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Bob Frank
Gwen Frishkoff
Kevin Glass

# Construction of Blink-free "Baseline" Data to be Used in Evaluating Results of ICA applied to Synthethetic EEG Datasets

## Introduction

In a previous report (NIC-TR002), we described a procedure for constructing realistic EEG datasets that can be used to evaluate the success of different ICA algorithms and implementations for the removal of ocular artifacts. These synthetic EEG datasets comprise "blink-free" EEG data, combined with simulated blink activity. By starting with artificially generated blinks, it is possible to compute the correlation of the ICA-filtered (cleaned) data with the original, blinkfree data after removal of blink-related activity.

The validity of this procedure critically depends on the nature of the baseline, or "blink-free" EEG. In particular, for the baseline to be valid, it is necessary to verify that the EEG activity is indeed blink-free. Although we removed the phasic blinks from the data, it is possible that other ocular activity remained: for example, vertical and horizontal saccades, or slow, blink-related activity due to the amplifier time constant. Indeed, we have reason to suspect that the baseline data used in a previous report [conference paper] may have contained some slow activity related to the amplifer recovery subsequent to large blink artifacts (see NIC-TR007 for further discussion). The present report describes the construction of the baseline data to be used in future experiments, and the methods for verifying that the data are truly absent of ocular artifacts.

## Methods

*EEG Data acquisition & preprocessing*

The EEG data acquisition and preprocessing are described in detail in NIC-TR002.

*Removal of ocular artifacts*

Ocular artifacts were removed from the EEG data in two steps. In step 1, blink-contaminated trials were manually detected and removed from the data. The resulting EEG data are plotted in Figure 1 (note that the data were mean-corrected to remove baseline offsets).

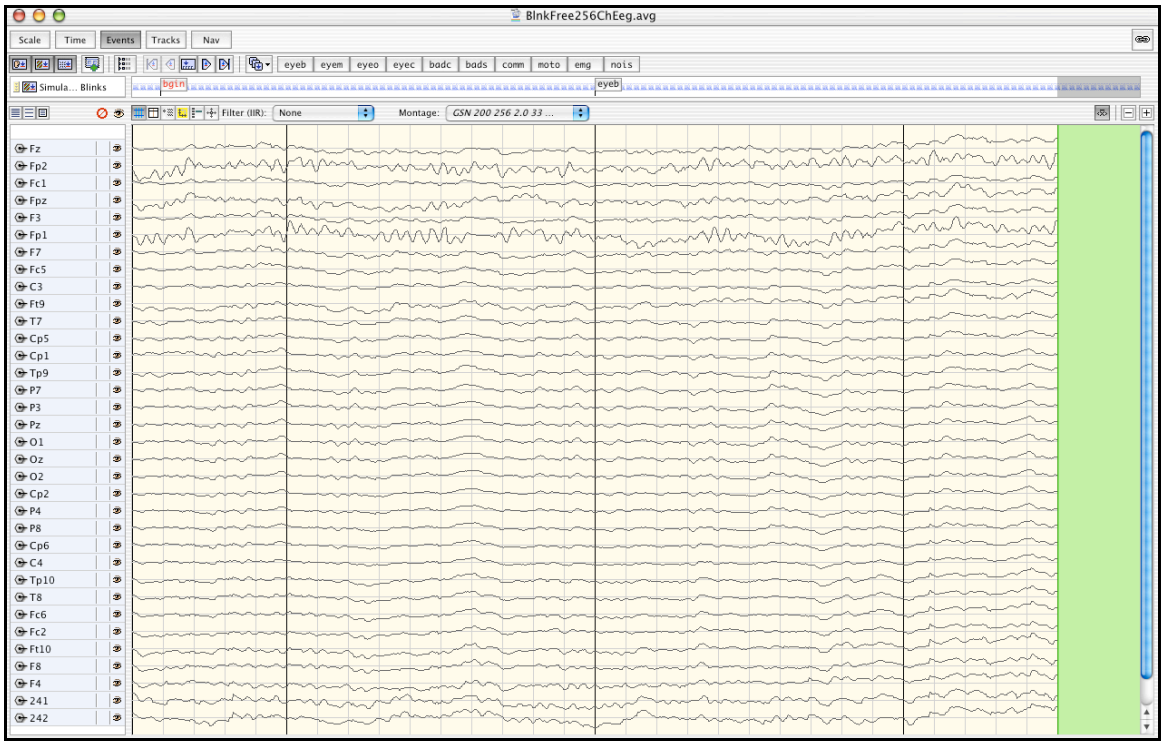


Figure 1. “Blinkfree” EEG data (with phasic blinks removed).

In step 2, ICA (infomax) was applied to the remaining data series. A single component (#21) met both of our criteria for blink-related activity: 1) the polarity of the EEG inverted above and below the eyes for the corresponding spatial projector, and 2) the projector correlated strongly with the blink template (r=.87). Figure 2 displays the projector corresponding to independent component #21.

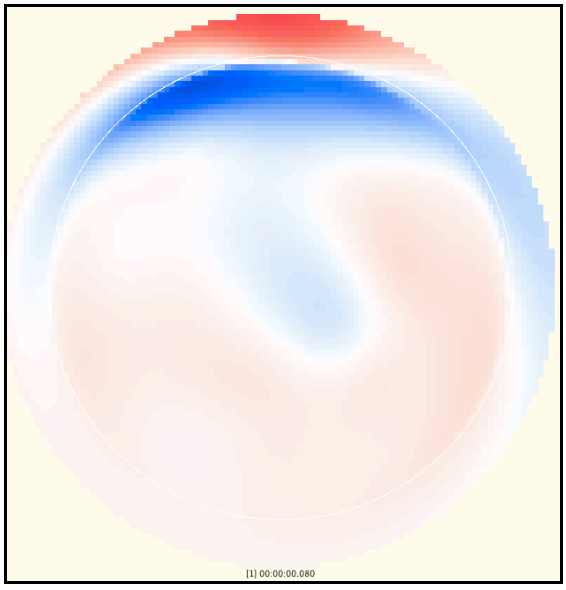

Figure 2. Projector corresponding to IC #21.

Figure 3 shows a 1-second sweep from the time series for independent component #21. Note the slow pattern of activity, which could suggest this component reflects amplifer recovery.

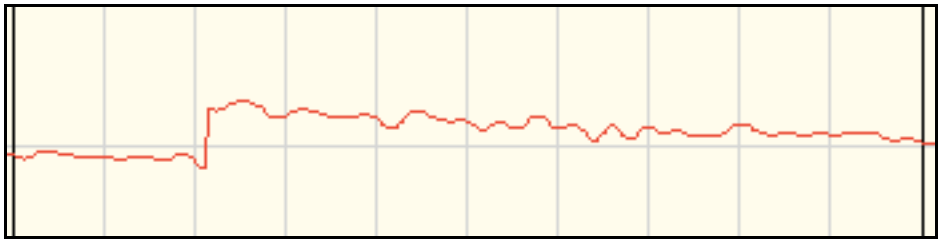

Figure 2. A 1-second interval of activity for IC #21.

It is difficult to evaluate whether this component is in fact related to amplifier recovery, since the blink-contaminated intervals were removed from the baseline, prior to the application of ICA. Nonetheless, independent component #21 had a strong correlation with the blink template and met the vertical polarity inversion criterion. Thus, IC #21 was subtracted from the data. The resulting blink-free EEG is plotted in Figure 4.

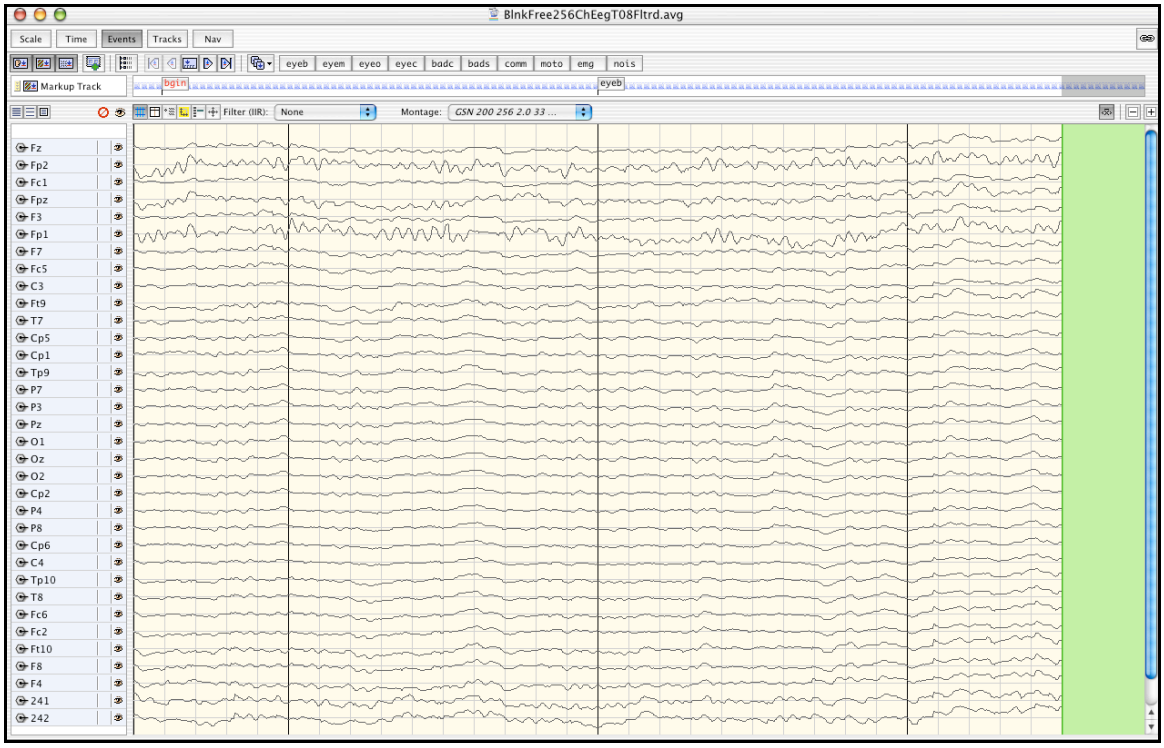


Figure 4. “Blinkfree” EEG data (with phasic blinks and IC#24).

As shown in Figure 4, there is no apparent blink-related activity remaining after removal of the phasic blinks (step 1) and IC#21 (step 2).

*Verification of baseline data*
To verify that the baseline data were truly free from ocular artifacts, we applied ICA (infomax) a second time. None of the projectors corresponding to the independent components matched the blink criteria. The highest correlation between a projector and the blink template was only .328, yet this component did not invert over the eyes. Only one component showed polarity inversion above and below the eyes, and the correlation of this projector with the blink template was only .261. These results provide strong evidence that the baseline data are free from blinks and other ocular activity. Consequently, we used this dataset as the baseline for all subsequent experiments using the methdology described in NIC-TR002.

## Summary & Conclusions

We have demonstrated the construction of a truly blinkfree EEG dataset, which will be used for future ICA experiments, to test the efficacy of ICA with a range of different experimental parameters (see [conference paper] for discussion). The name of this new baseline is 'BlnkFree256ChEegT08Fltrd.' Application of ICA to these data confirms that there is no blink-related activity remaining after removal of the phasic blinks (step 1) and subtraction of IC#21 (step 2), which we have tentatively interpreted as activity related to blink recovery (a function of the amplifier time constant, which is 10 seconds for these data).

## References

Glass, K., Frishkoff, G., Frank, R., Davey, C., Dien, J., Malony, A., & Tucker, D. (2004, September 2004). *A Framework for Evaluating ICA Methods of Artifact Removal from Multichannel EEG.* Paper accepted to the ICA 2004 Conference, Grenada, Spain.

Frank, R., & Frishkoff, G. (2004). *NIC Technical Report 04-002: Generation of Simulated Blink Data* (TR No. 002). Eugene, Oregon: Neuroinformatics Center.

Frishkoff, G., & Frank, R. (2004). *NIC Technical Report 04-007: Evidence for blink-related components with distinct spectral characteristics* (TR No. 007). Eugene, Oregon: Neuroinformatics Center.