



“Better the devil you know”: A preliminary study of the differential modulating effects of reputation on reward processing for boys with and without externalizing behavior problems

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BACKGROUND

Very little is known about the neurobiological correlates of reward processing during social decision-making in the developing brain and whether prior social and moral information (reputations) modulates reward responses in youth as has been demonstrated in adults. Moreover, although externalizing behavior problems in youth are associated with deficits in reward processing and social cognition, a real-life social interaction paradigm using functional neuroimaging (fMRI) has not yet been applied to probe reward processing in such youth.

Similar activation in adolescents in response to reward related stimuli as found in adults suggests some developmental continuity in corticostriatal circuits. Group differences are interpreted with caution given the small group sizes in the current study. Notwithstanding this limitation, the study provides preliminary evidence for anomalous reward responses in boys with externalizing behavior problems, thereby providing a possible biological correlate of well-established social-cognitive and reward-related theories of externalizing behavior disorders.

METHODS

Participants

Subjects ($n = 20$; ages 11-16) were selected from a larger study of social cognition and externalizing behavior problems (Sharp, et al., 2011). Subjects in the larger study ($n = 171$) of male youth were recruited from community youth groups (Boy Scouts). Groups met weekly for activities and boys had known each other for an average of 2.3 years ($SD = 1.4$ years). Boy Scouts were purposefully recruited in order to exploit the fact that these children have already established reputations (models) of each other. The final sample had an overall mean age of 12.70 ($SD = 1.71$): those with externalizing problems ($n = 10$) and without externalizing problems ($n = 10$).

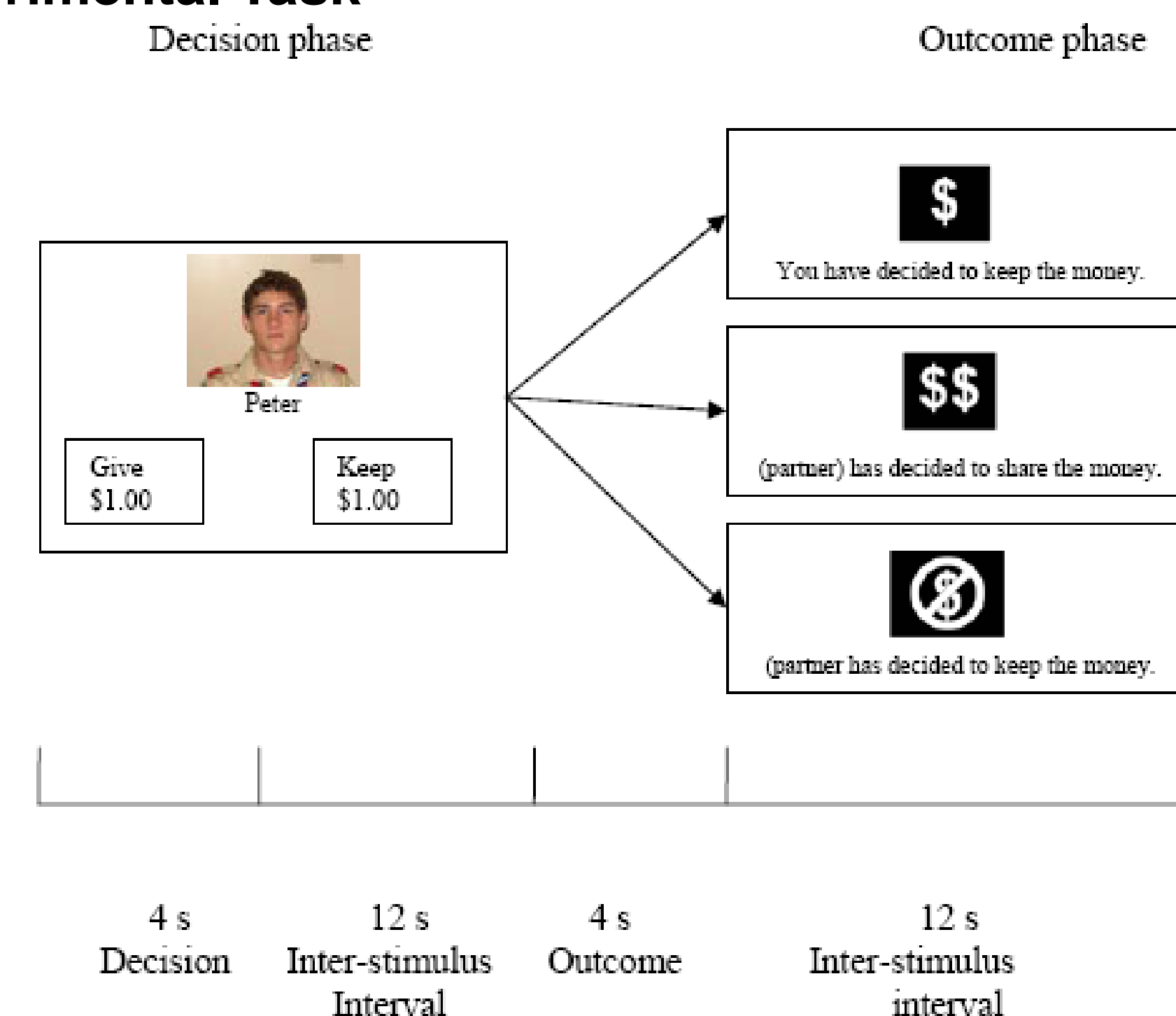
Measures

Youth self-report and parent-report. The Youth Self Report (YSR; Achenbach & Rescorla, 2001) and Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001) were used. For analyses, the recommended T -score of 65 on the Externalizing subscale was used to identify boys in the externalizing group.

Peer nomination as relationally aggressive or pro-social. A peer nomination instrument developed by Werner and Crick (1999) was used to assess relational aggression and pro-social behavior. This measure has been shown to be reliable (Werner & Crick, 1999).

Combined measure of externalizing behavior problems. A boy was considered to meet criteria for externalizing behavior problems if he was above cut-off for parent- and self-report externalizing problems, and described as “only relationally aggressive.” This variable in combination with fMRI exclusion criteria was used to identify boys in the externalizing group. On the day of scanning, the CBCL was administered again in order to confirm stability of group status. Differences between means were even more significant on the day of scanning ($t = -4.224$; $df = 18$; $p = .001$).

Figure 1. Experimental Task



Data Analyses

Data from each participant were analyzed within the framework of a general linear model using AFNI (Cox, 1996). In addition to the twelve experimental conditions, the six translation and six rotation parameters from the motion correction procedure were included in the model as regressors of no interest to reduce further the impact of participant head movement on the analyzed data. Deconvolution (Glover, 1997) was used to estimate the impulse response function (IRF) over a seven-TR (12 s) window following stimulus onset for each condition at each voxel for each participant, with no assumptions about the shape of the response function. Thus, a beta weight was estimated at two-second intervals for each of seven time points beginning at the onset of the each phase of the trial (Decision/Outcome) for each decision-partner combination (i.e., Keep/Share, Kind/Mean/Neutral) for the decision phase and for each outcome-partner combination (i.e., Positive/Negative, Kind/Mean/Neutral) for the outcome phase. The mean of the third time point (i.e., six seconds following decision or outcome onset, roughly the point at which the typical hemodynamic response function peaks) and the two flanking time points were averaged for each of the time courses associated with both the Decision and Outcome phases. These means and the time courses from which they were derived were then transformed to Talairach space (Talairach & Tournoux, 1988) using a twelve-point affine transformation and used as the dependent variable in group analyses.

Behavioral Results

Figure 2. The effect of reputation on pre-and post scan trust ratings. Main effects for Reputation ($F = 8.17$, $df = 2,18$, $p = .001$) and Time ($F = 33.90$, $df = 2,18$, $p < .001$) as well as an interaction effect between Reputation and Time ($F = 10.13$, $df = 2,18$, $p < .001$). Pre-scan question: “How much do you trust X to give you back \$2 when you give him \$1?”. Post-scan question: “On the basis of what happened in the game today, how much do you trust X now?”

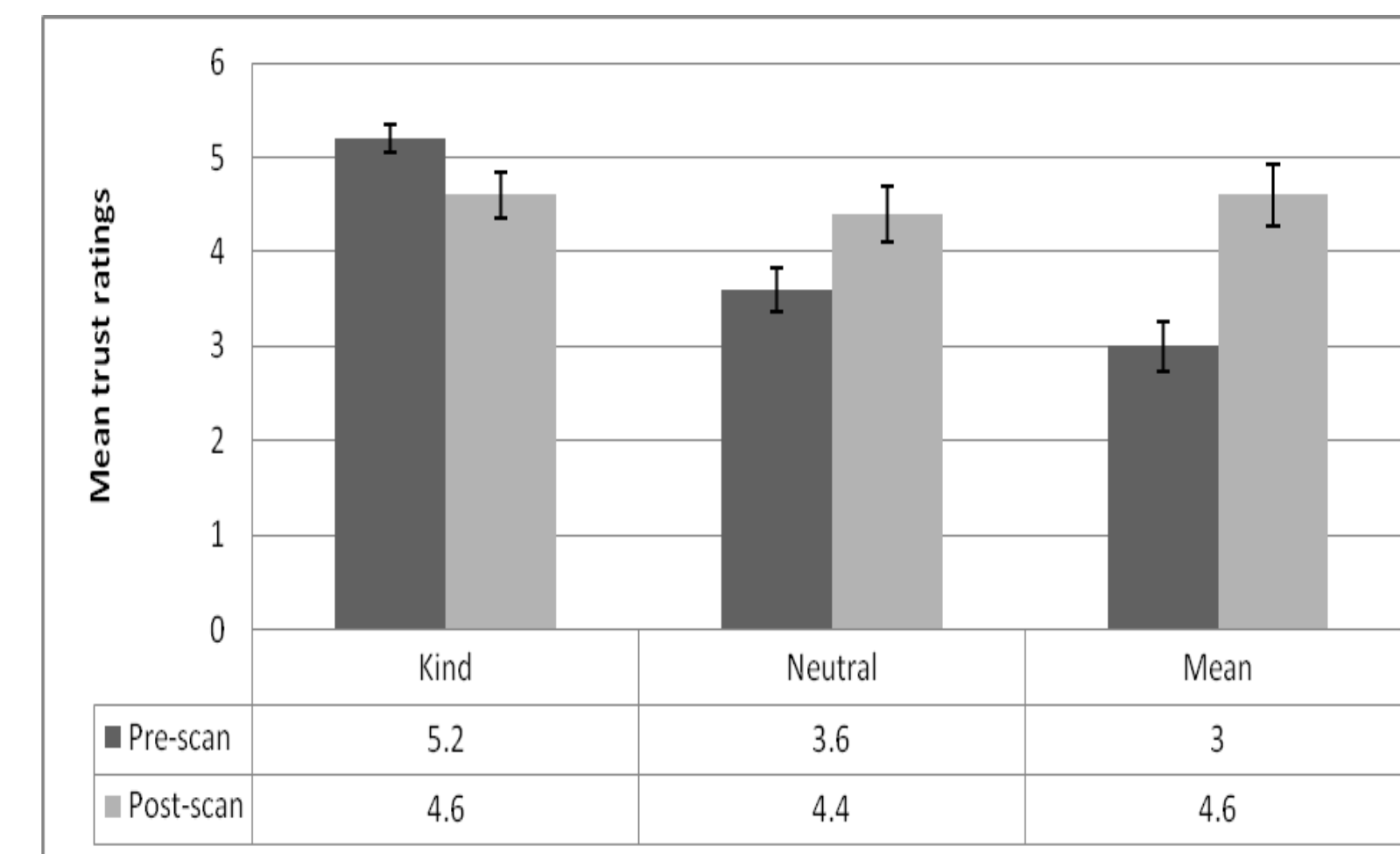
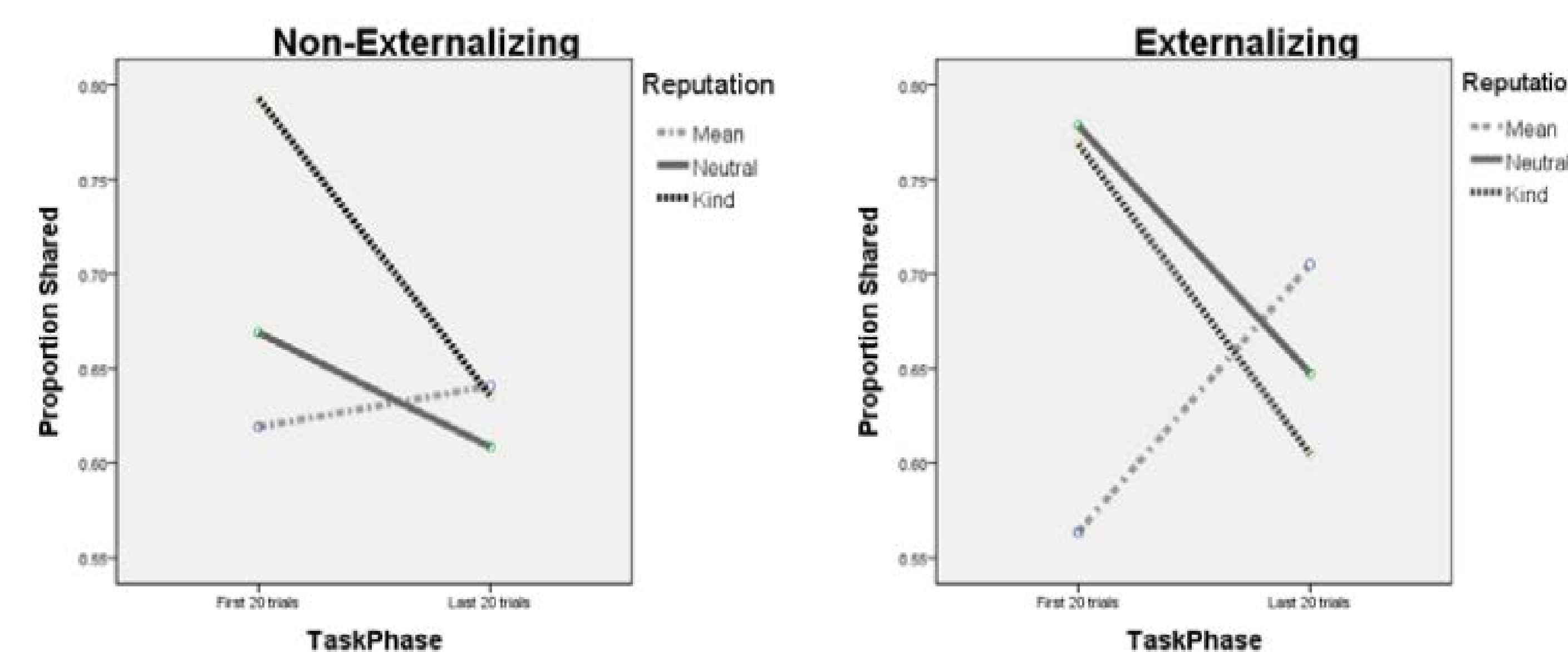


Figure 3. The effect of reputation on share decisions. The proportion of share decisions for each partner type, broken down by high and low externalizing and early (first 20) or late (last 20) trials (Task Phase). No main effect was found for Reputation type on the decision to share ($F(2,72) = 1.97$, $p = .15$) and no interaction with Externalizing behavior ($F(2,72) = 0.23$, $p = 0.64$). The interaction between Reputation and Task Phase however, was significant, ($F(2,72)=6.48$, $p=.003$).



Brain Results

Figure 4. Decision phase. Brain results for the decision phase of the game. Increased activity in the ACC was associated with decisions about neutral partners vs. kind/mean partners $F(1,18) = 10.324$, $p = 0.005$ for the full sample, with no interaction effects for Group*Reputation, $F(1,18) = 0.092$, $p = 0.766$ or Group*Decision, $F(1,18) = 0.004$, $p = 0.95$. In the bilateral insula regions there was no main effect for Reputation, $F(1,18) = 0.009$, $p = 0.925$, but a marginally significant interaction effect for Group*Decision, such that increased insula activity was associated with share decisions for the externalizing group, $F(1,18) = 4.045$, $p = 0.06$

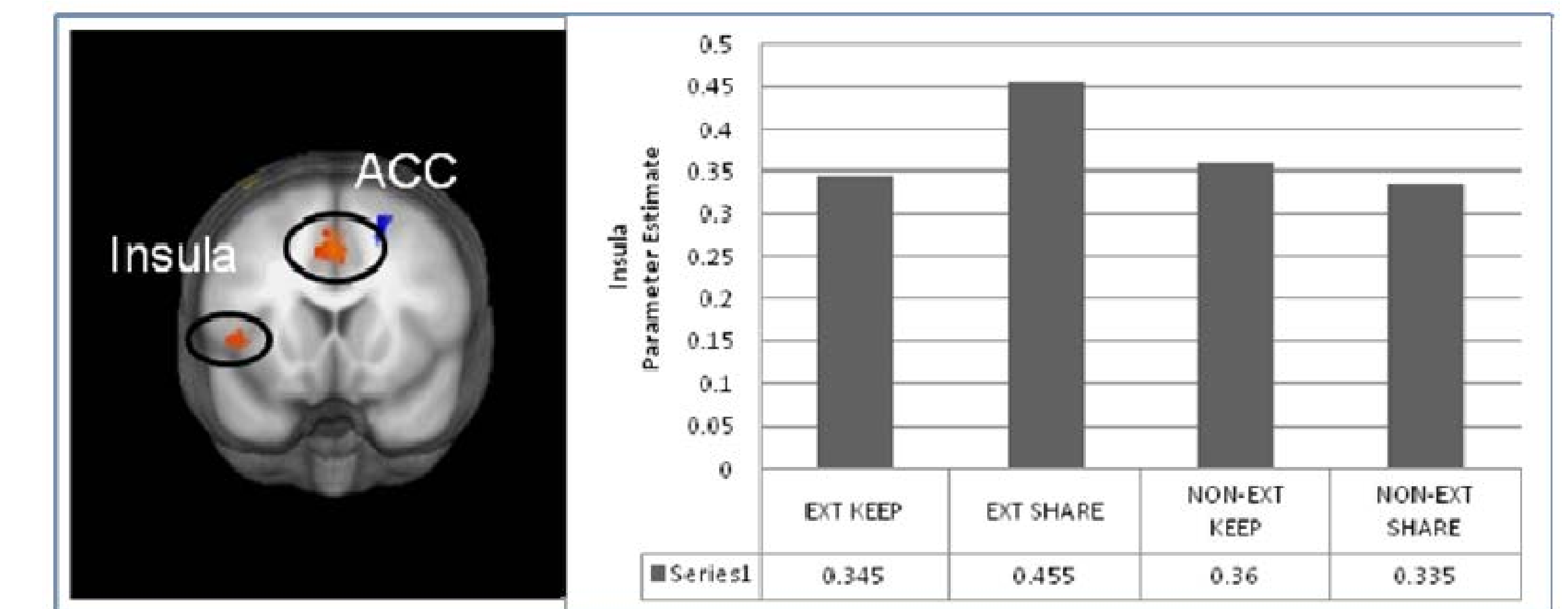


Figure 5. Outcome phase. A significant Reputation*Group interaction in the caudate $F(1,18) = 14.442$, $p = 0.002$ was found. There was also a significant interaction effect for Reputation*Outcome $F(1,18) = 4.606$, $p = 0.048$. Thus, increased BOLD responses in the caudate were associated with outcomes from Neutral partner for Non-externalizing boys, while the caudate responded more strongly to outcomes from Kind/Mean partners for Externalizing boys. No main effect was found for Reputation in caudate $F(1,18) = 0.244$, $p = 0.628$. In the bilateral insula (Figure 5), a marginal main effect for Reputation $F(1,18) = 3.182$, $p = 0.09$ was found with greater responses associated with Neutral reputations vs. Kind/Mean reputations, except for boys with externalizing problems, as evidenced by an interaction effect for Reputation*Group $F(1,18) = 2.863$, $p = 0.108$ whose bilateral insula responses did not differ by reputation type. There was no Outcome*Group interaction effect in the bilateral insula $F(1,18) = 0.662$, $p = 0.426$.

