Moral cognition and serotonin:  
No association with the 5HT2A receptor; 
a possible association with the serotonin transporter

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BACKGROUND
Serotonin has been linked to emotional and social behavior, including social status and aggression, but only in very few studies specifically to moral behavior. Lesion and fMRI studies indicate that specific brain regions are important for judgments of what is morally acceptable: medial and orbital frontal cortex, anterior cingulate cortex, and amygdala.

In moral dilemmas, Crockett et al. (2010) found that normal subjects given citalopram became less willing to endorse utilitarian solutions, which was interpreted in terms of enhanced harm avoidance. Others have found that subchronic SSRI treatment rendered healthy subjects more cooperative in social interaction paradigms. These studies do not, however, suggest the mechanism by which changes in serotonin may affect behavior, i.e. through SERT or postsynaptic receptors.

OBJECTIVE
Here, in a group of healthy individuals, we evaluated the association between two measures of moral cognition and SERT and 5-HT2A receptor availability, as measured with PET.

METHODS
41 subjects (11 females; mean age 37.4 ± 21.4, range 20-82 years). Mean level of education was 15.2 ± 2.6 (range 8 - 17).

Moral Behavior Inventory
In the Moral Behavior Inventory (MBI), a 24 item questionnaire first described by Mendez et al. (2005), the subject is asked to rate each item on a Likert scale from 1-4 (1: not wrong; 4: very wrong): “How wrong is it if you: “Fail to keep minor promises”, “Always let others pay at a restaurant”, “Take credit for others work” etc. The total score (maximum 96) is the sum of scores on all items.

Moral dilemmas ... were translated from Greene et al.’s study (2004). “Personal” refers to dilemmas in which the person is more personally involved than in the “impersonal” ones. An example of an impersonal dilemma is the trolley dilemma in which the subject must decide whether it is appropriate to pull a switch that will result in the trolley changing track and running into one instead of five workmen. All subjects read four impersonal and five personal dilemmas. “Yes” responses to both types of dilemmas may be considered utilitarian answers, and we combined them in one score.

RESULTS
5-HT2A receptor binding and moral cognition
We performed four separate correlations between the scores of MBI and utilitarian answers in Moral Dilemmas on the one hand, and 5-HT2A receptor binding in the amygdala and frontal cortex on the other. None of the correlations were significant, not even at trend level.

SERT binding and moral cognition
MBI and utilitarian answers in moral dilemmas were each correlated with SERT binding in four regions: amygdala, inferior and middle frontal gyri, ACC and OFC. In three regions correlations were non-significant. In the anterior cingulate cortex, MBI and SERT binding correlated negatively (r = -.336; p = .035), and utilitarian answers correlated positively (r = .399; p = .021)(figure). These correlations decreased when gender was also included as a covariate, and became non-significant. Also Bonferroni correction rendered the correlations non-significant.

CONCLUSION
In partial correlations corrected for age, we found no associations between 5-HT2A receptor binding and the moral scores.

In one of four regions of interest, the anterior cingulate cortex, high SERT binding was associated with both utilitarian answers to moral dilemmas and low scores on the MBI, indicating a permissive attitude to moral behavior. These results did not survive correction for either gender or multiple tests, and thus should be considered preliminary.

REFERENCES

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