Right TPJ stimulation shifts the balance between individual cost and the other’s benefit

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Introduction: Humans often show altruistic behavior that appears consistent with moral values and preferences for equality and fairness. Yet the precise motives underlying altruistic behavior and their neural mechanisms remain unclear. For instance, economic theories propose that altruistic acts may emerge also from concerns for social image [1]. While recent neuroimaging studies have shown that the right temporoparietal junction (TPJ) is more engaged for altruistic donations [2] and for moral vs. amoral behavior [3], it has also been proposed that self-image concerns when being observed during prosocial behavior may equally engage the right TPJ [4]. To disentangle these three hypotheses, we used a single paradigm and transcranial magnetic stimulation (TMS) to test whether right TPJ stimulation affects one or a combination of the following three functions: (i) trade-off between individual cost and other benefit when helping others; (ii) concerns for self-image representation; (iii) social preference computation in moral versus amoral behavior.

Methods: We applied inhibitory theta burst stimulation (TBS) over the right TPJ (40 seconds, 600 pulses) in 15 subjects and over a control region (vertex) in 14 subjects. After TBS, subjects performed two decision tasks which measured willingness to give money to two types of organizations (good/bad). In the first condition, subjects chose to accept or to reject costly monetary transfers to a morally good organization. Each trial varied the size of the transfer (from 4 to 40 Swiss Francs) and the cost to the participant (from -1 to -10 Swiss Francs). In the second condition, subjects decided whether to accept or reject such monetary transfers to a morally bad organization, which were coupled with monetary gains for themselves (from +1 to +10 Swiss Francs). The two decision conditions were paired with an audience manipulation, as participants were observed by an external person in half of the trials.

Results: We used two logistic regression models (one for each task) that included the following regressors: monetary gain/loss for the subjects, gain for the organization, the audience effect and the effect of TBS. For both good and bad organizations, TPJ stimulation led to a shift in the trade-off between the participant’s self-interest and the organization’s outcome. For the good organization, the right TPJ TBS led to higher acceptance of monetary transfer despite higher losses (figure 1), whereas for the bad organization, the stimulation led to a lower acceptance of transfers at a given gain level (figure 2). The audience effect was present in both the TPJ and control groups for the good organization, and was not modulated by TBS.

Conclusions: Our results demonstrate a key role of the right TPJ in adjusting the balance between one’s monetary outcome and the moral value of an altruistic act. Thus, the TPJ adjusts the trade-off between subjects’ own morality and monetary interests. The results reveal that the key contribution of the right TPJ is neither to increase altruistic giving or moral versus amoral behaviour per se nor to modulate the influence of self-image concern. Instead, the TPJ appears to adjust a cost/benefit trade-off between moral value and self-interest. This neural mechanism is an important cornerstone in line with social and moral preferences and should be important for future research on how other-regarding behaviors and motives depend on the payoff allocation between the subject and subject’s partner.

Color coded map for times of acceptance to donate (warm color shows more acceptance; cold color shows less acceptance) for the good organization in the control group (vertex) and TPJ group. The black line represents the acceptance ratio between losing money to oneself and giving money to the good organization.

Color coded map for times of acceptance to donate (warm color shows more acceptance; cold color shows less acceptance) in the bad organization in the control group (vertex) and TPJ group. The black line represents the acceptance ratio between earning money to oneself and giving money to the bad organization.