**Distinctive neural response towards certain and conditional monetary loss in adolescents with attention-deficit/hyperactivity disorder**

J. Van Dessel, M. Moerkerke, E. Sonuga-Barke, S. Van der Oord, J. Lemiere, M. Danckaerts

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**Introduction**

The neural response towards cues signalling monetary gain and loss has been extensively studied through the Monetary Incentive Delay (MID) task [1]. Abnormalities in reward processing have been found in adolescents and adults with attention-deficit/hyperactivity disorder (ADHD). Anticipation of loss is often directly compared against anticipation of gain to represent the trade-off between positive and negative outcomes. In daily life situations, these events occur independently from each other and monetary loss can be escapable. We used an adaptation of the MID functional Magnetic Resonance Imaging (fMRI) task to assess the specific brain response pattern of typically developing adolescents and adolescents with ADHD towards monetary loss, representing a common social penalty.

**Methods**

Thirty-nine right-handed male adolescents with ADHD and 33 age-matched controls (9-18 years) performed a reaction time task under three conditions: (i) on Certain Loss trials, a monetary loss of €0.20, €1, or €5 occurred irrespective of response speed, (ii) on Conditional Loss trials, monetary loss could be avoided when responding in time, and (iii) on No Loss trials, no money could be lost. Participants started with €150 and were told that they could take home the remainder after 135 trials. The game was set that 4/5 of the start amount was lost. fMRI BOLD responses were acquired to compare anticipatory brain activation following the different cue types. Standard preprocessing and statistical analysis was performed in Statistical Parametric Mapping 12 (Wellcome department of Neuroimaging, London, UK). Repeated-measures ANOVA’s examined the effects of condition (certain loss, conditional loss, no loss) as a within subject factor and group (ADHD, controls) as a between subject factor on reaction time (RT). To examine the effects of monetary level on these variables further ANOVAs were conducted with monetary value (€0.20, €1, €5) and task condition (certain loss, conditional loss) as within-subject factors, and group as a between-subject factor. Post-hoc t-tests were used to explore significant interaction effects, when appropriate.

**Results**

RTs were significantly (p<0.05) shorter following conditional loss trials than certain loss and no loss trials. There was no interaction between cue type and group for RT. No main effect of the monetary amount was found. Prospect of certain monetary loss altered the neural response in emotion-related brain regions towards the end of the task, while conditional loss provoked an increased aversive state that remained constant throughout the task. A significant (p<0.05 FWE-corrected) dose-response relationship was found for the bilateral anterior insula, anterior cingulate cortex and parietal inferior gyrus for the Conditional Loss > No Loss contrast. In the ADHD group, conditional loss cues elicited an unusually strong pattern of activation within brain regions known, more generally, to be implicated in the processing of aversive events.

**Conclusions**

We provide some of the first evidence of a distinctive brain pattern between conditional and certain monetary loss in adolescents with ADHD compared to typically developing controls. The identification of such contingencies can provide more insight how adolescents respond to monetary loss in daily life.