ORAL or POSTER presentation

A method for validation of cognitive models on a neurophysiological level

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Cognitive models are usually validated on the basis of behavioral data. However, this approach does not take into account that the underlying cognitive processes are not definable on behavioral data alone. A model that provides valid behavioral data could therefore still be based on non-valid processes. In this work we implement an approach to model validation that compares data from EEG signals to data from different modules of an ACT-R model. Through this, the validation is shifted from a behavioural level to the level of underlying processes.

The method describes the relevant steps of preprocessing and data comparison. In a first step the relevant information is extracted from the two streams of data and transformed to be comparable. Next, the actual matching algorithm is applied. Processes in the cognitive model are compared to EEG data on the basis of single trials for each participant individually. Results are given in the form of matches from independent components (ICs) of the EEG signal to modules of the cognitive architecture. The matched ICs are then localized on the scalp and examined for the brain area that was ascribed to the respective module in previous fMRI research.

Application of the method to data from an experiment yielded positive results for the visual modality, where 17 of 21 matches were located in occipital brain regions. Matches to declarative and imaginal modules partly supported our hypotheses, whereas matches of motoric processes did not result in support for the method. This could have several reasons. First, the method could have problems with matching this modality. Second, ACT-R is kept very simple in terms of motor processing and may not be able to model the processes correctly. Third, the model itself could be wrong.

Despite the mixed results of this first application, there is great potential in the matching of EEG and model data. The success of the visual matching indicated that the approach is a promising way to re-think cognitive model-validation. In future research, the method needs to be applied to data from other experiments and other cognitive models in order to test its general applicability.