

# Combining eye tracking, key logging, and electroencephalographic data: towards an integrated tool for translators

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The process of translating from a source language into a target language is a highly demanding cognitive task involving a number of processes such as sensory processing, memory access, decision making, and motor output. The retrieval from semantic long-term memory and the mapping of words (or concepts) between the languages plays an important part in that context. Comprehensive studies of such complex processes including the reading of words or sentences and the typing of the translation require a number of signals to be recorded, namely the electroencephalogram (EEG), the electrooculogram (EOG), the electrocardiogram (ECG), the tracking of the eye gaze direction, and the logging of keystrokes. Therefore, an integrated monitoring system for studying language translation is introduced, comprising the simultaneous recording of EEG, EOG, ECG, eye gaze, and keystrokes.

These different data streams are recorded with three independent systems: 1) Translog 2006 with integrated GWM (Gaze-to-Word Mapping) and ETU (Eye Tracking Universal) Driver modules, 2) Matlab and C++/Qt-based recording software, and 3) ClearView by Tobii Technologies. Translog is the central application that is used for stimuli presentation (source text) and receives the produced (target) text, i.e. logs keystrokes. The application sends out time stamps over the network using either UDP or TCP/IP and all other systems that record data receive these stamps and save them in their respective files, thus making all data streams synchronized using Translog relative time. That way, it is possible to align the different data sets offline, that is, after the recordings have successfully been carried out. By default, a text string containing the current Translog time is transmitted every ten seconds.

Translog, GWM and ETU-Driver were heavily modified and integrated into a unified application. To this end, Translog uses an instance of GWM and ETU-Driver that are visible as COM objects. It handles the events that are raised by these two classes. ETU-Driver provides the access to the data from various eye-tracking devices and logs it in raw (samples) and filtered (fixations) formats. GWM maps gaze fixations (transmitted from ETU-Driver) onto words (visible in Translog) both from source and target texts using advanced mapping algorithms resistant to the inaccuracies in gaze data. The resulting file generated by this module consists of words that were focused by a participant during an experiment.

The second system captures data from either a multichannel or portable EEG amplifier. Third, ClearView logs raw eye tracking data (like ETU-Driver).

To visualize the data recorded by Translog, GWM, ETU-Driver, and the EEG tools, an application called KiEV was developed. A visualization with five horizontal panels on the same timeline is displayed, namely word focuses (in source and target texts), the target text production, pupil size dilations and EEG data. Moreover, Translog has its own visualization tool where the progress of text typing may be analyzed in detail. ClearView replays the gaze data over video captured from the screen and produces heat map visualizations.