Rude - neutral - gentle: looking through the style of action

G. Di Cesare[1], C. Di Dio[1], G. Valente[2], E. Ruffaldi[3]

1 University of Parma, Department of Neuroscience, via Volturno 39/E, 43100 Parma, Italy; 2 Department of Cognitive Neuroscience Faculty of Psychology and Neuroscience, Maastricht University, 6200 MD Maastricht, The Netherland; 3 PERCRO, Scuola Superiore Sant'Anna, Pisa, Italy.

9th FENS FORUM OF NEUROSCIENCE 2014 Milan Italy

Introduction

Besides goal and intention, there is another fundamental aspect of an observed action: its dynamics. Action dynamics gives information on the internal state of the agent and provides an appraisal of the affective and/or cognitive component underpinning the relation between the performing agent and the recipient. This aspect of action dynamics has been named by Stern vitality forms (Stern 2010). Vitality forms are composed by four basic components of movement: time profile, force, space and direction.

Aims

The present study consists of two functional magnetic resonance imaging (fMRI) experiments. The aim of Experiment 1 (Exp.1) was to confirm the location of the anatomical areas involved in vitality form processing described in Di Cesare et al. 2013.
The aim of Experiment 2 (Exp.2) was to investigate whether the coding of velocity and vitality forms is characterized by distinct activation patterns.

Methods

Participants: 16 right-handed subjects participated in Exp.1 and Exp.2.

Stimuli

In Exp.1 video-clips were presented to the participants showing two actors (1 male and 1 female) performing 4 different actions using an object: hand a cup (Fig.1AB); move a bottle; pass a ball; give a packet of cracker.
All actions were executed using two different vitality forms: rude or gentle.

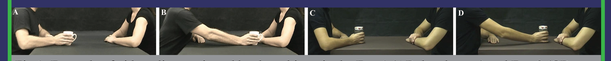

Fig.1: Example of video-clips as viewed by the subjects in the Exp.1 (AB, hand a cup) and Exp.2 (CD, pass a jar).

In Exp. 2 video-clips were presented to the participants showing two male actors, only one of whom performed an action (move a jar, a bottle, a can; see Fig.1CD) towards the other actor using his right hand. All actions were performed using 3 different vitality forms: gentle, neutral, rude.

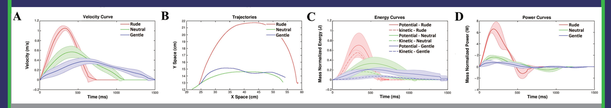

Fig.2: Kinematic and dynamic profiles of the actions performed with three vitality forms (gentle, neutral, rude) in the Exp.2. Graph A depicts the velocity profiles (Y axes) and duration (X axes). Graph B depicts the action trajectories (gentle, blue line; neutral, green line; aggressive, red line). Graph C depicts the potential energy. Graph D depicts the power required to perform the action on the object.

Paradigm and Task

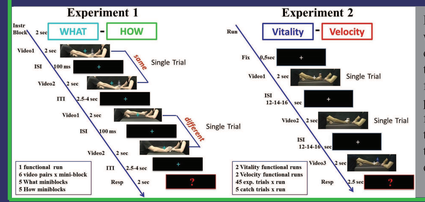

Fig.3: in Exp.1, the participants were asked to focus on the goal of the presented action (what task) or to focus on the vitality forms (how task). In Exp.2, participants were asked to focus on the vitality forms of the observed action (vitality task) or to focus on the velocity of the action (velocity task).

Results

Experiment 1

Overall effect of "what" and "how" tasks

The observation of all video-clips vs. implicit baseline revealed a rather similar pattern of activations for both tasks (what and how).
More specifically there was a significant activation of visual temporal area, posterior parietal lobe and cerebellum bilaterally, as well as of the left inferior frontal gyrus. Additional activations were found in the premotor cortex, particularly for what task (Fig.4).

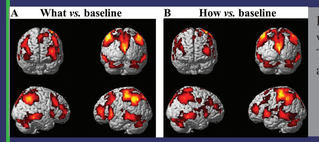

Fig.4: Brain activations resulting from A. the task what and B. the task how vs. implicit baseline. These activations (PFWE<0.05 at cluster level) are rendered into a standard MNI brain template.

Contrast between "what" and "how" tasks

The contrast between tasks what vs. how revealed activations, in the posterior parietal lobe bilaterally, left premotor cortex and prefrontal cortex (Fig.5A).
The opposite contrast (how vs. what), revealed specific activations in the dorso-central insula bilaterally (Fig.5BC).

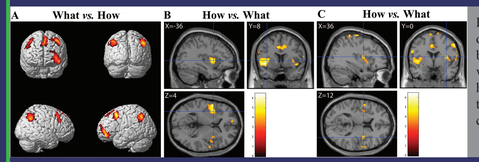

Fig.5: Signal change during direct contrast between A. what-task vs. how-task and BC. how-task vs. what-task (PFWE<0.05 at cluster level).

Esperiment 2 - Univariate analysis

Overall effect of "vitality" and "velocity" tasks

In Exp.2, the observation of all video-clips vs. implicit baseline revealed a rather similar pattern of activations for both tasks (vitality and velocity).
More specifically observation of the video-clips for each task vs. implicit baseline revealed signal increase in visual occipito-temporal areas, parietal lobe, SMA, premotor and prefrontal cortex Fig.6AB).
Additionally, insular activation was observed bilaterally.

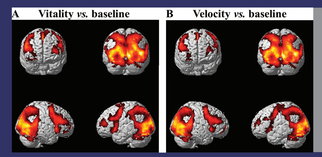

Fig.6: Signal change resulting from A. vitality task and B. velocity tasks vs. implicit baseline. (PFWE<0.05).

Contrasts between "vitality" and "velocity" tasks

The direct contrast between vitality and velocity tasks revealed stronger activations, for vitality task, in the prefrontal lobe, with left prevalence and in the insula bilaterally (Fig.7AB).
The opposite contrast, velocity vs. vitality tasks, revealed no significant activations (P>0.05).

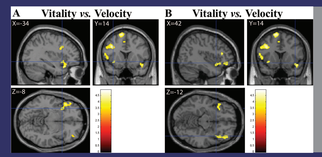

Fig.7: Signal change in the left insula (A) and in the right insula (B). resulting from direct contrast between vitality task vs. velocity task (PFWE<0.05).

Experiment 2 - Multivariate pattern recognition analysis

The univariate analysis carried out in Exp. 2, contrasting vitality forms with velocity, produced activation of the anterior ventral part of insula (Fig.7AB).
To assess possible differences in task*levels activations (rude vs. fast, neutral vs. medium, gentle vs. neutral), we performed a multivoxel pattern analysis using an algorithm to learn, on training trials, the relationship between task*levels and assess each relative spatial activation patterns.
This information was used to correctly classify the patterns associated with the remaining unlabeled trials (Fig.8).

The multivoxel pattern analysis revealed that the classifier mean accuracy for the levels across 16 participants was respectively for the left and right insula: 58,2% and 59,6% for the contrast rude vs. fast, 58,8% and 57,7% for the contrast neutral vs. medium and 56,7% and 55,7% for gentle vs. slow. In contrast, for the two control areas (CTRL 1, CRTL 2), the classifier mean accuracy across the same 16 participants was, for the left and right insula respectively: 50,6% and 48,6% for the contrast rude vs. fast, 50,7% and 50,6% for the contrast neutral vs. medium and 50,5% and 50,5% for gentle vs. slow (Fig.8).

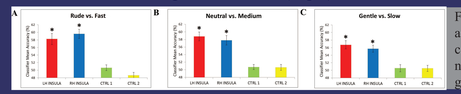

Fig.8: Mean classification accuracies obtained for the contrasts: rude vs. fast (A), neutral vs. medium (B), gentle vs. slow (C).

Subsequently, group discriminative maps were inspected for consistency of spatial activation patterns across participants. Fig.9 shows the main pattern of discriminative maps clustered in the right insula ($p<0.05$ FDR corrected).

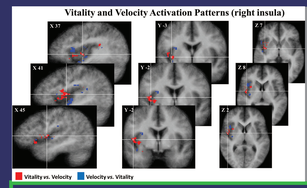

Fig.9: Discriminative group maps of 50% of active voxels most discriminative for the perceptual difference of vitality (red) and velocity (blue) collapsing three different contrasts (rude vs. fast, neutral vs. medium, gentle vs. slow) in the right insula. Each voxel was reported if it was present at least in 10 of the 16 participants. These activation patterns (P< 0.05 FDR corrected) are overlaid on the average anatomical template of 16 participants in Tailarach coordinates.

Discussion

The vitality forms are an intrinsic property of the action that provide an appraisal of interpersonal relations allowing one to relate to and understand others. The present data show that recognition of vitality forms is mediated by a specific anatomical and functional pathway, different from those mediating action understanding. Exp.1 and Exp.2 confirmed the activation of dorso-central insula during vitality forms judgement of the observed actions.This insular sector appears to be the site of transformation from the physical/dynamic aspect of the stimuli to the affective/cognitive component of the same stimuli. It connects somatomotor areas to medial limbic temporal areas. This somatomotor-insular-limbic interconnection should provide the specific sensation characterizing the vitality affects intrinsic to action processing.