Moral decision-making in Adolescents with Tourette Syndrome

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Altered social cognition may be a key feature of Tourette syndrome (TS) and there is speculation that TS is a disorder of a social decision-making network (1, 2). These concepts predict that moral reasoning (MR), the mental faculty for assessing right and wrong in social contexts, is affected in TS. MR may involve the affective cognitive functions of empathy and negative emotions and the non-affective cognitive function of self-control. These functions are positively associated with greater sensitivity to ethical violations (3, 4). Evidence exists for enhanced emotional empathy, but reduced cognitive empathy, and increased impulsivity in TS (5, 6). Whether MR is altered and how these altered cognitive functions are related to MR was not explored previously in TS subjects. Based on the prior findings of reduced cognitive empathy and heightened impulsivity, we hypothesized that TS adolescents would exhibit greater tolerance of ethical violations.

MR was assessed in 21 untreated TS adolescents without confounding co-morbidities and 21 age-matched healthy controls (for details see Supporting Information [SI]). To study moral decision-making, we used a small set of differing moral dilemmas: *incidental* (sacrifice of one person is an expected but unwanted consequence of actions saving a greater number); *instrumental* (sacrifice of one is essential to save a greater number) and *filler* (dishonest behaviors) dilemmas (7**,** see SI). Each dilemma scenario is accompanied by questions exploring moral acceptability, valence, and arousal ratings (see SI). Response to *filler* dilemmas were separately analyzed because they did not include a distinction between self and other involvement (for the full results see SI).

Instrumental-Incidental

Acceptability: The *Group* x *Type of dilemma* interaction term was significant [$F(1,40)=139.0$, $p<0.001$, $\eta_p^2=0.776$]. Post-hoc comparison reported higher score in TS compared to controls for both type of dilemmas (*Incidental:* $p=0.001$; *Instrumental*: $p<0.001$, Figure 1A). Significant difference between incidental and instrumental dilemmas is only reported for the control group ($p<0.001$).

Valence: The *Group* x *Type of dilemma* interaction term was significant [$F(1,40)=111.3$, $p<0.001$, $\eta_p^2=0.735$]. Post-hoc comparison reported higher score in TS compared to controls for all type of dilemmas ($p<0.001$, Figure 1A). A significant difference between incidental and instrumental dilemmas is only reported for the control group ($p<0.001$).

Arousal: The *Group* x *Type of dilemma* interaction term was significant [$F(1,40)=6.790$, $p=0.012$, $\eta_p^2=0.145$]. Post-hoc comparison reported higher score in TS compared to controls for incidental dilemmas ($p=0.003$), while no difference was reported for instrumental dilemmas ($p=0.756$, Figure 1).

Figure 1 over here

Filler

Acceptability: The ANOVA documented a main effect of the *Group* [$F(1,40)=36.26$, $p<0.001$, $\eta_p^2=0.473$], with higher score in TS compared with controls. Figure 1B.

Valence: The ANOVA documented a main effect of *Group* [$F(1,40)=12.35$, $p<0.001$, $\eta_p^2=0.235$], with higher score in TS compared with controls. Figure 1B.

Arousal: The ANOVA documented a main effect of *Group* [$F(1,40)= 42.65$, $p<0.001$, $\eta_p^2=0.516$], with higher score in TS compared with controls. Figure 1 B.

We documented a greater tolerance of unethical behaviours in TS adolescents compared to controls. This was present in most scenarios and derived measures. Reduced moral disapproval (MD) of ethical violations in TS is consistent with prior evidence of reduced cognitive empathy and increased impulsivity (5, 6), which is associated with reduced MD in healthy humans (3, 4). Reduced MD is surprising in view of enhanced emotional empathy in TS (5). This result suggests that affective processes play a marginal role in determining the MR abnormalities in TS. Our results are consistent with the suggestions that TS is characterized by deficits in social reasoning and abnormalities of the decision-making network (1, 2).

Authors' Roles

1. Research project: A. Conception, B. Organization, C. Execution.

2. Statistical Analysis: A. Design, B. Execution, C. Review and Critique.

3. Manuscript Preparation: A. Writing of the first draft, B. Review and Critique.

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Caption to figure

Figure 1. **A)** The figure shows acceptability, valence and arousal ratings for TS and controls participants dealing with *incidental and instrumental* moral dilemmas. **B)** The figure shows acceptability, valence and arousal ratings for TS and controls participants dealing with *filler* moral dilemmas. *Acceptability* rating was measured via 8-point scale (0=not at all, 7=completely); *Arousal* rating was measured (i.e., the degree of calm/ activation) via a 9-point scale (1=calm, 9=activation); *Valence* rating was measured (i.e., the degree of pleasantness/unpleasantness) via 9-point scale (1=dislike, 9=like) for the resolutions suggested in the dilemmas. *Indicates a significant difference in the post-hoc comparison.