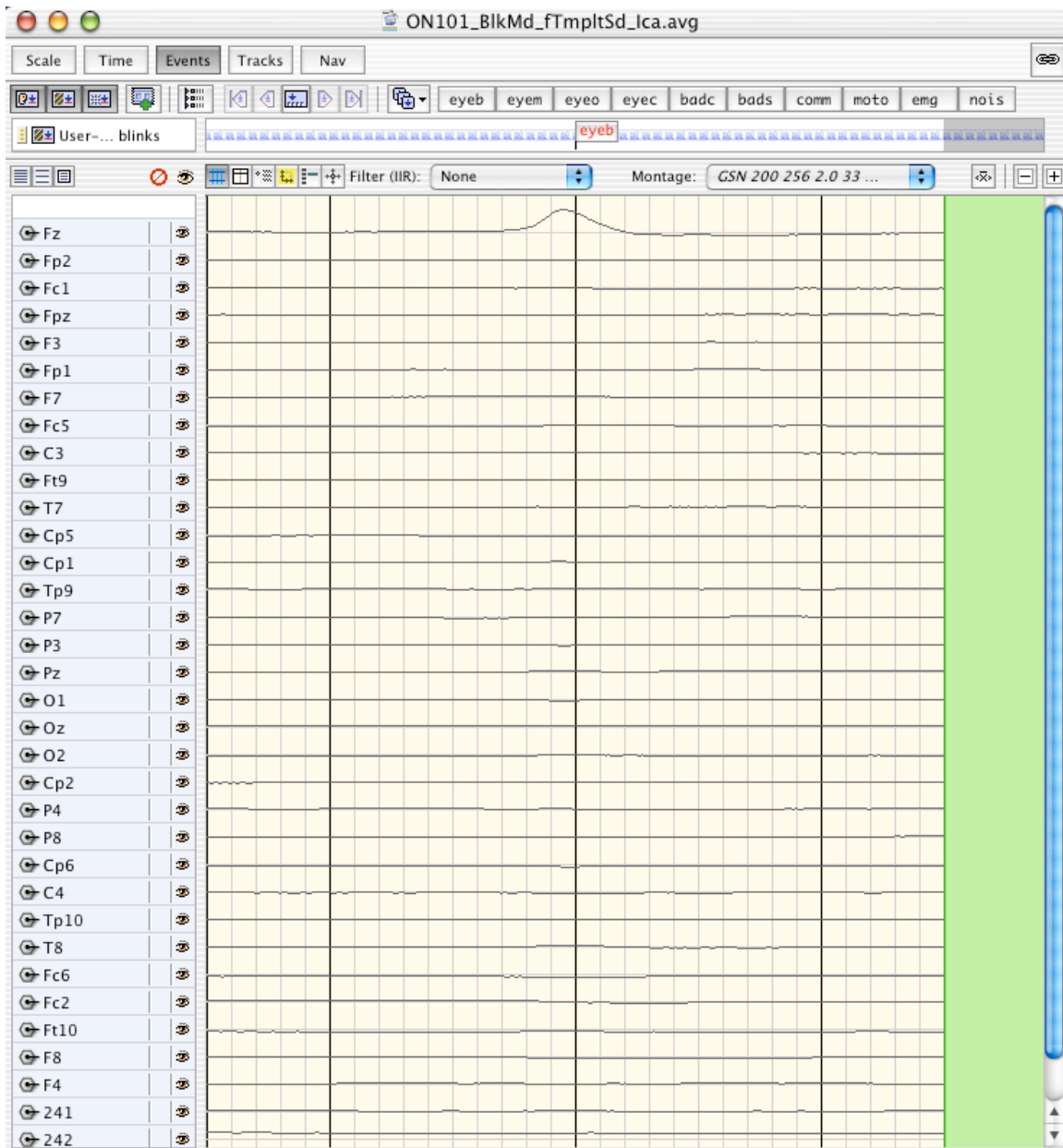


Figure 4. Independent components #1–34, extracted using FastICA with a fixed seed (blink template).

Independent components #1 and #7 met both of our criteria for blink-related activity: the spatial projectors corresponding to both IC inverted in polarity over the eyes, and both projectors correlated with the blink template, $r > .85$ (IC#1 correlation = 1.00; IC#7 correlation = 0.87).

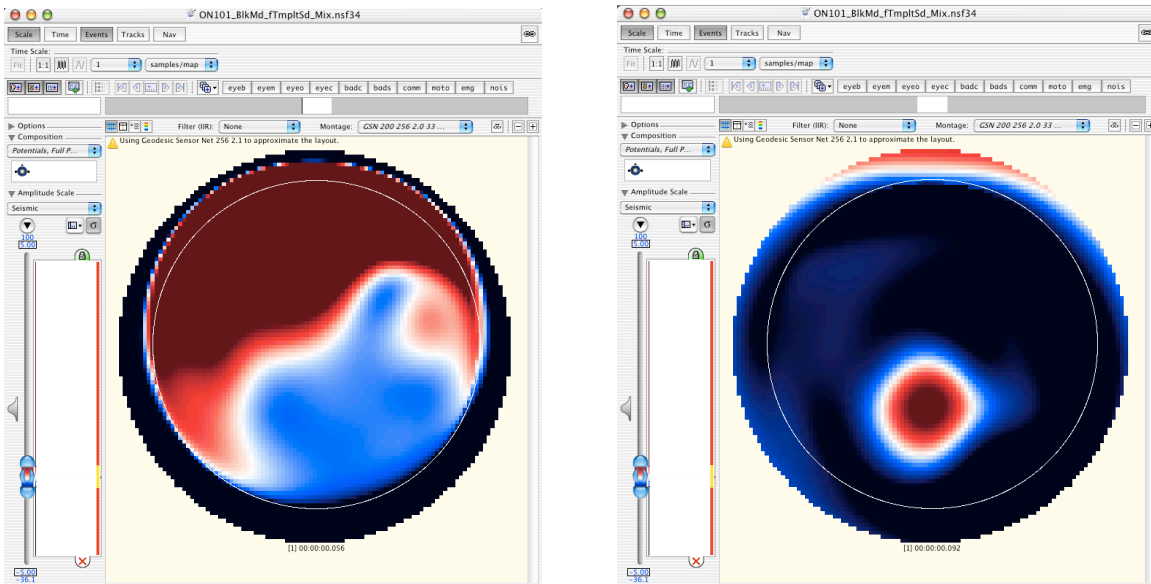


Figure 5. (a) Independent Component #1 (blink-template seed, correlation = 1.00).
 (b) Independent Component #7 (correlation = .87).

Clearly, some ocular activity remains after subtracting out the contribution of IC#1:

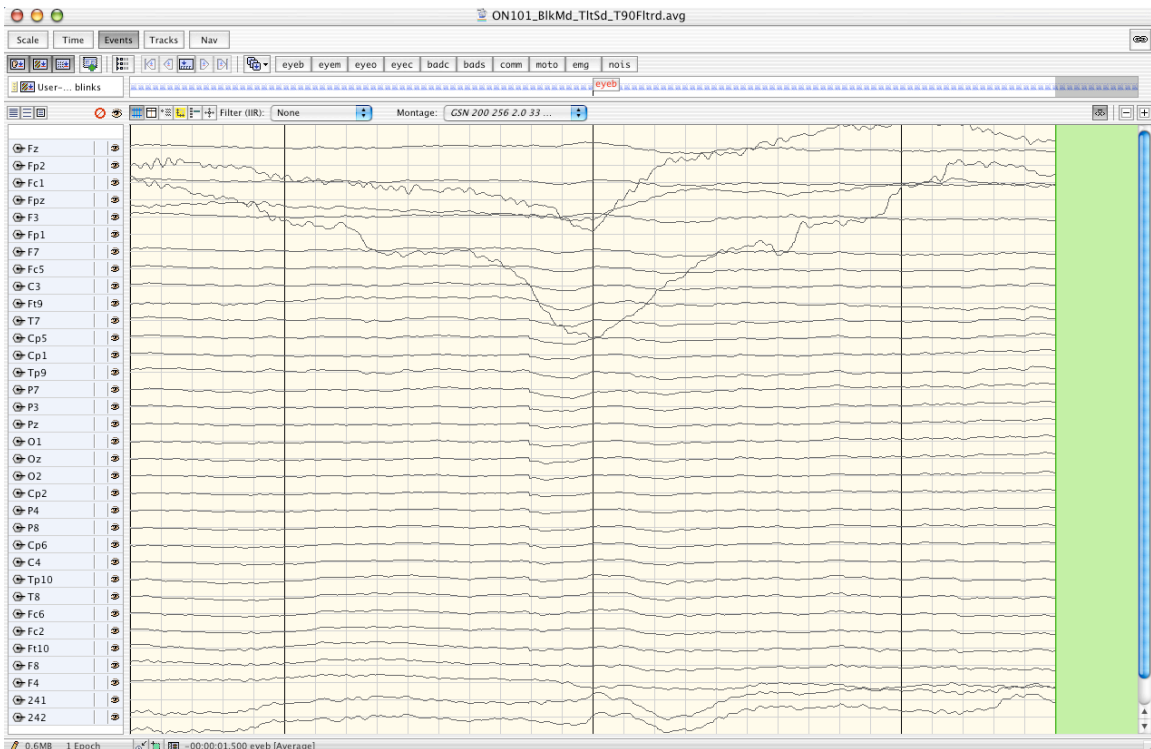


Figure 6. Blink-averaged data after removing IC #1.

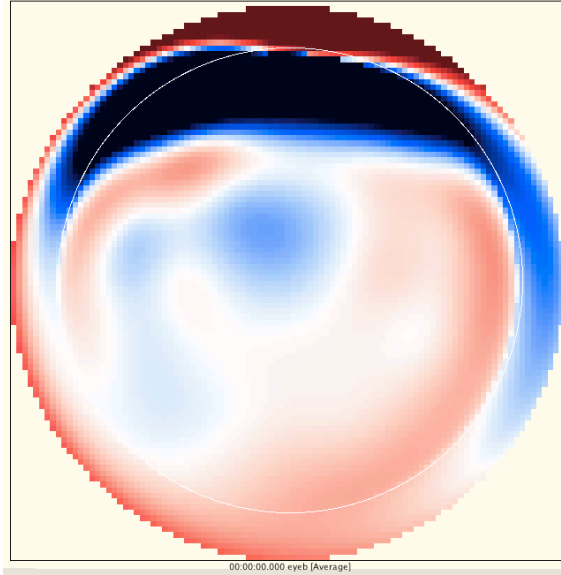


Figure 7. Blink-averaged data after removing IC #1. Topography at time 0 (peak of averaged blink activity).

Further, some channel Fp2 (above the eyes) still has artifacts, even after removal of both IC#1 and IC#7:

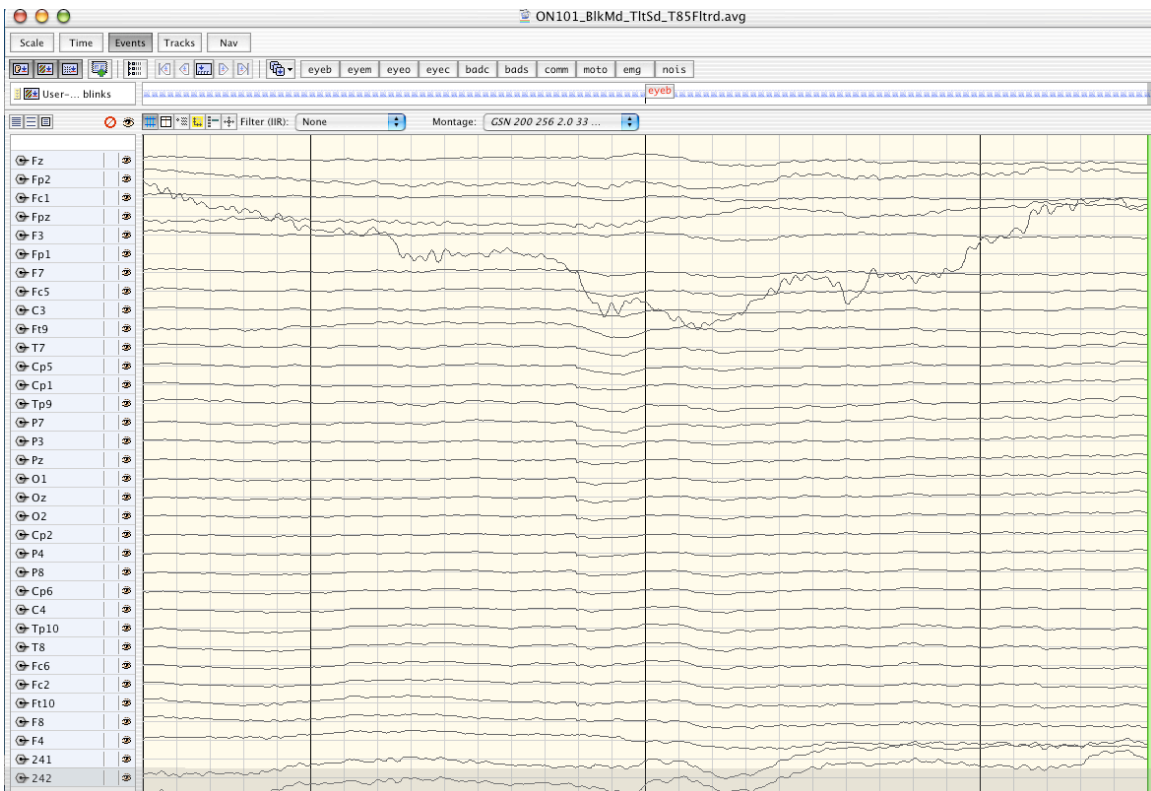


Figure 8. Blink-averaged data after removing IC #1 and #7.

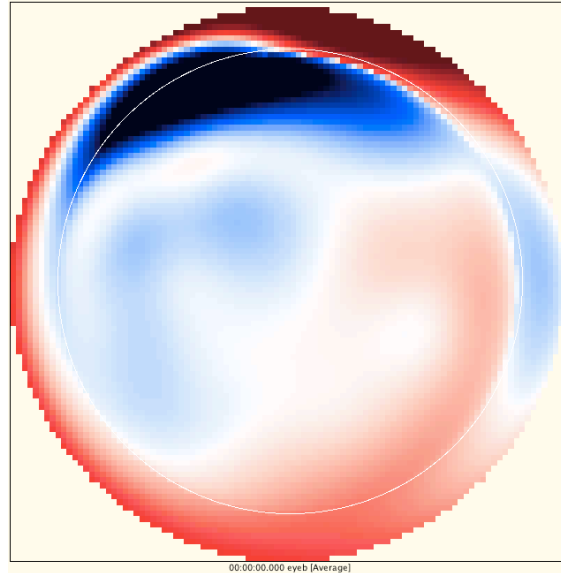


Figure 10. Blink-averaged data after removing IC #1 and #7. Topography at time 0 (peak of averaged blink activity).

(using the time series corresponding to the real blinks to derive a temporal template (similar to the spatial template) -- e.g., crude use of real-blink time series gives low correlation with best-match IC, but correlation is still 10-1,0000 times larger than correlation with any other IC)

INSERT PIC SHOWING RELATIVE CORRELATION OF BLINK STREAM, IC
(similar to scree plot, order by correlation)

Next deal with non-blink artifacts (e.g., bad samples) -- either by preprocessing the data prior to ICA or through application of automatic artifact detection after ICA filtering.

Summary & Conclusions

Two possible approaches:

1. Use fixed starting seed, based on blink template. Average vs. individualized blink template
2. Use random seed with parallel FastICA-- multiple runs with parFICA & measure relative kurtosis. successful run both captures the blink activity spatially and temporally and has the max nonzero kurtosis (relative to other ICA runs)... to be explored in a subsequent report.