

Brain areas activated during electric microstates of mental imagery versus abstract thinking

D. Lehmann^a, T. Koenig^b, B. Henggeler^a, W. Strik^b, K. Kochi^a,
M. Koukkou^b and R.D. Pascual-Marqui^a

^a) The KEY Institute for Brain-Mind Research, Psychiatrische Universitätsklinik, CH-8029 Zurich, Schweiz (<http://www.unizh.ch/keyinst/>); ^b) Abtlg. für Psychiatrische Neurophysiologie, Universitätsspital für Klinische Psychiatrie, CH-3000 Bern, Schweiz

Which brain areas incorporate visual imagery and abstract thought automatically, i.e. when there is no conscious attention to distinguish between these seemingly different two modes of mentation?

We combined two independent studies^(1,2) that used microstate analysis of brain electric multi-channel data. EEG- and ERP-microstates are time epochs of quasi-stable map landscapes of momentary potential topography, lasting <100ms in duration. In study #1, during spontaneous mentation, 13 subjects were prompted to report "what just went through your mind".

The reports were classified into mental (visual) imagery or abstract thought (e.g., thinking about a house vs. a theory). The last EEG microstate before prompting was identified as imagery or abstract. - In study #2, 25 subjects read visually imaginable and abstract nouns (e.g. "house", "theory") at ~0.5/s, and repeated the last word if followed by a question mark. ERP microstate 286-354 ms post-stimulus had significantly different potential maps for the two word classes. LORETA intracortical tomography was computed from the EEG and ERP microstate potential maps. The results of the two studies were combined (Fisher's probability combination). Common across subjects for both studies (Fig. 1), visual imagery-associated activity was right inferior-temporal (Brodmann 20, 36, 37), for abstract thought left orbito-frontal (Brodmann 38, 47).

In both studies, subjects had to remember the last spontaneous mentation or presented word, but did not know that imagery vs. abstract mentation was studied. Thus, the identified brain areas were activated automatically without task to imagine or to formulate, and identical areas were activated regardless whether the mentation was triggered by internal, spontaneous events (sudden ideas) or by external, imposed events (word display). The two modes of mentation clearly engaged different brain regions. The EEG- and ERP-microstates seem to be valid candidates for the "atoms of thought".

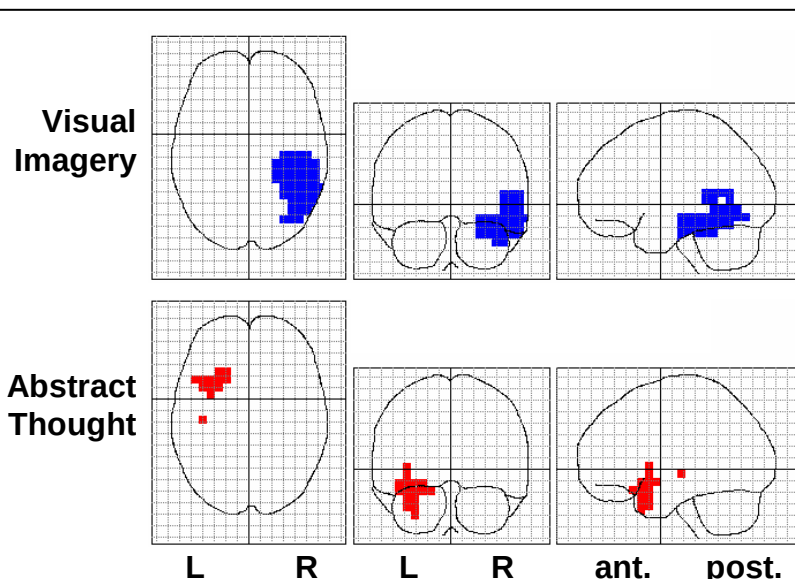


Fig. 1. Glass brain view of concordant (at Fisher's combined $p < 0.05$) LORETA voxels for automatic imagery and abstract thought in the two studies: during spontaneous mentation and during word reading.

References: 1) Lehmann, D., et al.: Brain electric microstates and momentary conscious mind states as building blocks of spontaneous thinking: I. Visual imagery and abstract thoughts. *Int. J. Psychophysiol.* 29: 1-11 (1998). - 2) Koenig, T. et al.: Event-related electric microstates of the brain differ between words with visual and abstract meaning. *Electroenceph. Clin. Neurophysiol.* 106: 535-546 (1998).