Predicting Human RSVP performance from EEG data

Rapid serial visual presentation (RSVP) paradigms demonstrate that humans recognize the “gist” of a natural scene extremely rapidly, on the order of tens of milliseconds (Potter & Levy, 1969). Thorpe et al. (1996) showed that human event related potentials (ERPs) start to differ for target as compared to non-target stimuli about 130ms after stimulus onset. When analyzing error patterns in RSVP, humans show a high inter-observer consistency as to in which sequences targets are difficult or easy to detect. In a recent study, we demonstrated that a statistical measure of image statistics, “Bayesian surprise”, reliably predicts these human errors (Einhäuser et al., submitted). In particular, “surprising” events before a target stimulus effectively mask the target, akin to the well-known phenomenon of attentional blink (Raymond et al., 1992; for recent work on naturalistic stimuli: Evans & Treisman, 2005; Einhäuser et al., 2007). The brain signals underlying the attentional blink have been studied with electroencephalography (EEG, Kranczioch et al., 2003; Sergent et al., 2005) and with other imaging methods, such as functional magnetic resonance imaging (fMRI, Marois et al., 2004). In December 2006, we – in collaboration with the Swartz Center of Computational Neuroscience at UCSD (S. Makeig) and the Department of Computer Science at USC (L. Itti) - recorded 256-channel EEG in 3 human observers, while they were viewing RSVP sequences and performed an animal/no-animal detection task. These results shall be used to address the following, so far unresolved questions:

1. Which EEG features discriminate target from non-target stimuli in an RSVP presentation on a trial-by-trial basis?
2. Can EEG signals in combination with the behavioral data better predict target occurrence than either signal alone?
3. Do similar brain mechanisms underlie the “surprise” masking phenomenon, as do underlie the attentional blink?

The Semester project, which may be continued in a follow-up Master thesis, will conduct the first steps of data analysis:

1. Perform appropriate data pre-processing (e.g., spatio-temporal ICA) to remove recording artifacts and to extract candidate features for target prediction.
2. Apply machine learning techniques (discriminant analyses, linear and non-linear classifiers, etc.) to identify EEG features that are predictive of target occurrence in the RSVP stream.

The student is expected to interact with our collaborators at UCSD and USC.

References