# Model-Based Classification: Differential Changes in Functional Connectivity between Patients with Somatoform Pain Disorder and Healthy Controls

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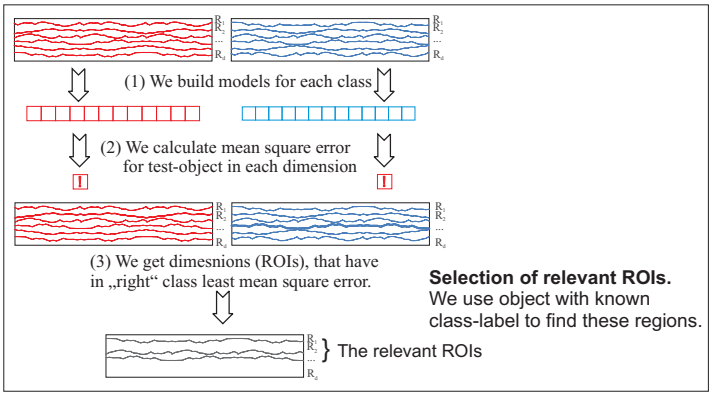
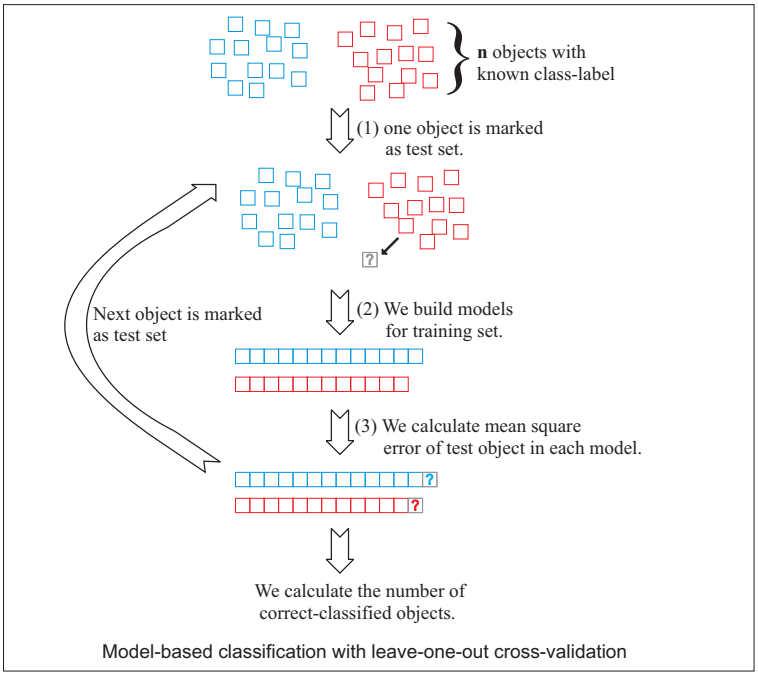
**Introduction:** Pain disorder characterized by chronic, fluctuating pain experiences without sufficient somatic explanation is related to a couple of regions including at least the pain matrix and pain regulation relevant areas. The goal of our study was to detect pain disorder relevant regions in an a priori hypothesis-free approach. To obtain a very general set of ROIs, all voxels within the brain have been labelled according to 90 ROIs following (Tzourio-Mazoyer et. al.; 2002). We propose a novel method to find the most relevant networks associated with pain disorder. The decision is based on the linear dependence between the voxel time courses of ROIs. We assume that the information we are looking for is concealed in the interaction of ROIs. The results confirm our assumption.

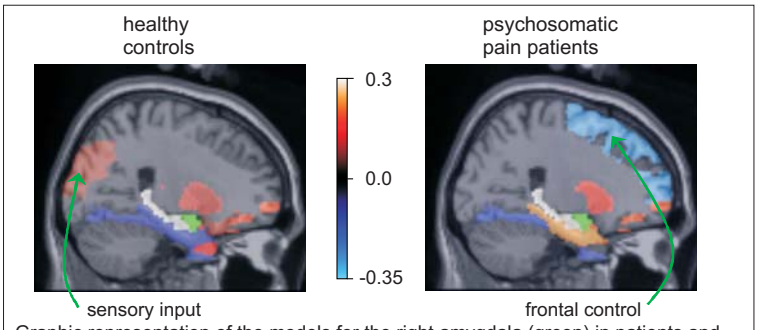
**Methods:** Our study involves task functional magnetic resonance imaging data (fMRI) of 13 subjects with pain disorder and 13 healthy controls with a pain paradigm (Gündel et. al.; 2007). To detect the best discriminating networks, we apply a model-based classifier introduced in (Böhm et. al.; 2009). The basic idea of this classifier is to support classification decisions by detecting differences in the interaction patterns among time series. Applied to fMRI data, this classifier provides insights into the differences of brain networks between patients and controls. Brain networks are characterized by linear models which capture the interactions of voxel time courses between different ROIs. For classification, group-specific interaction patterns are detected from a training data set. Leave-one-out cross-validated classification accuracy allows measuring the discriminatory power of the classifier while guaranteeing for statistical significance. To identify the most important brain networks for the identification of pain disorder, we first ranked the 90 ROIs according to their contribution to classification accuracy. From the 10 most relevant ROIs, we constructed all possible subsets ($2^{10}$ or 1024) and evaluated the classification accuracy.




Model-based classification with leave-one-out cross-validation

**Results:** We have applied our method to "pain data" from (Gündel et. al.; 2007). We use regions labels from (Tzourio-Mazoyer et. al.; 2002). From ten best relevant ROIs we have found four ROIs (inferior orbitofrontal cortex (Right), inferior orbitofrontal cortex (Left), medial orbitofrontal cortex (Right), medial orbitofrontal cortex (Left)). The four ROIs are sufficient for the classification with good accuracy. We have tried all possible ROIs subsets ($2^{10}$ or 1024). The four ROIs gave the best result. With the help of these four ROIs we achieved classification accuracy of 96% or there is only one of 26 person wrongly classified.




Graphic representation of the models for the right amygdala (green) in patients and controls involving all 90 AAL-ROIs. While healthy controls show functional connectivity of the amygdala to sensory areas (right superior occipital), patients show increased connectivity to medial frontal areas (right superior frontal). Red to white: areas with a signal-time course with positive linear coefficient in the model, Blue: negative linear coefficient, respectively.

**Conclusions:** We have shown that classification decision gives us the information to find relevant ROIs. Detected ROIs represent relevant areas in pain and emotion regulation leading to the hypothesis that most important changes in pain disorder regard rather an altered pain regulation than changed pain representation.

**References:**

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