Neural circuits of empathy in the perception of someone else's congruent and incongruent emotional facial response and their relationship with emotional awareness

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Background

Humans are able to predict emotional responses of their conspecifics and to have empathic concern toward them. Providing information about the future actions of other people, and eliciting effective social communication may account for the two major roles for empathy[(1).] Both emotion sharing and executive control processes operate in concert in the decoding of cues such as emotional facial expressions which provide information on an individual's emotional state. In a social interaction, if the emotional cues provided by someone else are inappropriate in regard to oneself's expectations, prosocial behaviour may not occur. In the present experiment, we investigated the neural mechanisms of experiencing expected vs. unexpected emotional reaction of someone else using [^{15}O]H_2O positron emission tomography (PET).

Methods

We collected data from 19 healthy right-handed subjects (8 male, 11 female; mean age: 50.5 ± 6.4). Empathy level was evaluated using the French version of the Levels of Emotional Awareness Scale (LEAS)[(2)]. While undergoing PET scans, subjects were presented with a series of visual scenarios. Scenarios were composed of a short description of a social interaction concerning the subject and another person. The subjects had to choose between two possibilities concerning the situation. At the end of each scenario, a 3s video-clip of virtual characters (created with Poser® v6 software) showed the face emotional response of the other person. Emotional reactions were either congruent or incongruent in relation to the situation. The subjects were intentionally misleaded to believe that their response determined the other person's emotional response. Data were analyzed with SPM5.

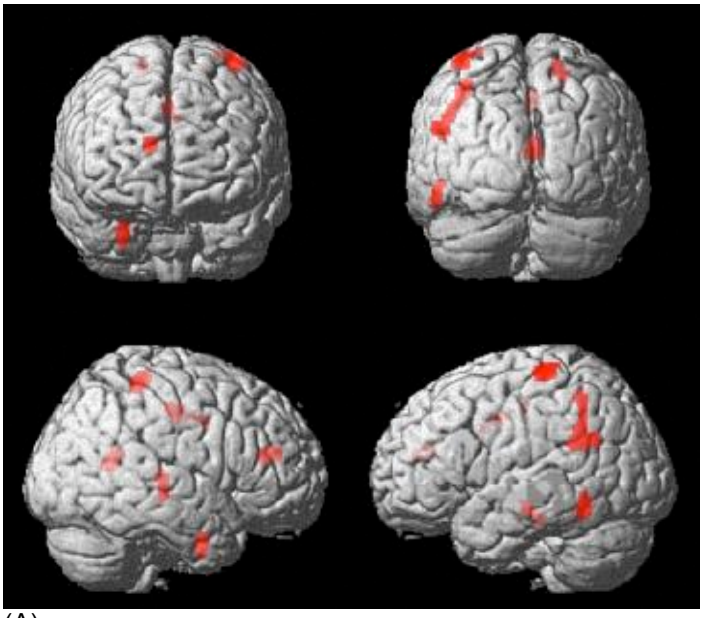
Results

The results revealed that congruent (relative to incongruent) emotional response increased activity in left inferior and middle temporal cortex, right insula, left temporo-parietal junction, fronto-parietal junction bilateraly, parahippocampal gyrus bilateraly, posterior (right) and anterior (right and left) cingulate cortex and right medial frontal cortex. Incongruent (relative to congruent) emotional response increased activity in left fusiform gyrus, left insula, middle (bilateraly) and superior (right) temporal cortex and right fronto-parietal junction. Regional cerebral blood flow was correlated significantly correlated with LEAS score ($p<0.001$) in precuneus ($r=0.70$) and associative cortex i.e. angular and supramarginal gyrus ($r=0.68$).

Conclusion

Situations of expected emotional reaction induced activity in empathy processing-related brain structures, whereas unexpected responses activated sense of fairness (left insula[3]) and face processing regions. These findings suggest that observing others' inappropriate socio-emotional behaviour do not imply the same neural pathways as empathic process and, as a consequence, the perception-action cycle, required in prosocial behaviour, is disrupted.

[1] de Vignemont, F. and Singer, T., 2006. The empathic brain: how, when and why ? TRENDS in Cognitive Sciences.10: 435-44.
[2] Lane, R.D. (1991). LEAS scoring manual & glossary. Tuscon, AZ: Author.
[3] Sanfey AG, Rilling JK, Aronson JA, Nystrom LE, Cohen JD, 2003. The neural basis of economic decision-making in the Ultimatum Game. Science. 300:1673-5.



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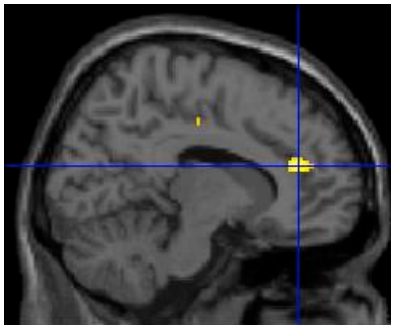
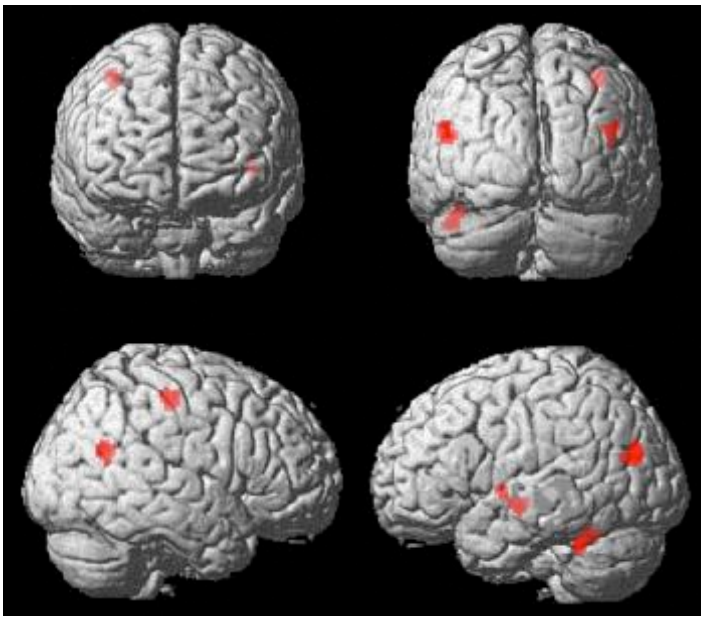


(B)

FIG. 1. (A) Global rCBF pattern of congruent emotional facial response vs. Incongruent.
(B) Differential activity located in right medial frontal cortex [12; 38; 18]. $p< 0.01$; $k>50$.



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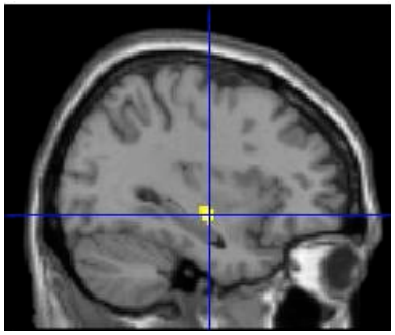

(B)

FIG. 2. (A) Global rCBF pattern of incongruent emotional facial response vs. congruent. (B) Differential activity located in left insula [-32 -12 -8]. $p < 0.01$; $k > 50$.