Population based pattern classification of emotional brain states using fMRI signal

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INTRODUCTION

Prediction of brain states from brain activity constitutes a major scope of cognitive neuroscience. It has been pointed out (Haynes et al., 2007) that multivariate approaches are more sensitive in decoding brain states as they integrate spatial and temporal information from different regions of the brain as compare to univariate methods. The existing methods (Sitaram et al., 2011, Laconte 2011) are optimized for each participant, because SVM training is carried out on subject-specific data. Hence, there is no methodology and implementation for real-time population based or subject-independent classification of brain states. A subject independent classifier could find use in clinical rehabilitation, where patients with brain abnormalities pertaining to motor, cognitive or emotion processing could be retrained to achieve normal level of functioning by providing feedback from a real-time pattern classifier that is trained on healthy subjects.

The first objective of the present study was the technical demonstration of a first subject independent real-time pattern classifier and feedback system. The second objective was assessing whether healthy participants could learn to self-regulate their emotional brain network based on feedback derived from he subject-independent SVM classifier. We hypothesized that those healthy participants who learn to self-regulate their emotional network in a happy vs. disgust binary classifier will display an enhancement of the priming effect in an affective priming task.

MATERIALS & METHODS

The pattern classifier system was used from our previous study (Sitaram et al 2011). In the present system, we implemented online co-registration and normalization of functional images to a standard brain (Montreal Neurological Institute, MNI). The classifier model was trained on 12 subjects' data from our pervious study on classification of happy and disgust emotion.

Participants were instructed to identify one or more emotional episodes from their personal lives for each type of emotion (e.g., happy or disgust). The experiment was performed in 3 days. On day 1 participant performed a pre-test before feedback training. Feedback training with the subject independent classifier was performed on day 2. A post-test identical in protocol to the pre-test was finally performed on day 3.

The pre- and post- behavioral test was a block design, which consisted of 6 trails of alternating happy and disgust imaginary blocks followed both by an affective priming task. The priming task was modified from Suslow et al. 2003 (Suslow 2003), and was used to assess the effect of the emotional network self-regulation, learned with feedback training. Subjects were required to rate the emotional valence of the target. Due to normal priming effect, participants tent to rate the target with a higher valance accordingly to the prime.

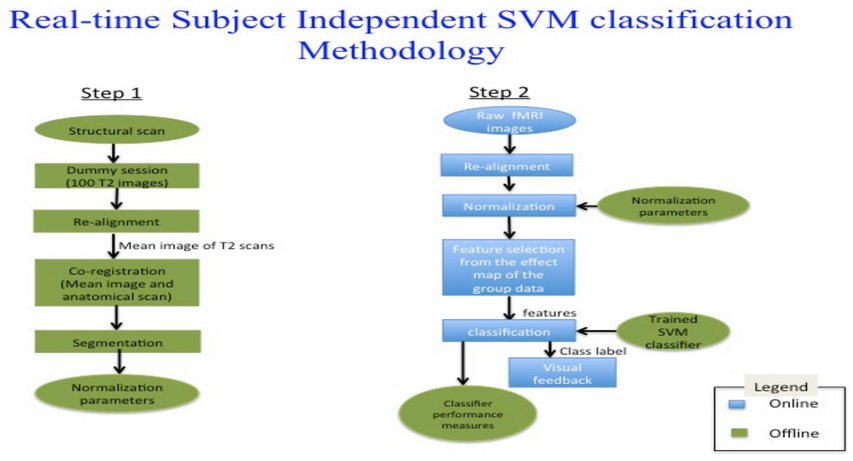
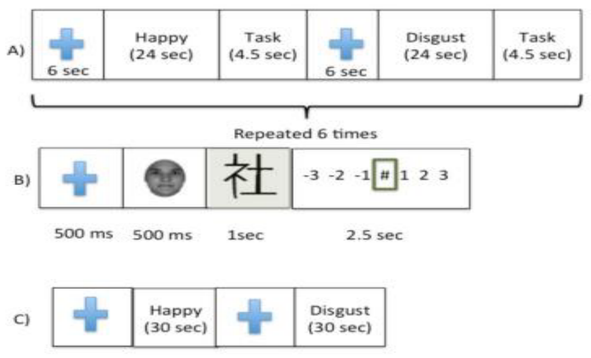


Figure1: Schematic procedure for performing the experiment



ure2: Schematic illustration of experimental paradigm. A) Pre- l Post –test B) Behavioral task. Neurofeedback training with ject independent classifier.

RESULTS

The model, which was trained on 12 subjects, was able to classify the data of the new subject with above chance accuracy. The plots of classification accuracy across the runs in (A) Pre-test (B) Training and(C) Post-test is shown in figure 3. We observe that most of the subjects were able to regulate with the passage of time during training. In the pretest, the classification accuracy was always around chance level where as in the post-test most of the subject were able to perform better as compare to pretest.

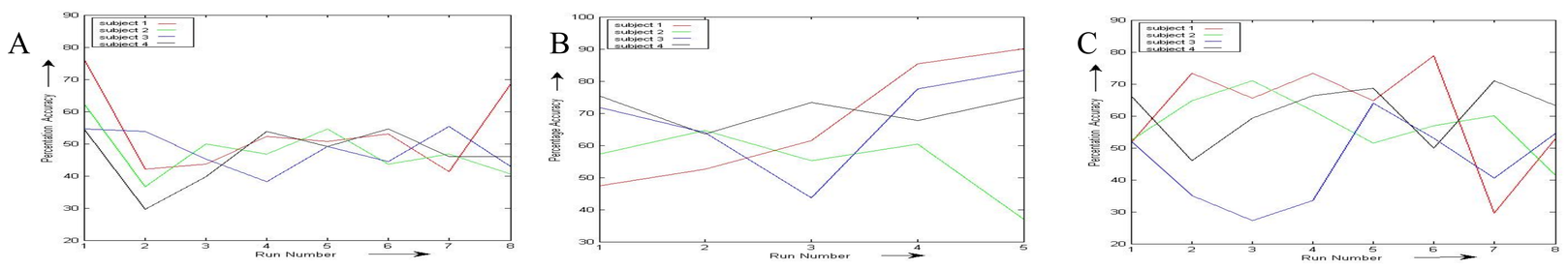


Figure 3: Classification accuracy of the four subject across the run for Pre-test (A), Training (B) and Post-test (C) .

The behavioral data analysis was performed in the post-test in order to see if there is any significant difference between the rating of the Chinese ideogram after the regulation vs. the rating after baseline. The conditions which show significant difference in the rating were baseline block (Happy face as prime) vs. Disgust regulation (Happy face as prime) and baseline block (Disgust face as prime) vs. Happy regulation block (Disgust face as prime).

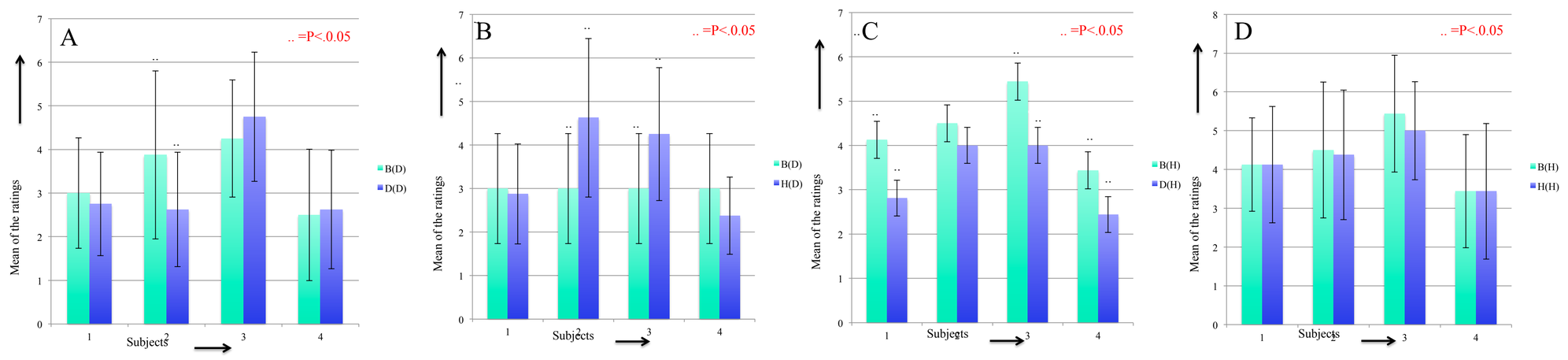
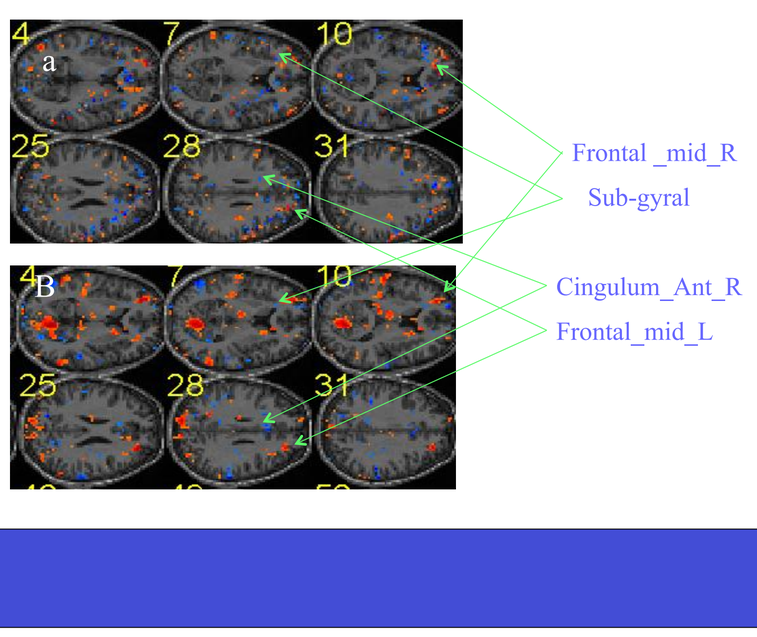


Figure 4.Behavioral data analysis. A)Baseline (Disgust face as prime) vs. Disgust regulation (disgust face as prime). B)Baseline (Disgust face as prime) vs. Happy regulation (disgust face as prime). C) Baseline (Happy face as prime) vs. Disgust regulation (Happy face as prime). D)Baseline (Happy face as prime) vs. Disgust regulation (Happy face as prime).



The offline analysis was performed on the training data in order to create the effect maps. Most of the subjects Effect map from the first run (c)does not resemble the group effect map(d). But in the last run due to learning effect the subject's effect map(a) was resembling the effect map of the generated on the group data. In figure 5, we show Some of the common activations between (b & d) the effect map generated by the group data on which classifier was built (c) and (b) the effect map of the subject in the first run (c) and after the subject was trained in the last (a) to regulate brain activity using subject independent classifier

CONCLUSIONS

Our results indicate that it is possible to develop a subject independent classifier system, and that it can be used to train people to regulate their brain activity. There is a significant difference in the rating of Chinese ideogram when the regulation and prime are having different valence as compare to if they are of same valence.

References

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