Affective appraisal of avatar postures: An fMRI study

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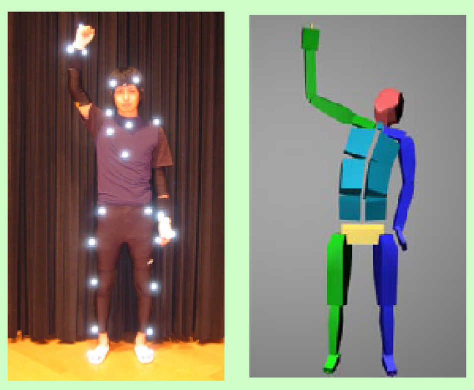
BACKGROUND

Non-verbal communication, which includes facial expressions as well as body postures, accounts for more than 90% of human communication (1). Although most fMRI studies have focused on emotional facial expressions, the ability to perceive and recognize affective states from body postures also plays a critical role in social development, see for example recent research in imitation and autism (2). Recently, Hadjikhani and de Gelder (3) studied the neural correlates of perception of body expression of fear. Their study showed clear activations of fusiform gyrus (previously associated with the processing of face and facial expressions) and amygdala. They argued that the similarity in neural activity for the observed perceptual filling-in could be due to synergies between the mechanisms underlying recognition of facial expressions and body expressions.

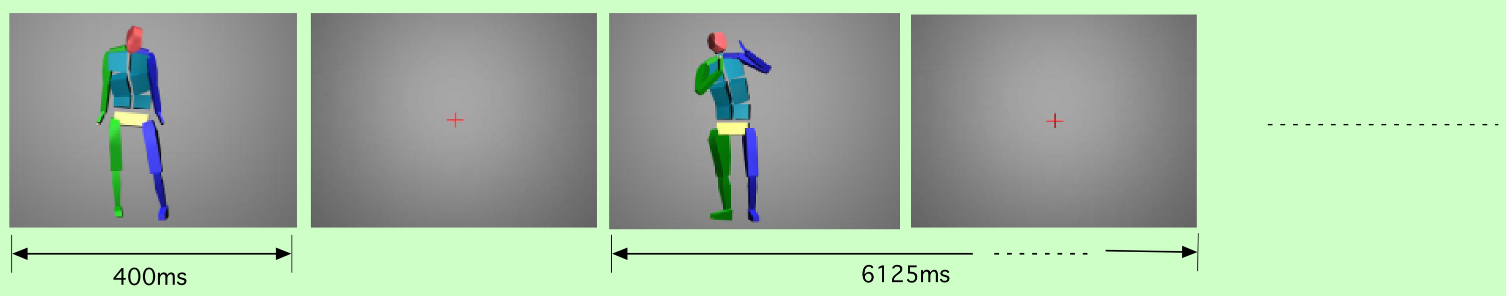
The goal of the present study is to examine this hypothesis in the context of the affective appraisal of postural expressions of various emotional states.

METHODS

Stimuli consisted of 5x6 human postures depicted by an anthropomorphic avatar (right panel) without facial features. The postures were obtained from motion capture (left panel) of actors expressing five different emotional states (happy, sad, angry, fearful, neutral) with the whole body. Stimuli selection followed the results of a separate behavioral study (4). The subjects of that study were instructed to categorize each stimulus in a forced-choice procedure. For each emotion, the 6 pictures yielding the highest recognition rate (84% average) were chosen for the present study.



In this study, the subjects were instructed to rate the emotional expressiveness of each stimulus on a three finger rating scale (from neutral to very expressive). Each stimulus was presented for 400ms with ISIs of 6.125s and a p=.2 probability of null-events during which a fixation cross was displayed (see below).



Sixteen Japanese right-handed university students (9 males, aged 20-27) participated after providing informed consent according to AIST safety and ethics guidelines. Scanning was performed on a GE 3T Signa scanner (23 slices covering the whole brain, 3.125x3.125x5 mm voxel, T2* weighted gradient echo EPI, TR=2s, TE=29.8ms). After standard preprocessing (SPM2), statistical analysis was carried out using ANOVAs (within subjects) over specific contrasts from the first level analysis (GLM) of each subject with rating as a covariate.

RESULTS

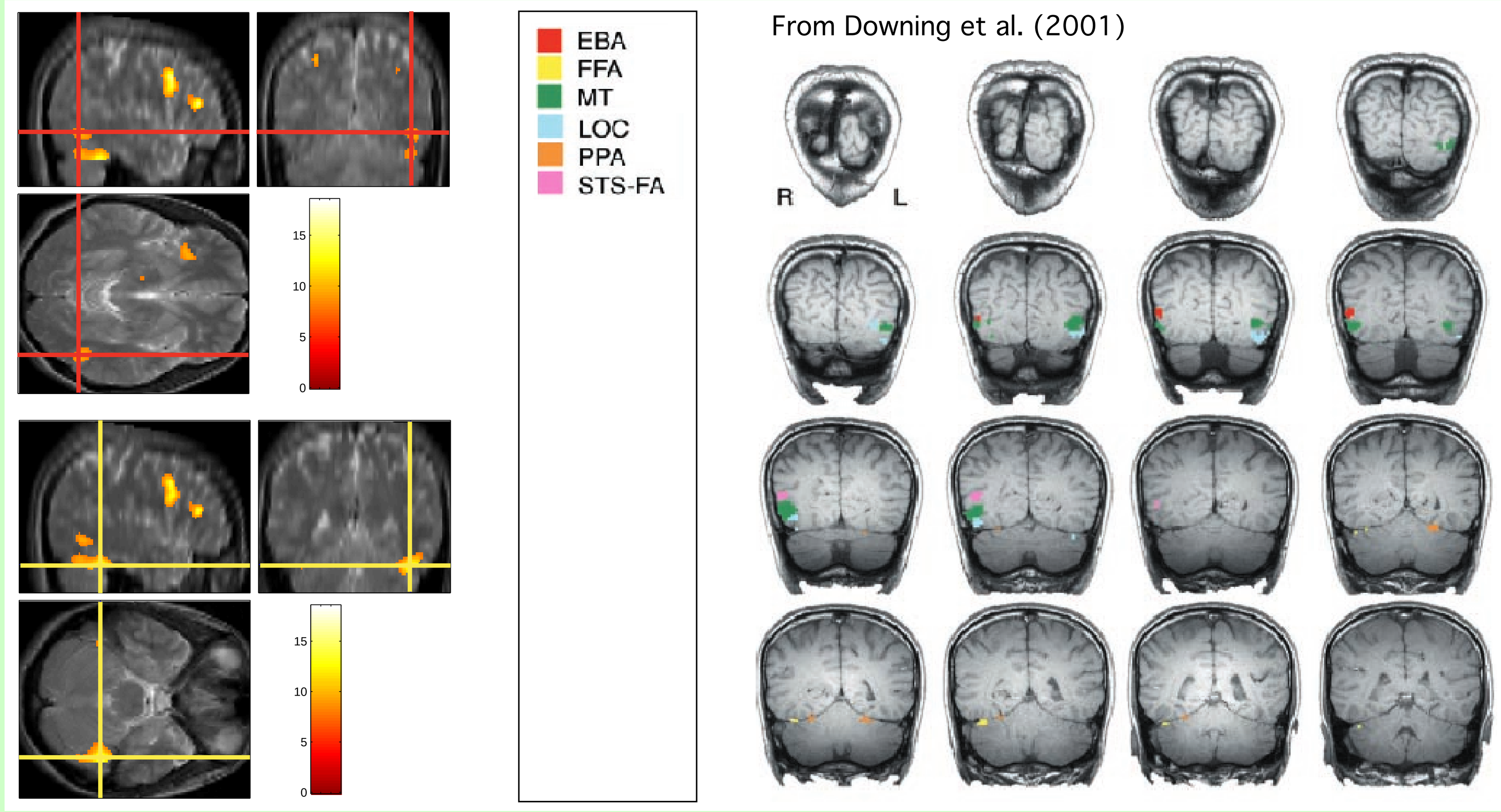
A linear increase of hemodynamic activation correlated to rising expressiveness of the stimulus was observed in the anterior cingulate gyrus (see Table, pFWE_corrected<.05).

Voxels	P_{FWE}	P_{FDR}	T	Location			Region	BA	Range
15	0.013	0.017	9.14	-7	11	34	Cingulate Gyrus	32	1

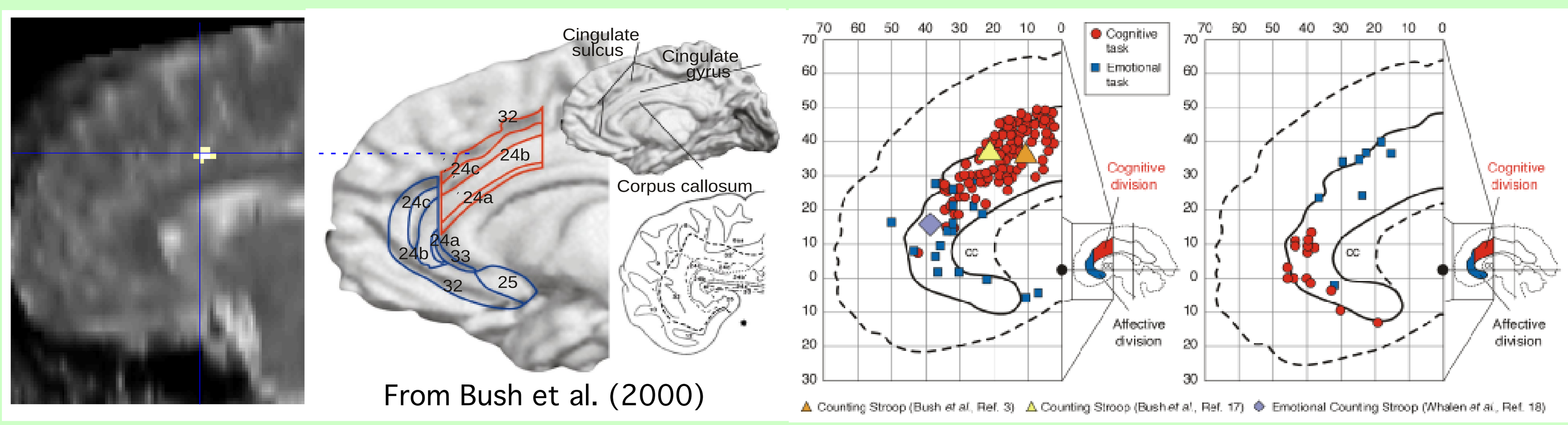
Other activations (task-specific contrast) yielded the activations shown in the following table (pFWE_corrected<.05).

Voxels	P_{FWE}	P_{FDR}	T	Location			Region	BA	Range
2410	0.000	0.000	18.48	-31	0	47	Middle Frontal Gyrus	6	3
90	0.000	0.000	15.72	-51	34	22	Middle Frontal Gyrus	46	3
188	0.000	0.000	15.43	49	33	13	Middle Frontal Gyrus	46	3
661	0.000	0.000	17.83	51	13	32	Middle Frontal Gyrus	9	1
163	0.007	0.000	9.95	-31	24	-6	Inferior Frontal Gyrus	47	7
73	0.008	0.000	9.77	-31	-57	48	Superior Parietal Lobule	7	3
40	0.021	0.000	8.78	33	-61	43	Superior Parietal Lobule	7	1
94	0.015	0.000	9.15	27	-74	31	Precuneus	19	7
24	0.025	0.000	8.56	-9	-71	40	Precuneus	7	1
535	0.000	0.000	14.39	45	-45	-21	Fusiform Gyrus	37	7
9	0.032	0.000	8.34	-43	-47	-21	Fusiform Gyrus	37	7
130	0.009	0.000	9.71	47	-60	-3	Inferior Temporal Gyrus	19	5
134	0.014	0.000	9.17	39	-75	3	Middle Occipital Gyrus	19	7
56	0.016	0.000	9.03	-29	-81	4	Middle Occipital Gyrus	18	5

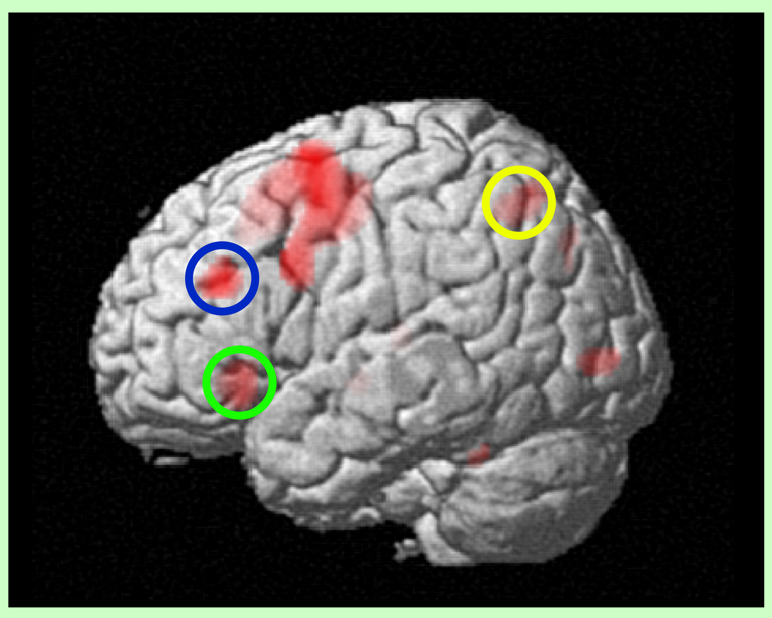
DISCUSSION



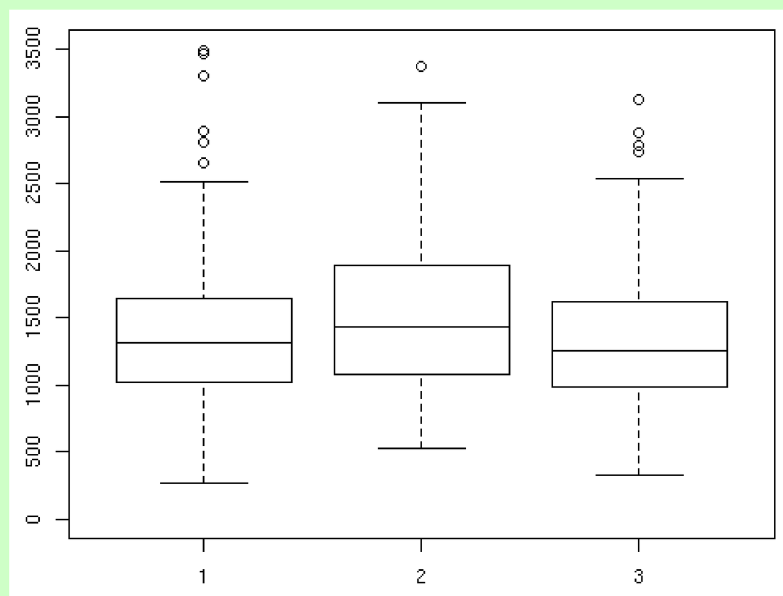
The cluster of activation (top left) observed in the inferior temporal gyrus overlaps a region recently shown to relate to the processing of body-related parts (5). This region, provisionally named EBA (extrastriate body area) appears to respond selectively to visual images of human bodies and body parts, with the exception of faces. Downing et al. (2001) speculated that this region might be involved in the identification of individuals, perhaps under conditions in which face recognition is not possible (e.g., in our study). Alternatively, it might be critical for perceiving the position and/or configuration of another person's body, perhaps as part of a broader system for inferring the actions and intentions of others. Similarly to Hadjikhani and de Gelder (2003), significant activation of the right-hemisphere FFA (fusiform face area) was observed (bottom left).



The absence of amygdala activation might be explained by the fact that emotions other than fear were considered, and also by the cognitive, rather than emotional, nature of the task. This is confirmed by an ACC activity restricted to its dorsal (cognitive) division (red outline). The affective division (blue outline) is activated by tasks that relate to affective or emotional content, but deactivated by cognitively demanding tasks (right panel).



The clusters in BA7 (in yellow) and BA46 (in blue) are reasonable given the strong reciprocal connections between those areas and ACC, with BA46 possibly regulating (7) the activity of BA47 (in green), a putative locus of the human mirror neuron system.



Response times (in ms) for each rating: Although there was no correlation between response times and ratings (c=0.0296±0.013), using response times as a covariate also resulted in significant ACC activation (pFWE_corrected<.05). Further investigation is therefore needed.

CONCLUSION

The study extends the recent observation (1) that face-sensitive regions contribute to the processing of expressiveness of postures even when no facial cues are available. Activation in the mirror neuron system suggests that affective appraisal of expressiveness of body postures may proceed from motor simulation based theory of mind modulated by the cognitive division of the anterior cingulate gyrus.

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