

Event related (de)synchronization during comprehension of a foreign language

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Abstract

Recent studies on semantic processing showed that the sensorimotor cortex is involved in language comprehension and language translation [1] and that activity of the motor system is modulated by the processing of action related phrases [2]. These findings support the claim that the sensorimotor functions help to structure thoughts about actions and events by (partial) simulation of its processes [3].

Parting from this, an experiment was designed to study the dynamics of the EEG oscillations during comprehension of a foreign language. In the experiment, the participants were asked to read four texts written in English. Three of the four texts contained brief stories in which motor actions of different velocities were included, e.g. stand (neutral), walk (slow) and run (fast). The remaining text was used as control condition; containing no motor actions.

Nine subjects (2 males and 7 females, aged 48.1 ± 9.6) participated on this study. The subjects were Norwegian-English professional translators and gave consented permission prior to their participation.

During the experiment two EEG signals were recorded using bipolar derivations at positions C3 and C4 (from the 10-20 standard). One subject

was discarded because of a bad EEG signal.

To process the EEG data, the recordings were filtered in three bands: i) theta (4-7 Hz), ii) mu (8-12 Hz) and iii) beta (20-30 Hz).

After filtering, the EEG signals were squared, smoothed with a moving average filter (in a time window of 1 s) and transformed with the logarithm. This method is termed logarithmic band power (logBP). Changes in the EEG power related to the speed condition, were measured for each band individually as event related (de)synchronization [4]:

$$ERDS = \frac{task_j - ref}{ref} * 100$$

where *ref* was the average logBP value obtained during a fixation cross period, presented 1.5 min before reading each text; and *task_j* value corresponds to the average logBP during reading a text with a specific speed condition.

An ANOVA for repeated measurements with factors SPEED x CHANNEL was computed with the ERDS values for each band separately. Significant differences in the mu band revealed an event related synchronization (ERS, increase of power) between both slow and fast conditions compared to the control condition. In the beta band, the slow condition showed also an ERS significantly different compared to the control condition. Additionally, there was a marginally significant ($p = 0.07$) difference between the EEG channels, i.e., hemispheres; where the left hemisphere (channel C3) showed an event related desynchronization (ERD). There were no significant differences in the theta band for any condition.

This study brings evidence of the embodiment of actions during comprehension of a foreign language. Differences in the EEG power can be appreciated when the text includes motor actions. The power in the mu band is increased by inclusion of motor actions in the text, but no effect was revealed by differences in the speed itself. The beta band showed a similar effect, but only for text containing a description at a slow speed. These two bands are associated to the activation of groups of neurons related to motor execution and motor imagery. Also, the so called 'mirror neurons' are active in these ranges [5, 6]. A comparison with a group of bilinguals with less developed translation skills could reveal more information about the cognitive processes involved not only during the embodiment but during the comprehension of a foreign language.

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