Move Happy and Be Happy: Effects of Dynamic Expressions of Emotion On Brain Activation And Affective State

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Introduction

- **Only 30-35% of patients with Major Depression achieve remission in response to medications. Many others cannot use medications because of side effects. The development of cost-effective non-pharmacological intervention, may improve clinical condition for many depressed patients.**
- **Exercise is an effective intervention for depression but adherence is difficult for depressed individuals because of low energy and lack of motivation. A set of short motor-sequences designed to improve affective state, and performed 5 min 2-3 times/day similar to physical therapy for musculoskeletal injuries, might be easier to adhere to.**
- **As a first step towards developing such an intervention, we aimed to demonstrate that affective state of healthy individuals can be modified by performance of specific movements. Based on James-Lang theory of emotions and Damasio's somatic marker hypothesis we hypothesized that** *during performance of happy (or sad or fearful) movements, proprioceptive feedback from the muscles and joints will produce specific brain activation pattern(s) that will induce or enhance the corresponding emotion.*
- **Observation and execution of movements activate the same mirror neuron network. This mechanism of shared representations for perception and action of body and facial movements was proposed as the basis for action recognition, emotion recognition, and empathy. Calvio-Merino (2006) demonstrated that observation of a movement simulates the neural commands for performing that same movement, which based on motor control theories, create an internal representation of the expected proprioceptive feedback from that movement (Kawato 1999, Ebner & Pasalar 2008). This simulation of the expected sensory input might be used during motor observation to induce the corresponding emotions (Wiens 2005). Thus, we aimed to further understand the brain mechanisms underlying the effects of movements on emotion, by collecting fMRI data during observation of happy, sad and fearful movements. We hypothesized that** *observation of emotional movements will activate emotional processing regions, which are probably the same regions activated by proprioceptive feedback during actual execution of these movements.*

Methods

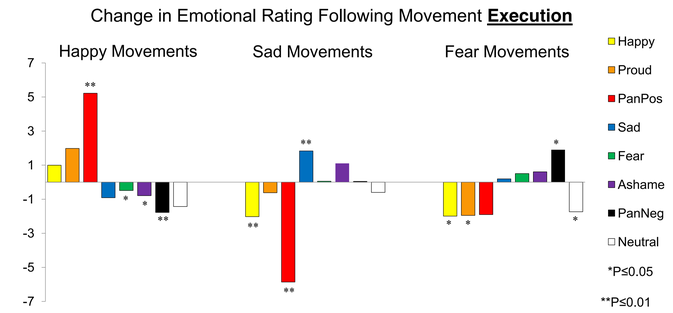
- **22 Subjects (11 males and 11 females 21- 45 years old) were taught to perform sequences of happy, sad, fearfull and neutral whole-body movements, which are the same as those presented in 3 s video-clips that have been perceived and validated in previous studies as representing those emotions (Atkinson et al. 2004). All video clips were performed by actors who wore headwear so that facial expressions were not visible.**

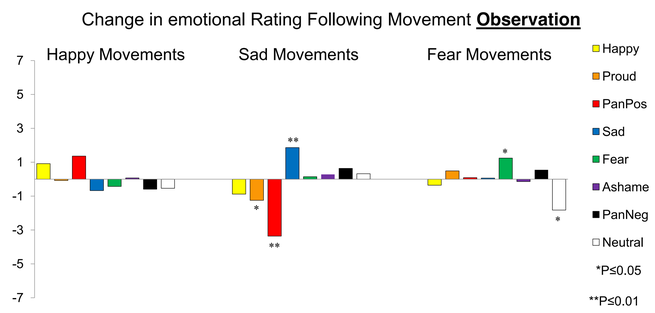
Pictures created from the video clips that were used in this study, by freezing each short movie in the middle of the movement. The left picture was produced from a sad movement, the middle from a fearful movement and the right picture from a happy movement.

- **Affective state was measured before and after motor execution of each emotional motor sequence, using the PANAS (Positive and Negative Affect Schedule) and visual analogue scales for several emotions.**
- **Same procedures were used to measure effects on affective state of observing similar movements.**
- **Brain activation patterns during observation of the same happy, sad, fearful and neutral movements, were collected using fMRI.**
- **Statistical analyses: Behavioral data: t-test on the difference in affective ratings between post- and pre- task performance; fMRI data: Whole brain t-test for the contrasts: happy-neutral, sad-neutral, fear-neutral.**

Results

Behavioral Results





- **Motor execution of happy movements significantly ↑ positive affective state (PanPos) and ↓ negative affective state (PanNeg), fear and shame.**
- **Motor execution and observation of sad movements significantly ↑ sadness and ↓ positive affective state.**
- **Fear motor execution significantly ↑ negative affective state and ↓ happy, pride and neutral feelings, while observation ↑ fear and ↓ neutral feelings.**

Functional MRI Results

Happy Movements - Neutral Movements

Region ($P_{uncorrcted}$ voxel<0.001 and $P_{FDR-corr}$ cluster<0.05)	Z score
R Lateral Inferior frontal gyrus (BA 44/45)	4.57
R superior temporal lobe (BA 21)	4.78
R Superior/Middle temporal gyrus (STS) (BA 38) extending to:	4.56
R anterior insula	4.50
R caudet	4.11
R Putamen	3.54
R Ventral striatum	4.53
R Occipital Gyrus (BA 19)	4.51
L Putamen extending to:	4.75
L posterior insula	4.52
L Caudet	4.70
L ventral striatum	3.89
Thalamus	3.64
PAG	4.19
L Hypothalamic Area	3.95
Bi lateral Cerebellum	3.84

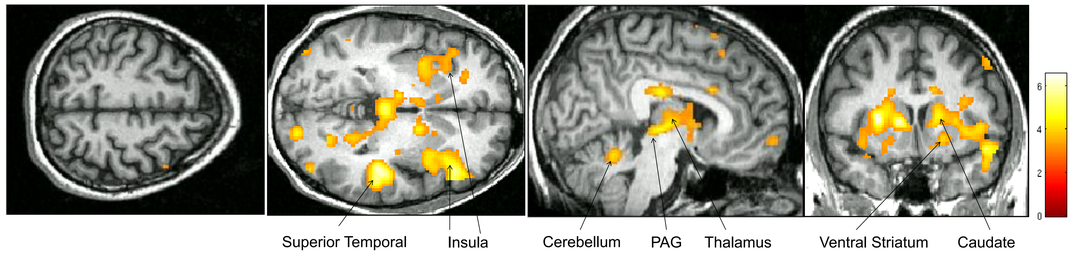
Fear Movements - Neutral Movements

Region ($P_{uncorrcted}$ voxel<0.001 and $P_{FDR-corr}$ cluster<0.05)	Z score
R Superior Frontal Gyrus (BA 6) extending to:	4.35
R Anterior Insula	2.87
R Middle Temporal Gyrus (BA 39) extending to:	4.54
R Occipital Gyrus (BA 18)	4.18
L Superior Parietal Lobe/Precunius (BA 7) extending to:	3.91
R Superior Parietal Lobe/Precunius (BA 7)	3.63
L Occipital gyrus (BA 19) extending to:	4.75
L Inferior Temporal / Fusiform Gyrus (BA37)	3.79

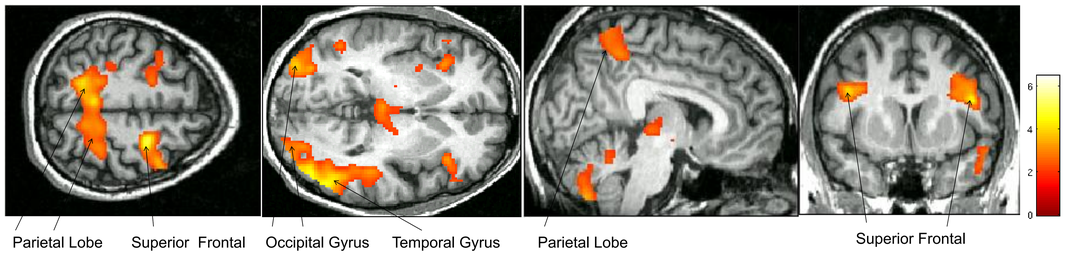
Sad Movements – Neutral Movements

No regions were significant under the criteria of $P_{uncorrcted}$ voxel<0.001 and $P_{FDR-corr}$ cluster<0.05

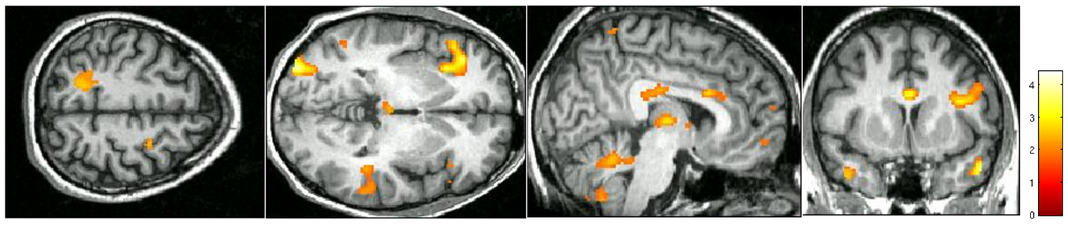
Happy Movements - Neutral Movements (Display Threshold p=0.003)



Fear Movements – Neutral Movements (Display Threshold p=0.03)



Sad Movements – Neutral Movements (Display Threshold p=0.03)



- **Happy, sad and fearful movements differentially activated emotional regions. In addition to regions activated by all emotional movements (thalamus, insula, cerebellum), only happy movements activated the ventral striatum, which plays important role in reward and motivation**

Summary & Conclusions

The results support our hypothesis that execution of emotional movements may enhance the corresponding affect through activation of emotional processing regions in the brain. Future research will determine the strength and duration of emotional motor execution effects on depressed individuals, and the motor characteristic of happy movements, in order to devise intervention composed of simpler movements with similar attributes.

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