Supplementary Methods

Given the similarity between our two experiments, we describe their methods in parallel throughout these supplementary methods.

Subjects. In Experiment 1 (E1), twenty-seven healthy, neurologically normal young-adult volunteers (13 female; age range: 18-35y; mean age: 24y) participated in one fMRI session. In Experiment 2 (E2), a separate set of eighteen healthy, neurologically normal young-adult volunteers (7 female; age range: 19-34y; mean age: 24y) participated in one fMRI session. We used these relatively large samples in order to have sufficient power to assess effects of individual differences in altruism. All subjects acclimated to the fMRI environment using a mock MRI scanner and participated in two practice runs, one inside and one outside of the fMRI scanner. An additional 6 subjects (E1 = 3, E2 = 3) were excluded because of head motion of greater than one voxel or because of experimental non-compliance. Psychometric data from an additional subject in E2 was lost due to a computer error; this subject’s fMRI data was included in the determination of the fMRI activation maps (n = 19) but not in the correlation analyses (n = 18). All subjects gave written informed consent as part of a protocol approved by the Institutional Review Board of Duke University Medical Center.

Charity Selection. Upon arriving in the lab, subjects were told they would play a game in which they could win money for themselves and for a charity. Each subject was given a sheet with names and brief descriptions of selected local charities (Central North Carolina Chapter of the American Red Cross; Animal Protection Society of Durham, North Carolina; Joy Charter School of Durham, North Carolina; Easter Seals – United Cerebral Palsy of North Carolina; Durham Literacy Center). After choosing one of the charities, the subject read an extended statement of that charity’s goals and community impact, viewed photographs of the outreach programs of that charity, and read a letter from a local representative of that charity confirming its participation in our study. Throughout the experiment, subjects were given full information and there was no deception used. After the completion of data collection from all subjects in each experiment, cumulative earnings were mailed to the selected charities.

Experimental Task. Both experiments used modified version of the monetary incentive delay response time task developed by Knutson and colleagues. The primary difference between our two experiments was the use of an event-related design in E1 and a blocked design in E2.
In E1, each trial began with a textual instruction screen stating whether the subject or computer would be acting on that trial (we refer to these as “Playing” or “Watching” trials, respectively), and whether the subject or charity could receive money for the trial (“subject-receiving” or “charity-receiving”, respectively). If the instruction screen indicated a Playing trial, subjects pressed one of two buttons with their right hand to initiate the trial: index finger for subject-receiving or middle finger for charity-receiving. The mean response time to initiate the trials across subjects was 1600 milliseconds (s.d. = 156ms). If the instruction indicated a watching trial, then no action was needed by the subject; the trial began automatically after a delay interval drawn from a distribution yoked to that of the subject’s own response times. Next, a fixation screen appeared for a variable delay (1-7s), followed by the appearance of a target (i.e., red concentric circles). The four trial types composed from the factorial combination of actor and recipient were presented in a random order. We adopted a design in which a computer played, as opposed to another subject, in order to control for variability associated with subjects’ attitudes towards particular human subjects.

The design in E2 was similar, save that the textual information screen appeared once at the beginning of each block and that subjects did not have to press a button to initiate each trial. The trials were grouped into 40s blocks, which were presented in a fixed order in each run and were separated by 20s periods of visual fixation. We also added a 40-second control block in which visual stimuli were presented in a random sequence whose interstimulus timing was drawn from the same timing distribution as in experimental blocks; no rewards were provided in the control block. Otherwise, trial parameters were similar to E1.

On Playing trials, the subjects pressed a button (same finger as for instruction screen) as soon as the target appeared. For each trial, a reaction time threshold was calculated based on the previous 10 trials to equate success rates for every subject (~60-65%); if the response was faster than this threshold, money was earned. Separate thresholds were used for subject-receiving and charity-receiving trials, so that subjects could not choose to respond slowly on some trials (e.g., for charities) to improve their chances of winning on others (e.g., for themselves). The success or failure of each trial was indicated via a feedback screen that appeared immediately after the response to the target (2s duration). On Watching trials, the same sequence of screens was displayed but subjects were not required to make any button presses. Computer response times were drawn from a distribution yoked to each subjects’ mean response time ±5ms (uniform). At the end of each trial there was an interstimulus interval of 1-7 seconds during which time a fixation cross was displayed.
In E1, there was an error in the stimulus display program that increased the computer response time by 2ms (from right below threshold to right above threshold, on some trials). This error caused the success rate of Watching trials to be only 37%. We conducted a series of additional analyses to verify that this display error did not influence our conclusions. First, we evaluated whether there was any relation between proportion correct and altruism. There was no significant correlation across subjects (nor any trend toward significance) between altruism scores and proportion of correct responses in any of our four conditions, nor between altruism and the difference in proportion correct between Watching and Playing trials (all \( p > 0.15 \)). Nor was there any significant correlation (or trend) between proportion correct and pSTC activation in either subject-receiving or charity-receiving trials (both \( p > 0.15 \)). Thus, while it is possible that the differences in success rates between Watching and Playing trials could have contributed to some of the activation described in Supplementary Table 1, there was no evidence that relative success rate influenced the observed correlations between altruism scores and right pSTC activity.

This error was corrected in E2, and the obtained success rate across trial types was more closely matched: 59% for watching trials and 65% on playing trials. We note that in E2 there were unexpected negative correlations between altruism (PAL) scores and percentage of Playing trials won for both subject-receiving (\( r = -0.64, p = 0.004 \)) and charity-receiving (\( r = -0.46, p = 0.06 \)) trials. However, there was no correlation (or trend) between proportion correct and pSTC activation in either any condition (all \( r < 0.2 \)), nor was there a main effect upon the Watching – Playing difference. These results suggest that the behavioral differences had no effect upon the observed brain-behavior correlations.

In E1, subjects participated in a mean of 5 runs (range 3-7), each lasting 6 minutes and including approximately 30 trials (i.e., totaling about 35 trials/condition for each subject). Each trial was worth $0.36. For their performance on the task, subjects earned $12-$20 (mean = $15; s.d. = $3) for their selected charity and $11-$21 (mean = $15; s.d. = $2) for themselves. Subjects received an additional $15 for completion of the study. In E2, subjects participated in a mean of 4 runs (range 3-4), each lasting 8 minutes and 40 seconds and including approximately 62 trials (i.e., totaling about 62 trials/condition for each subject). Each trial was worth $0.26. For their performance on the task, subjects earned $17-$28 (mean = $21; s.d. = $2.40) for their selected charity and $17-$26 (mean = $21; s.d. = $2) for themselves. Subjects received an additional $20 for completion of the study.

**Imaging Methods.** In E1, fMRI data were acquired on a 3T GE scanner with a multi-channel (8 coil) parallel imaging system, using a gradient echo spiral-in pulse sequence with parameters (TR
High resolution 3D full-brain SPGR anatomical images were acquired and used for normalizing and coregistering individual subjects’ data. In E2, FMRI data were acquired on a 4T GE scanner using a gradient echo echoplanar pulse sequence with parameters (TR = 2000ms; TE = 30ms; 34 axial slices parallel to the AC-PC plane, with voxel size of 3.75*3.75*3.8mm). High resolution 3D full-brain SPGR anatomical images were used for normalizing and coregistering individual subjects’ data.

E1 used an event-related design and analyses. Functional images were corrected for head motion and time of acquisition within a TR and were normalized into a standard stereotaxic space (Montreal Neurological Institute) for intersubject comparison using SPM (Wellcome Department of Cognitive Neurology, University College London). A smoothing filter of width 8mm was applied following normalization. We excised epochs of activation, for all trials, that were time-locked to the occurrence of the target stimulus, separating our trials into four conditions determined by the factorial combination of who was acting (i.e., subject Watching or subject Playing) and who was the potential recipient (i.e., subject-receiving or charity-receiving). To obtain a measure of activation for each subject and trial type that was independent of the shape of the fMRI hemodynamic response, we calculated the total area under the curve over the six time points from +1.5s through +9.0s. We then subjected the area under the curve measurements to across-subjects analyses to determine areas with greater activation to Watching than to Playing, for subject-receiving and charity-receiving conditions independently. Clusters were labeled as significant if there were 6 or more contiguous voxels at a threshold of \( p < 0.001 \).

E2 used a blocked design and analyses. Functional images were corrected for head motion and time of acquisition within a TR and were normalized into a standard stereotaxic space (Montreal Neurological Institute) for intersubject comparison using the FLIRT component of the analysis package FSL. Imaging data was processed with the FEAT (FMRI Expert Analysis Tool) Version 5.63 component of FSL using a mixed-effects model. A smoothing filter of 5mm was applied. The threshold significance value for clusters of activation was determined using false discovery rate thresholding \( (z > 2.3; \text{corrected threshold of } p < 0.05) \).

References