Neural correlates of altruistic and deontological guilt: An fMRI investigation in healthy individuals

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Introduction

The neuroanatomical correlates of basic emotions have been largely investigated using functional MRI (fMRI), while only a few studies have focussed on social emotions. Guilt is one of the most relevant social emotions, which is involved in many everyday life situations. Recently, deontological guilt, which derives from violating one's own interior moral values, has been identified as a more specific type of guilt. An abnormal processing of moral emotions may lead to amoral and inappropriate behaviours, which are frequently observed in psychiatric and neurological conditions. Altruistic guilt has also been characterized as involved in mentalizing, and playing a relevant role in the maintenance of depression.

Aim of this study is to investigate, using fMRI, the neural correlates of deontological and altruistic guilt.

Methods

Twenty-two right-handed healthy volunteers (F/M 13/9; mean [SD] age=26.8 [3.0]) were recruited for this fMRI experiment at 3.0 T. An event-related fMRI design was employed using an emotional paradigm based on the presentation of face expressions followed by contextual sentences. Different emotional states were evoked, using deontological and altruistic guilt as target, and anger and sadness as control conditions. Volunteers were requested to indicate their guilt feeling by button pressing. Data were processed using SPM5 and analyzed with the general linear model for event-related designs. A random-effects analysis was performed to investigate changes of brain activation as a function of task's conditions.
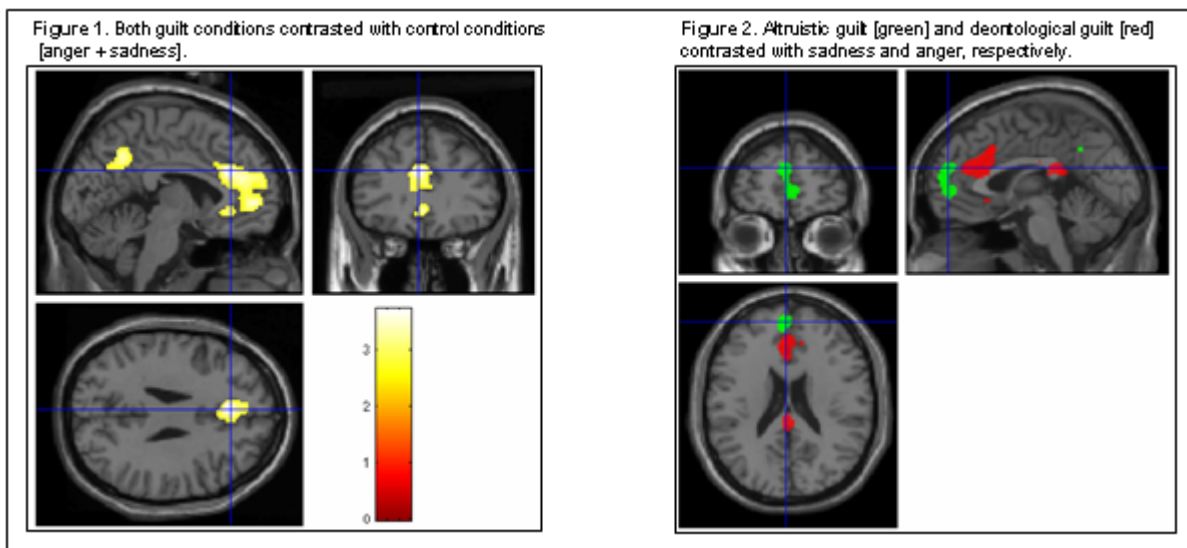
Results

A paired-t Student test on subjects' behavioural responses comparing both guilt conditions together against anger and sadness revealed significantly more guilt answers (mean [SD]=19.45 [14.9]) in the former, when compared to control emotions together [SD]=9.6[11.2]), $t(18) = 2.496$, $p = 0.017$.

A within subjects ANOVA was performed on the functional images. The event onset was defined by the disappearance of the text on the screen. Both guilt conditions showed a significantly higher cluster-level activation in the Anterior Cingulate Cortex (ACC; BA 32), medial Frontal Gyrus (medFG, BA 10) at p corrected , $p<.005$, and in the Posterior Cingulate Cortex (PCC), at p uncorrected, $p<.005$ (Figure 1). Specific patterns of brain activation were found for each type of guilt compared to its control. Deontological guilt compared to anger revealed significant cluster-level increased activity in the ACC (BA 32; Talairach coordinates: x, y, z = -4, 30, 24, Z=3.63), and the Cingulate Gyrus (CG; Talairach coordinates: x, y, z = 2, 22, 32, Z=3.37) at p corrected, $p<.005$. Altruistic guilt compared to sadness, activated with greater intensity the medial Frontal Gyrus (medFG, BA 10; Talairach coordinates: x, y, z = 4, 50, 20, Z=3.14), including the medial Prefontal Cortex (medPFC, BA 9, Talairach coordinates: x, y, z = -2, 60, 8, Z=3.03), at p uncorrected, $p<.005$ (Figure 2).

Discussion

The ACC, extending to the medFG (BA 10), and PCC are both activated when experiencing feelings of guilt. This result is in line with previous neuroimaging findings where ACC and PCC activity had been found through script-driven guilt inducing tasks (Shin et al., 2000; Takahashi et al., 2004). Deontological guilt compared to anger showed more intense activation in the ACC. This part of the brain seems to be activated in many different emotional processes, including guilt feelings, regret (Fitzgerald et al., 2005), and deception (Spence 2001; 2004). Finally, Altruistic guilt showed significantly higher activity in more prefrontal brain areas, that are involved in empathy and Theory of Mind (Blair et al., 1999; Fletcher, 1995). This might be related to the more interpersonal characteristics of this kind of guilt, where others mental state representation is required.

This study suggests the existence of specific neuronal networks underlying the processing of different kinds of guilt. Feelings of altruistic guilt might be exaggerated in depression, while patients with obsessive-compulsive disorder (Mancini 2004; 2008) might be more prone to feel deontologically guilty (as the opposite of psychopaths). fMRI might play a relevant role in clarifying the patho-physiological role of deontological and altruistic guilt in psychiatric and neurological disorders.

Figure 1. Both guilt conditions contrasted with control conditions [anger + sadness].

Figure 2. Altruistic guilt [green] and deontological guilt [red] contrasted with sadness and anger, respectively.

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