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Sparse coding representation of emotional brain states in fMRI data

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Modern computer systems can deal with tremendous amounts of information, and these systems are becoming more and more complex. Still, there is no machine that develops emotions when processing complex stimuli. In this respect, processing in the human brain seems to differ from processing in machines not so much in the amount of data dealt with, but especially in terms of the global integration of parallel (local) processes as a whole [1].

FMRI (functional magnetic resonance imaging) is a method that gets us “behind the scenes” even if participants perform complex tasks. As “complex” refers to tasks that cannot described by activity in a single locus, multivariate techniques are the first choice on the way to break the code underlying these responses. Standard factor analysis is used to determine, in which of the brain regions activity is correlated (PCA) or which voxels are showing statistical independent activity (ICA) [2,3]. But on the way to understand such patterns, we are especially interested in the intrinsic organization of these correlated or statistical dependent modules. In this context, the use of Sparse Coding (SC) is twofold: We could try to find class-separating feature vectors that are sparse but still discriminative for the given classes [4]. But just the same, we can learn a set of base functions – alternatively to PCs and ICs – that resembles the task-specific patterns by a linear combination with as few as possible non-zero coefficients [5].

We analyzed an fMRI study to examine the brain responses to emotional conditions (anger, fear, surprise, joy, and sadness) and focused on the impact of sparse coding to the pattern characterization task.

We show how the structure of global brain activity and how the complexity of sparse patterns is changing during different emotional states and that different affective states of the system can be well discriminated using SC. Finally, we will address the question of how many voxels are needed to discriminate these emotional states.

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