NHH

INSTITUTT FOR SAMFUNNSØKONOMI

DEPARTMENT OF ECONOMICS

SAM 19 2015

ISSN: 0804-6824

August 2015

Discussion paper

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Norges Handelshøyskole

NORWEGIAN SCHOOL OF ECONOMICS

Equity theory and fair inequality: a neuroeconomic study

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Abstract

The present paper reports results from the first study designed to examine the neuronal responses to income inequality in situations in which individuals have made different contributions in terms of work effort. We conducted an experiment that included a prescanning phase in which the participants earned money by working, and a neuronal scanning phase in which we examined how the brain responded when the participants evaluated different distributions of their earnings. We provide causal evidence of the relative contribution of work effort being crucial for understanding the hemodynamic response in the brain. We found a significant hemodynamic response in the striatum to deviations from the distribution of income that was proportional to work effort, but found no effect of deviations from the equal distribution of income. We also observed a striking correlation between the hemodynamic response in the striatum and the self-reported evaluation of the income distributions. Our results provide the first set of neuronal evidence for equity theory and suggest that people distinguish between fair and unfair inequalities.

Keywords: fairness; inequality; striatum; equity theory

JEL Code: D63

The study of inequality, its sources and consequences, has been a core issue in all of the social sciences and in the philosophical literature on distributive justice. Important normative theories have argued that income inequalities are inherently unfair (Rawls, 1971), whereas other theories, in particular libertarianism and liberal egalitarian theories of justice (Nozick, 1974; Dworkin, 1981; Arneson, 1989; Roemer, 1998), argue that income inequalities can be fair if they reflect morally relevant differences. This theoretical debate is mirrored in the political debate on tax, welfare, and health policies, where a key question is whether some inequalities should be accepted as fair. In particular, a core issue in the design of tax and welfare policies is how to handle income inequalities caused by differences in work effort, productivity or risk-taking. Similar issues arise in the discussion of how to handle inequalities in health due to life style choices. Moreover, in the private sector, heated debates about the fairness of workplace inequalities in earnings are common (Card et al., 2012).

Preferences for income distribution have been extensively studied in both controlled economic experiments and surveys, and the nature of such preferences has become one of the major questions in behavioral research in social psychology and economics. Important papers in behavioral economics have studied how people respond to different income distributions and have documented, using economic experiments, that people dislike unequal outcomes and are willing to make a trade-off between their own income and equality Fehr and Schmidt (1999); Bolton and Ockenfels (2000); Engelmann and Strobel (2004). An extensive and influential literature on equity theory in social psychology has studied how perceptions of fairness in social situations depend on the relationship between input and output. The main result reported in this literature is that people find it fair that the income (output) of a person is in proportion to the work effort (input), and that they dislike deviations from a proportional distribution (Adams, 1965; Walster et al., 1973; Leventhal, 1980). In line with equity theory, more recent papers in behavioral economics, studying distributive behavior in situations in which people have earned the money being distributed, have found that the majority of people accept income inequalities as fair if the inequalities correspond to differences in contributions (Cappelen et al., 2007, 2010, 2013; Frohlich et al., 2004; Konow, 2000). Thus, there is evidence suggesting that people are averse both to deviations from an equal income distribution and to deviations from an income distribution in proportion to work effort.

An important neuroeconomic study by Tricomi et al. (Tricomi et al., 2010) provided suggestive neuronal evidence of inequality aversion. There is, however, no direct neural evidence of how the brain evaluates an income distribution in situations in which people have made different contributions in terms of work effort. The present paper reports from the first neuroimaging study designed to examine how the brain responds to the distribution of income in such situations. As such, it is also the first study to examine the neuronal basis for equity theory. We focus on two main questions. First, we examine whether a person's contribution in terms of work effort affects the way in which the brain's reward system responds to different income distributions. Addressing this question also allows us to examine how the brain's reward system responds to deviations from a proportional income distribution, and to compare this response with the response to deviations from an equal income distribution and to an increase in own income. Second, we study how the hemodynamic response in the brain to distributions of earned income correlates with the self-reported evaluations of the same income distributions.

To address these questions, we designed an experiment with two phases: a prescanning phase, in which the participants earned money by working on a real-effort task, and a scanning phase, in which we used functional magnetic resonance imaging (fMRI) to examine how different regions of the brain responded when the participants evaluated different distributions of their earnings. The participants were 47 male students from the Norwegian School of Economics.

In the prescanning phase of the experiment, each participant was randomly assigned to work on repetitive office work, stuffing envelopes, and entering records into a database, for a specific length of time. Roughly half of the participants (23 subjects) were randomly assigned to work for 60 min, whereas the remaining participants were randomly assigned to work for either 30 or 90 min (12 subjects in each group). All participants were told that their earnings would be based on an hourly wage of 500 NOK (approximately 85 USD), but that a random process could interfere so that their final payment would not necessarily be the same as their earnings.

In the scanning phase, the participants where matched with another participant and each pair worked for 120 min in total and the sum of their earnings was 1000 NOK. We had three conditions that differed only with respect to how much the participant in the scanner had contributed in terms of work effort. In the 30:90 condition, the participant in the scanner had worked for 30 min and was matched with someone who had worked 90 min. Participants in the 60:60 condition had worked for 60 min and was matched with someone who had also worked for 60 min, and the participant in 90:30 condition had worked 90 min and was matched with someone who had worked 30 min. For the participant in the scanner, the share of total work effort in the three conditions was thus either 25%, 50% or 75% depending on the condition.

While inside the MR-scanner, the participants rated a sequence of 51 possible distributions of the total earnings on a scale that ranged from very bad (-5) to very good (+5). How much each participant in the pair had contributed in terms of work effort and earnings was common knowledge. Interspersed with the rating trials were 30 control trials. In the control trials, no income distribution was shown and the task of the participants was only to tick off a specific number on the rating scale. The control trials allowed us to distinguish between the neural response that resulted from motor and visual stimulation when ticking off a number on the rating scale and the neural response that resulted from the subjective evaluation of an income distribution.

A key feature of the design was that participants who disliked deviations from a proportional income distribution would respond differently to an increase in own income depending on which condition they were in. For such participants, an increase in own income beyond 250 NOK would have two counteracting effects in the 30:90 condition: they would like getting more money for themselves, but they would dislike the increase in the deviation from a proportional income distribution. For a participant in the 90:30 condition, however, an increase in their own income would result in both more money for themselves and a reduction in the deviation from a proportional income distribution, as long as their own income was below 750 NOK. We would therefore predict that participants in the 90:30 condition valued an increase in own income more than did participants in the 30:90 condition for own income ranging between 250 and 750 NOK (Prediction 1). Similarly, we would predict that participants in the 60:60 condition valued an increase in own income more than did those in the 30:90 condition in the interval between 250 and 500 NOK (Prediction 2), and that they valued an increase in own income less than did those in the 90:30 condition in the interval between 500 and 750 NOK (Prediction 3).

1 Results

Figure 1 shows the average subjective rating of the income distributions as a function of own income for the participants in the three conditions. The participants in the three conditions had earnings of 250, 500 and 750 NOK respectively, as indicated in the figure. We observe that the way in which participants evaluate a given income distribution differ between the conditions. We also note that the subjective ratings flatten out and, strikingly, even tend to drop, when the participant received a share of total income that was much larger than their earnings. The subjective ratings also show that the participants evaluated income inequalities very differently in the three conditions. For example, the income inequality (250 NOK, 750 NOK) was given a neutral rating by the participants who had worked for 30 min (where the inequality corresponded to differences in earnings); in contrast, it was given a highly negative rating by the participants who had worked for 60 or 90 min (where the inequality did not correspond to differences in earnings).

In the study of the neuronal underpinnings of the behavioral results, we focus on the response in the striatum. The striatum is a key part of the emotional circuitry of the brain and plays an important role in motivating and regulating behavior (Kompus et al., 2012). Furthermore, the striatum has been associated with social preferences and moral choices in many earlier studies (Bartels and Zeki, 2000; Bault et al., 2011; Harbaugh et al., 2007; Hsu et al., 2008; Fliessbach et al., 2007; Lane et al., 1997; Moll et al., 2006; Sanfey, 2007; Tabibnia et al., 2008; Tricomi et al., 2010). In the striatum we identify the left and the right caudate nucleus as regions of interest because experimental trials produced significantly different blood- oxygen-level-dependent (BOLD) response compared with control trials in these two regions. Both regions are indicated in Figure 2A. For the two striatal regions we find a significant negative correlation between the subjective ratings and the BOLD response ($p < 0.01$ for both regions), which means that decreased blood activation in these regions is associated with increased subjective valuation.

In Table 1, we test whether the BOLD response in the two striatal regions and the subjective rating are in line with our three predictions. Columns 1-3 report the results from regressions testing the prediction that participants who worked for 90 min have a stronger response to an increase in own income than do participants who worked 30 min (Prediction 1). We find that this indeed was the case: the marginal effect of own income on both the BOLD response and the subjective rating was smaller for those participants who worked for 30 min than it was for those who worked for 90 min in the relevant interval of own income. The difference between the two conditions is statistically significant for the subjective rating ($p = 0.016$) and for the left caudate nucleus ($p = 0.043$), but not for the right caudate nucleus ($p = 0.141$). The difference in the marginal effects of own income is illustrated in Figure 2B. The results reported in columns 4-6 and columns 7-9 also provide support for our two additional predictions. In the relevant intervals of own income, we find that the response to an increase in own income for participants who worked for 60 min is stronger than for those who worked for 30 min, which is in line with Prediction 2 (subjective rating, $p = 0.017$; left caudate nucleus, $p = 0.075$; and right caudate nucleus, $p = 0.150$), and weaker than for those who had worked 90 min, which is in line with Prediction 3 (subjective rating, $p < 0.01$; left caudate nucleus, $p = 0.049$; and right caudate nucleus, $p = 0.251$). Our results thus provide strong causal evidence of the effect of relative work effort on both the BOLD response in the striatum and the subjective evaluations. The differences between the three conditions furthermore provide suggestive evidence of the participants being concerned with deviations from a proportional income distribution.

In Table 2 we report the results from regressions in which we directly examine how the participants respond to deviations from a proportional income distribution. We find that deviation from proportionality is significantly correlated with both the subjective rating ($p < 0.01$) and the BOLD response in the two striatal regions ($p < 0.01$ for the left caudate nucleus, and $p = 0.045$ for the right caudate nucleus). We interpret this result as providing the first set of evidence of a neuronal basis for the acceptance of income inequalities that correspond to differences in work effort. The regressions reported in Table 2 also estimate the effect of deviations from equality. We observe that deviations from equality, in contrast with deviations from proportionality, has no significant effect on the subjective rating or the BOLD response in the two striatal regions.

Using the estimates in Table 2, we compare the effect of a reduction in the deviation from proportionality with the effect of an increase in own income. Our estimates imply that a reduction in the deviation from proportionality of 10 percentage points results in the same BOLD response as an increase in own income of 73 NOK in the left caudate nucleus and the same BOLD response as an increase in own income of 45 NOK in the right caudate nucleus. For the subjective rating, we find that a reduction in the deviation from proportionality by 10 percentage points has the same effect as an increase in own income of 34 NOK.

In addition to the two regions in the striatum, we also identified several regions in the prefrontal cortex where experimental trials produced significantly different BOLD response from control trials. The analysis of the BOLD responses in these regions, which is reported in the supplementary material, did not show a clear pattern for how these regions respond to own income or to deviations from proportionality. However, it is interesting to observe that deviations from proportionality had a significant effect on the BOLD response in the left inferior frontal gyrus. This result suggests that cognitive processes in the prefrontal cortex are involved in the evaluation of fair and unfair inequalities Almås et al. (2010).

2 Discussion

The present study has examined how participants respond to different distributions of a fixed sum of earned income between themselves and another participants. We had three experimental conditions that differed only with respect to the work effort of the participants. We found a strong effect of the conditions on the participants BOLD response in the striatum to an increase in own income (and a corresponding decrease in the income to the other participant). We also found strong evidence of the participants being concerned with deviations from a proportional income distribution. In contrast, we did not find evidence of participants disliking deviations from an equal income distribution. We interpret this as showing that concerns for outcome equality is of relatively little importance in situations in which income has been earned through work effort. This results is particularly striking since our sample is from a Scandinavian country that is among the most egalitarian countries in the world.

The fact that we did not find any significant BOLD activation in the striatum in response to deviations from equality also sheds light on the neuronal evidence of inequality aversion that was reported in the paper by Tricomi et al. (2010). In their experiment, there was no difference in the participants' contributions and, as a result, any deviation from an equal distribution would also be a deviation from a distribution in proportion to contributions. Thus, their finding is consistent with our results, because the neuronal response obtained using their design may well reflect a concern for a proportional distribution of income.

These results can be seen as adding to the literature on the role of social comparisons in the evaluation of income to self. Bault et al. (2011) showed that the striatal response to an economic gain depends on whether the gain was smaller or larger than the gain of a counterpart. Our results can be interpreted as showing that such social comparisons also take into account the relative contribution of the counterpart. Our results are also complementary to the results reported by Vostroknutov et al. (2012), who find that the response in the prefrontal cortex to an income inequality is sensitive to whether the inequality was a result of luck or skill.

Our paper has documented a striking similarity between the effect of our conditions on the subjective ratings and on the BOLD response in the striatum. The subjective ratings and the BOLD response also provided similar pictures of the trade-off between own income and deviations from proportionality. We interpret this as showing that attitudes to income distribution have a neuronal basis in the brain's reward system.

A materials

A.1 Participants

Forty-seven neurologically and psychiatrically healthy male individuals took part in this study.[1] The mean age was 24.8 years (range, 20–33 years) and six participants were left-handed. Prior to fMRI measurement, participants gave written informed consent. The study was performed according to the Declaration of Helsinki.

When participants arrived for the experiment, they were given a detailed general information sheet regarding the manner in which the experiment would proceed. The sessions were held over three weekends in the spring of 2011 at Haukeland University Hospital, and participants were given a participation and transportation allowance (450 NOK in total), in addition to the payment from the experiment.

Apart from an initial check of signed consent forms, all identification of behavior and payment in the experiment was based on a random number that each participant drew from a bowl when they arrived for the experiment.

A.2 Behavioral tasks

The experiment consisted of two phases: a prescanning phase, in which the participants earned income by working on a real-effort task, and a scanning phase, in which we used functional magnetic resonance imaging (fMRI) to examine how different regions of the brain responded when the participants evaluated different distributions of their earnings. In the prescanning phase of the experiment, each participant was randomly assigned to work either 30, 60, or 90 min performing repetitive office work, stuffing envelopes, and entering records into a database. They were told that their earnings would be based on a hourly wage of 500 NOK (approximately 85 USD), but that a random process could interfere so that their payment from the experiment would not necessarily be the same as their earnings.

In the scanning phase, the participants were matched with a participant who had worked either the same length of time, or with a participant who had worked a different length of time. The total working time for a pair was always 120 min, the total earnings of the pair was always 1000 NOK, and the amount earned by each participant was common knowledge. Each participant was then asked to evaluate a sequence of possible distributions of the total earnings between the two of them on a scale from very bad (-5) to very good (+5). See Figure S1 in the supplementary material for screenshots. In total they made 51 such evaluations. Since the

[1] Forty-eight students were recruited, but one did not show up.

participants evaluated ex post distributions of the earned income, there were no incentive effects of the different distributions; therefore, efficiency considerations did not affect the evaluations. Interspersed with the rating trials were 30 control trials. In the control trials, no income distribution was shown and the task of the participants was only to tick off a specific number on the rating scale.

The number of seconds at each stage is indicated in the screenshots in the supplementary material for a sequence of one experimental trial and one control trial (Figure S1): 1 s for fixation, 2 s for showing the income distribution, 4 s for evaluating the income distribution on the rating scale (or ticking off a number in case of the control trials), and an interval between trials of varying length (randomly distributed between 1 and 7 s) to increase temporal resolution. This averaged 11 s per trial (range, 8 - 14 s). Before entering the scanner, the screenshots were explained to the participants and they were trained on using the handgrip that controlled the interface. The hand that was used to hold the grip for the experimental interface was randomly allocated.

A.3 Image Acquisition

Data acquisition was performed on a 3T GE Signa Excite scanner. Thirty slices (3 mm thickness, 2.3×2.3×2.3 mm voxel size, 0.3 mm interslice gap) were obtained in an interleaved fashion parallel to the anterior commissure – posterior commissure (AC-PC) line, using a single-shot gradient echo-planar imaging (EPI) sequence (repetition time, 2000 ms; echo time, 30 ms; bandwidth, 116 kHz; flip angle, 90°; 96×96 pixel matrix; field of view 220 mm). Prior to functional scanning, a high-resolution anatomical brain image was recorded from each participant.

A.4 Image Preprocessing

All image processing and statistical analyses were performed using the statistical parametric mapping software SPM8. First, all images were realigned to the first image in the time-series to correct for head movement, and movement related image distortions were corrected by applying an unwarping procedure. Second, the images were normalized to the Montreal Neurological Institute (MNI) reference space. The transformation into the MNI space was estimated by warping an averaged image, which was created during the realignment procedure, into the MNI space. Subsequently this transformation was applied to each image of the time series. Normalized data were resliced to a cubic voxel size of 3 mm^3 and smoothed with a Gaussian kernel (8 mm FWHM).

A.5 Statistical Parametric Mapping

The statistical analysis was based on the general linear model framework, implemented in SPM. First, a design matrix was specified, in which the onset and duration of the experimental and control trial were specified. In addition, for each condition, the trial-by-trial responses were included as an additional regressor. The model was fitted to the data by applying a high-pass filter with a cutoff frequency of 128 s. Thereafter, contrasts between the parameter estimates were defined. Group analyses were estimated by combining these individual contrasts in one-sample t-tests. First, a one-sample t-test was used for comparing the experimental with the control condition. This analysis was performed by applying a family-wise-error (FWE) corrected statistical threshold of $p(FWE) < 0.05$ and a threshold of at least 20 voxels per cluster.

A.6 Single-trial Data

To study the neuronal responses to different types of inequality in the regions of interest, we estimated individual hemodynamic response functions (HRFs) using the method reported in Eichele et al. (2008). For each participant and region of interest (ROI) separately, the empirical event-related hemodynamic responses (HRs) were deconvolved by forming the convolution matrix of all trial onsets with an assumed kernel length of 20 s, and multiplying the pseudoinverse of this matrix with the filtered and unit variance normalized ROI time course. Single-trial amplitudes were recovered by fitting a design matrix containing separate predictors for each trial onset, convolved with the estimated HR onto the ROI time course. The single trial weights (scaling coefficients (β), were estimated using multiple linear regression.

There was a significant negative correlation between the subjective ratings and the BOLD response in the two striatal regions ($p < 0.01$ for both regions). In the analysis, the sign of the single-trial data was normalized such that the marginal BOLD response to own income in the striatal regions coincided with that of the subjective ratings.

B Analysis of Single-trial Data

The single trial data were analyzed using Stata, version 13.1, for each region separately.

The estimates of condition contrasts in subjective rating and BOLD response presented in Table 1 are based on the following regression:

$$y_{it} = \gamma_i + \beta_1 x_{it} + \beta_2 (T_i \times x_{it}) + \varepsilon_{it}, \tag{1}$$

where i index individuals, T_i is a dummy for which condition the individual was in, and t index trials. All regressions are estimated on the ranges of own income (x_{it}) relevant to the hypotheses that is tested. BOLD responses are normalized to individual unit variance, and the γ_is are fixed effects for individuals.

In Table 2 we report an OLS regression of the subjective rating and the BOLD response in the left and right caudate nucleus on own income, deviation from proportionality and deviation from equality. The regression is given by

$$y_{it} = \gamma_i + \beta_1 x_{it} + \beta_2 \frac{|x_{it} - m_i|}{\max |x_{it} - m_i|} + \beta_3 \frac{|x_{it} - 500|}{500} + \varepsilon_{it}, \tag{2}$$

where m_i is the participants earnings, $|x_{it} - m_i|$ is the deviation from a proportional income distribution, and $|x_{it} - 500|$ is the deviation from an equal income distribution.

Acknowledgments: We are grateful to Dan Benjamin, Colin Camerer, Marja-Liisa Halko, Magnus Johannesson, Shachar Kariv and Arno Riedl for valuable comments; Turid Randa and Roger Barndon for radiographic work; Heike Eichele, Sebastian Fest, Anja Haukeland, and Kristin Henriksen for excellent research assistance. This project was financed by the Research Council of Norway (grant 185831) and was administered by The Choice Lab, NHH Norwegian School of Economics.

References

Adams, Stacy J. (1965). "Inequity in social exchange," *Advances in Experimental Social Psychology*, 2: 267–299.

Almås, Ingvild, Alexander W. Cappelen, Erik Ø. Sørensen, and Bertil Tungodden (2010). "Fairness and the development of inequality acceptance," *Science*, 328(5982): 1176–1178.

Arneson, Richard (1989). "Equality and equal opportunity for welfare," *Philosophical Studies*, 56(1): 159–194.

Bartels, Andreas and Semir Zeki (2000). "The neural basis of romantic love," *NeuroReport*, 11(17): 3829–3834.

Bault, Nadège, Mateus Joffily, Aldo Rustichini, and Giorgio Coricelli (2011). "Medial prefrontal cortex and striatum mediate the influence of social comparison on the decision process," *Proceedings of the National Academy of Sciences*, 108(38): 16044–16049.

Bolton, Gary E. and Axel Ockenfels (2000). "ERC: A theory of equity, reciprocity, and competition," *American Economic Review*, 90(1): 166–193.

Cappelen, Alexander W., Astri Drange Hole, Erik Ø. Sørensen, and Bertil Tungodden (2007). "The pluralism of fairness ideals: An experimental approach," *American Economic Review*, 97(3): 818–827.

Cappelen, Alexander W., James Konow, Erik Ø. Sørensen, and Bertil Tungodden (2013). "Just luck: An experimental study of risk taking and fairness," *American Economic Review*, 103(3): 1398–1413.

Cappelen, Alexander W., Erik Ø. Sørensen, and Bertil Tungodden (2010). "Responsibility for what? Fairness and individual responsibility," *European Economic Review*, 54(3): 429–441.

Card, D., Alexandre Mas, Moretti Enrico, and Saez Emmanuel (2012). "Inequality at work: The effect of peer salaries on job satisfaction," *American Economic Review*, 102(6): 2981–3003.

Dworkin, Ronald (1981). "What is equality? Part 2: Equality of resources," *Philosophy and Public Affairs*, 10(4): 283–345.

Eichele, Tom, Stefan Debener, Vince D. Calhoun, Karsten Specht, Andreas K. Engel, Kenneth Hugdahl, D Yves von Cramon, and Markus Ullsperger (2008). "Prediction of human errors by maladaptive changes in event-related brain networks," *Proceedings of the National Academy of Sciences*, 105(16): 6173–6178.

Engel, Christoph (2011). "Dictator games: A meta study," *Experimental Economics*, 14(4): 583–610.

Engelmann, Dirk and Martin Strobel (2004). "Inequality aversion, efficiency, and maximin preferences in simple distribution experiments," *American Economic Review*, 94(4): 857–869.

Fehr, Ernst and Klaus M. Schmidt (1999). "A theory of fairness, competition and cooperation," *Quarterly Journal of Economics*, 114(3): 817–868.

Fliessbach, K., B. Weber, P. Trautner, T. Dohmen, U. Sunde, C. E. Elger, and A. Falk (2007). "Social comparison affects reward-related brain activity in the human ventral striatum," *Science*, 318(5854): 1305–1308.

Frohlich, Norman, Joe Oppenheimer, and Anja Kurki (2004). "Modeling other-regarding preferences and an experimental test," *Public Choice*, 119(1-2): 91–117.

Harbaugh, William T., Ulrich Mayr, and Daniel R. Burghart (2007). "Neural responses to taxation and voluntary giving reveal motives for charitable donations," *Science*, 316(5831): 1622–1625.

Hsu, Ming, Cédric Anen, and Steven R. Quartz (2008). "The right and the good: distributive justice and neural encoding of equity and efficiency," *Science*, 320(5879): 1092–1095.

Kompus, K., K. Specht, L. Ersland, H. T. Juvodden, H. van Wageningen, K. Hugdahl, and R. Westerhausen (2012). "A forced-attention dichotic listening fmri study on 113 subjects," *Brain and Language*, 121: 240–247.

Konow, James (2000). "Fair shares: Accountability and cognitive dissonance in allocation decisions," *American Economic Review*, 90(4): 1072–1091.

Lane, Richard D., Eric M. Reiman, M. M. Bradley, P. J. Lang, Geoffrey L. Ahern, Richard J. Davidson, and Gary E. Schwartz (1997). "Neuroanatomical correlates of pleasant and unpleasant emotion," *Neuropschologia*, 35(11): 1437–1444.

Leventhal, Gerald S. (1980). *What Should Be Done with Equity Theory?*, chapter 2, Springer, pp. 27–55.

Moll, Jorge, Frank Krueger, Roland Zahn, Matteo Pardini, Ricardo de Oliveira-Souza, and Jordan Grafman (2006). "Human fronto-mesolimbic networks guide decisions about charitable donation," *Proceedings of The National Academy of Science*, 103(42): 15623–15628.

Nozick, Robert (1974). *Anarchy, State, and Utopia*, New York: Basic Books.

Rawls, John (1971). *A Theory of Justice*, Cambridge, MA: Harvard University Press.

Roemer, John E. (1998). *Equality of Opportunity*, Cambridge, MA: Harvard University Press.

Sanfey, Alan G. (2007). "Social decision-making: Insights from game theory and neuroscience," *Science*, 318(5850): 598–602.

Tabibnia, Golnaz, Ajay B. Satpute, and Matthew D. Lieberman (2008). "The sunny side of fairness: Preferences for fairness activates reward circuitry (and disregarding unfairness activates self-control circuitry)," *Psychological Science*, 19(4): 339–347.

Tricomi, Elizabeth, Antonio Rangel, Colin F. Camerer, and John P. O'Doherty (2010). "Neural evidence for inequality-averse social preferences," *Nature*, 463(7284): 1089–1091.

Vostroknutov, Alexander, Philippe N. Tobler, and Aldo Rustichini (2012). "Causes of social reward differences encoded in human brain," *Journal of Neurophysiology*, 107: 1403–1412.

Walster, Elaine, Ellen Berscheid, and William G. Walster (1973). "New directions in equity research," *Journal of Personality and Social Pscychology*, 25(2): 151–176.

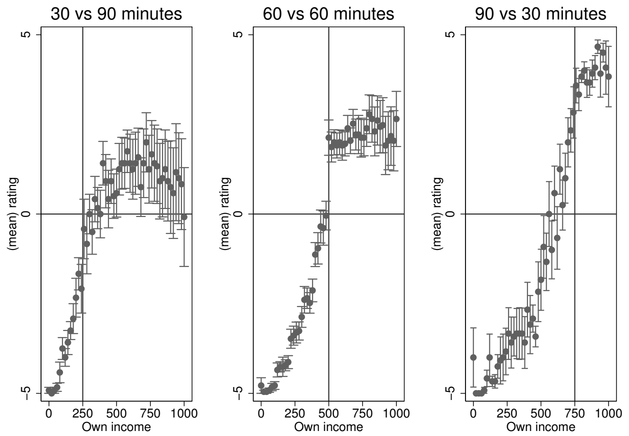


Figure 1: Subjective ratings in the scanner

The graphs show the mean and standard error of the subjective rating in the scanner for each of the 51 possible distributions of income. The subjective rating in the three graphs corresponds to the participants who worked for 30, 60, and 90 min, and was matched with participants who worked for 90, 60, and 30 min respectively. The participants' earnings in each condition are indicated by a vertical line.

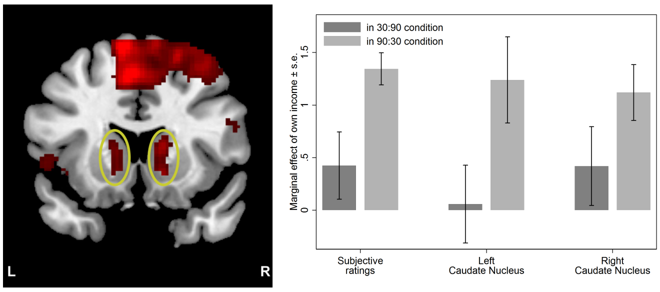


Figure 2: Regions of interest

Panel A indicates the two regions in the striatum, the left and right caudate nucleus, in which experimental trials produced significantly different blood-oxygen-level-dependent (BOLD) responses from control trials. Other displayed areas are regions that were located outside the striatum in which we also found difference between experimental and control trials, that were significant at a family wise error (FWE)-corrected threshold of $p(FWE) < 0.05$, and had at least 10 voxels per cluster. A complete list of these regions is reported and analyzed in the supplementary material. Panel B reports the marginal effect of own income on the subjective rating and the BOLD response in the left and right caudate nucleus for participants in the 30:90 condition and the 90:30 condition in the interval between 250 and 750 NOK.

Table 1: Effects of the conditions

	Prediction 1			Prediction 2			Prediction 3		
	Subjective	BOLD Caudate nucleus		Subjective	BOLD Caudate nucleus		Subjective	BOLD Caudate nucleus	
	ratings	left	right	ratings	left	right	ratings	left	right
Own income	1.343***	1.238***	1.119***	1.892***	1.160	1.302*	1.751***	1.599**	0.754
	(0.153)	(0.409)	(0.265)	(0.165)	(0.759)	(0.677)	(0.348)	(0.760)	(0.948)
Own income× 30:90 condition	-0.919**	-1.180**	-0.700	-1.306**	-2.115*	-1.580			
	(0.354)	(0.551)	(0.459)	(0.520)	(1.151)	(1.073)			
Own income × 60:60 condition							-1.614***	-2.213**	-1.368
							(0.490)	(1.086)	(1.170)

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table reports OLS regressions with individual fixed effects of the subjective rating and the BOLD-response in the left and right caudate nucleus on own income and the interaction between own income and conditions. All regressions only involve observations from the relevant conditions and the relevant intervals. The individual fixed effects capture the direct effect of each treatment. Prediction 1:the response to own income is lower in the 30:90 condition than in the 90:30 condition on $x_1 \in (250, 750)$. Prediction 2:the response to own income is lower in the 30:90 condition than in the 60:60 condition on $x_1 \in (250, 500]$. Prediction 3: the response to own income is lower in the 60:60 condition than in the 90:30 condition on $x_1 \in [500, 750)$. Marginal effects for subjective ratings are per 100 NOK; for BOLD responses, they are standard deviations per 1000 NOK.

Table 2: Effects of deviation from proportionality

	Subjective ratings	BOLD Caudate nucleus left	BOLD Caudate nucleus right
Own income(in 100s NOK)	1.119***	0.645***	0.632***
	(0.116)	(0.212)	(0.194)
Deviation from proportionality	-3.777***	-4.708***	-2.833**
	(1.161)	(1.611)	(1.373)
Deviation from equality	0.372	1.550	-0.468
	(0.970)	(1.698)	(1.594)

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table reports OLS regressions of the subjective rating and the BOLD-response in the left and right caudate nucleus on own income, deviation from proportionality and deviation from equality. Deviation from proportionality and deviation from equality are measured relative to the maximum deviation possible. BOLD outcomes are measured in units of 1/10 standard deviation.

C Supplementary material: The experiment

Figure S1 shows the in-scanner screenshots.[2]

D Supplementary material: Results for all 20 regions

We identified 18 regions in addition to the two regions in the striatum, where treatment trials produced significantly different BOLD response from control trials. In Table S1–S4 we report all the results that are reported in the main paper for the full set of 20 regions, together with MNI coordinates.

E Supplementary material: Robustness of the main results

In Table S5 we report robustness of the specification of the main model in the paper (Table 2).

The first three columns of Table S5 report a variation of Table 2 in the main paper where we use absolute deviations instead of the "relative to max deviation" formulation used in the main paper:

$$y_{it} = \gamma_i + \beta_1 x_{it} + \beta_2 |x_{it} - m_i| + \beta_3 |x_{it} - 500| + \varepsilon_{it}, \tag{S3}$$

We observe qualitatively the same pattern as in the paper.

The last two columns of Table S5 report on a variant of the Table 2 in the the main paper in which we include fixed effects for each possible subjective tick-off, (identified by including the control trials) and an indicator for the current trial being a control trial (in which all monetary outcomes are zero):

$$y_{it} = \gamma_i + C_{it} + R_{r(it)} + \beta_1 x_{it} + \beta_2 \frac{|x_{it} - m_i|}{\max |x_{it} - m_i|} + \beta_3 \frac{|x_{it} - 500|}{500} + \varepsilon_{it}, \tag{S4}$$

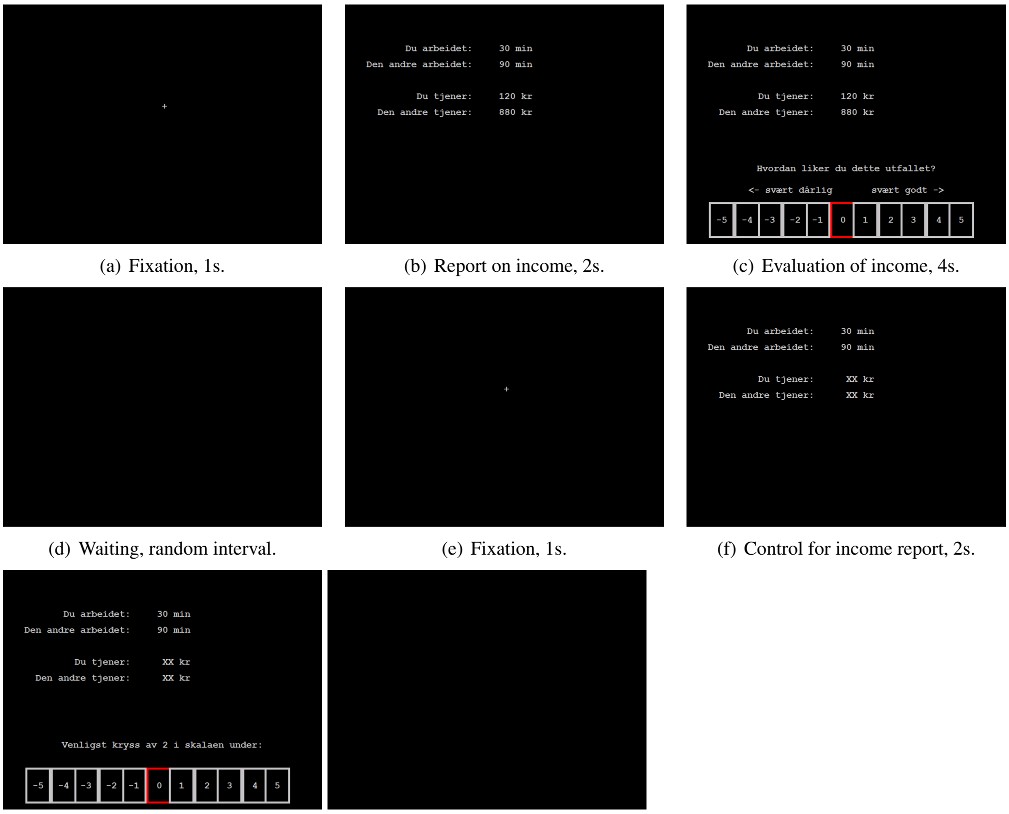
in which $R_{r(it)}$ is a dummy indicator for the subjective rating (or forced tick-off) r by individual i in trial t. Again we observe much the same (only slightly attenuated) results as reported in the main paper.

[2]Figures and tables at the end of this document.

F Supplementary material: Analysis of the post-scanner dictator game

A concern when conducting distributive games in a scanner is there might be strong experimenter demand effects since participants might feel particularly scrutinized. The results from the post-scanner dictator game allow us to address this concern. Figure S2 shows the share of the endowment given to the other participant in the post-scanner dictator game. The mean share given to others is 0.28 (standard error 0.03), and 17 out 47 participants gave nothing to the other participant. This result is similar to the result from earlier experiments with students, which suggests that the the present design did not invoke a strong experimenter demand effect (Engel, 2011).

Data from the post-scanner dictator game also allow us to examine whether the information collected in the scanner is predictive of behavior in a distributive situation outside the scanner. In Table S6 we observe that is the case: the amount given in the dictator game is significantly correlated with both subjective ratings and BOLD measures in the striatum.



(a) Fixation, 1s.
(b) Report on income, 2s.
(c) Evaluation of income, 4s.
(d) Waiting, random interval.
(e) Fixation, 1s.
(f) Control for income report, 2s.
(g) Control for evaluation, 4s.
(h) Waiting, random interval.

Figure S1: The trials in the scanner

In the scanner, participants were exposed to a total of 51 evaluation trials with different income distributions and 30 controls, in a randomized sequence. The panels above show a sub-sequence of one evaluation trial and one control trial. In both (c) and (g) the participant used buttons on a grip to tick of his evaluation or the control number. The grip had two buttons, one to press (and keep depressed) to move left, and one to move right. The interface was programmed using E-Prime version 2.

Translations: (b): “You worked: 30 min”, “The other worked: 90 min”. “You earn: 120 NOK”, “The other earns: 880 kr”. (c, added): “How do you like this outcome?”, “Very badly—Very well”. (f): Same text as (b), amounts X’d out. (g, bottom): “Please tick off 2 on the scale below:”.

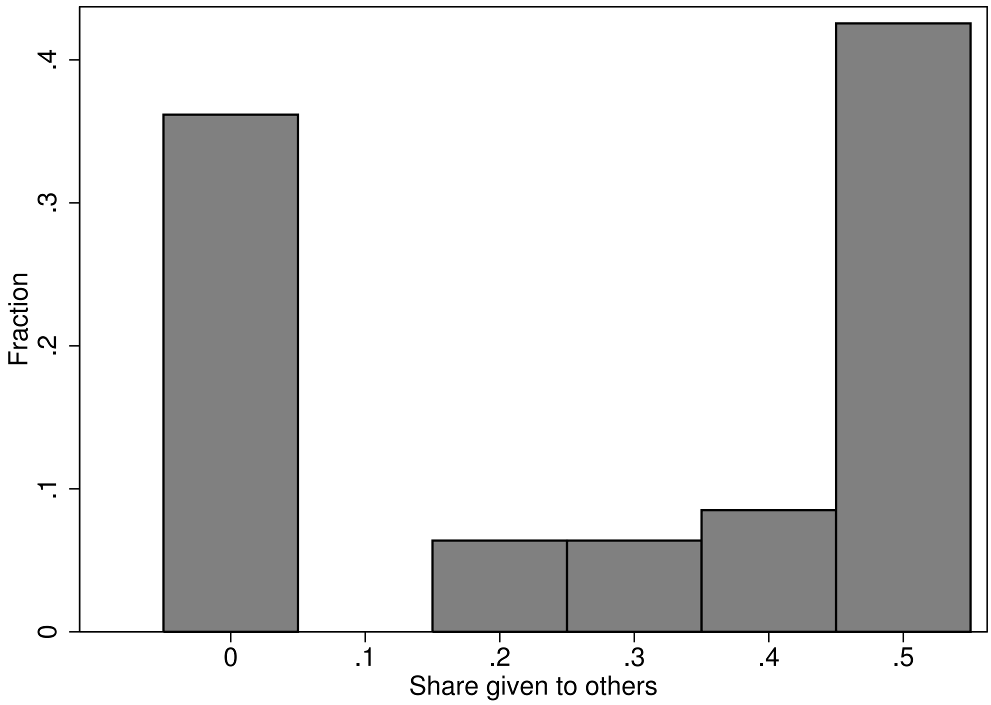


Figure S2: Share given in post-scanner dictator game
Share given is the share of the endowment (200 NOK) given to the other participant in the dictator game, where the dictator had to choose between 11 alternative shares: $0, 0.1, 0.2, \ldots, 1$. In a pair, one participant was randomly drawn to determine outcome for both.

ID-code:

Decision 2

We now want you to make a decision in a **real** distributive situation. In this case, you are also matched with another participant, but this participant is different from the one you were matched with in the scanner. This participant has worked the **same amount** of time as you.

Both of you have each been allocated 100 NOK in addition to what you earned from your work. Together, the two of you have earned 200 NOK and you have to decide you the 200 NOK between yourself and the other participant. Note that this is an anonymous decision so that we will not know which decision you make.

Below is a list of eleven alternative distributions of the total amount, 200 NOK. Please indicate your decision by making a cross in the box beside the alternative you prefer.

	To you in NOK	**To the other in NOK**	**Your decision (indicate your decision with a cross)**
1	200	0	
2	180	20	
3	160	40	
4	140	60	
5	120	80	
6	100	100	
7	80	120	
8	60	140	
9	40	160	
10	20	180	
11	0	200	

When you have made your decision, you put the sheet in the envelope and the envelope in the box. After the experiment, a computer will randomly select either your proposal or the proposal of the participant in this situation, and both of you will paid accordingly from this situation.

Figure S3: Form used for real choice post-scanning

Table S1: Results on prediction 1 in each of the 20 selected regions

			Own income		Own income $\times$ 30:90-condition	
Region	Coordinates	Description	parameter	Std.err.	parameter	Std.err.
1	-4,24,40	Left/right Anterior cingulate gyrus, Supplementary Motor Area	-0.261	0.337	-0.473	0.481
2	34,-66,44	Right Angular Gyrus, Inferior Paretial Lobe	-0.411	0.562	1.567**	0.676
3	-32,22,-4	Left Inferior Frontal Gyrus, Insula	0.401	0.573	-0.333	0.667
4	-36,-74,-46	Left Cerebellum	0.010	0.402	0.602	0.586
5	-38,-56,40	Left Angular Gyrus, Inferior Paretial Lobe	-0.393	0.555	0.850	0.664
6	-40,44,-2	Left Middle Frontal Gyrus	0.149	0.408	-0.515	0.564
7	12,24,-4	Right Caudate Nucleus	1.119***	0.265	-0.700	0.459
8	30,28,-4	Right Inferior Frontal Gyrus, Insula	0.719	0.601	-0.710	0.710
9	-14,22,-2	Left Caudate Nucleus	1.238***	0.409	-1.180**	0.551
10	34,-66,-34	Right Cerebellum	-0.393	0.443	0.823	0.506
11	-24,-100,-4	Left Inferior occipital gyrus	-0.035	0.335	0.597	0.460
12	-22,46,30	Left Middle Frontal Gyrus	-0.123	0.437	0.186	0.599
13	2,-88,2	Left/right Lingual Gyrus	-0.305	0.440	0.076	0.545
14	-46,18,40	Left Middle Frontal Gyrus	0.431	0.569	-0.639	0.688
15	-8,-84,-28	Left Cerebellum	0.889*	0.479	-0.981	0.677
16	4,-28,26	Right Posterior Cingulate Gyrus	0.356	0.282	-0.499	0.479
17	40,-86,-10	Right Inferior Occipital Gyrus	0.184	0.341	0.137	0.490
18	-6,54,36	Left Superior Medial Frontal Gyrus	-0.003	0.619	0.160	0.739
19	46,4,24	Right Inferior Frontal Gyrus	0.841	0.518	-0.824	0.657
20	-44,8,28	Left Inferior Frontal Gyrus	0.915**	0.432	-1.252**	0.520

This table refers to the regression from the main paper on Prediction 1, on all of the regions selected in the initial whole brain analysis. In the main paper, we report the results for regions 7 and 9. The regions are listed in terms of decreasing numbers of selected voxels. Coordinates are in MNI space.

Table S2: Results on prediction 2 in each of the 20 selected regions

			Own income		Own income × 30:90-condition	
Region	Coordinates	Description	parameter	Std.err.	parameter	Std.err.
1	-4,24,40	Left/right Anterior cingulate gyrus, Supplementary Motor Area	-0.063	0.791	-2.431^{**}	1.137
2	34,-66,44	Right Angular Gyrus, Inferior Paretial Lobe	0.053	0.630	0.168	1.065
3	-32,22,-4	Left Inferior Frontal Gyrus, Insula	1.510	0.966	-2.223	1.379
4	-36,-74,-46	Left Cerebellum	-1.938^{***}	0.705	1.989^{*}	1.109
5	-38,-56,40	Left Angular Gyrus, Inferior Paretial Lobe	0.531	0.880	-0.809	1.221
6	-40,44,-2	Left Middle Frontal Gyrus	0.366	0.679	-1.118	1.322
7	12,24,-4	Right Caudate Nucleus	1.302^{*}	0.677	-1.580	1.073
8	30,28,-4	Right Inferior Frontal Gyrus, Insula	-1.062	0.895	1.807	1.313
9	-14,22,-2	Left Caudate Nucleus	1.160	0.759	-2.115^{*}	1.151
10	34,-66,-34	Right Cerebellum	-0.758	0.800	0.979	1.361
11	-24,-100,-4	Left Inferior occipital gyrus	1.791^{***}	0.604	-3.577^{***}	1.194
12	-22,46,30	Left Middle Frontal Gyrus	0.862	1.056	0.019	1.359
13	2,-88,2	Left/right Lingual Gyrus	-0.636	1.059	-1.100	1.635
14	-46,18,40	Left Middle Frontal Gyrus	-0.297	0.708	-1.760	1.327
15	-8,-84,-28	Left Cerebellum	-0.005	0.760	-1.402	1.242
16	4,-28,26	Right Posterior Cingulate Gyrus	0.541	0.924	0.591	1.533
17	40,-86,-10	Right Inferior Occipital Gyrus	0.960	0.821	-2.293^{*}	1.309
18	-6,54,36	Left Superior Medial Frontal Gyrus	2.290^{***}	0.836	-2.861^{**}	1.273
19	46,4,24	Right Inferior Frontal Gyrus	-1.284^{*}	0.699	0.052	1.177
20	-44,8,28	Left Inferior Frontal Gyrus	0.928	0.756	-1.791	1.298

This table refers to the regression from the main paper on Prediction 2, on all of the regions selected in the initial whole brain analysis. In the main paper, we report the results for regions 7 and 9. The regions are listed in terms of decreasing numbers of selected voxels. Coordinates are in MNI space.

Table S3: Results on prediction 3 in each of the 20 selected regions

			Own income		Own income $\times$ 60:60-condition	
Region	Coordinates	Description	parameter	Std.err.	parameter	Std.err.
1	-4,24,40	Left/right Anterior cingulate gyrus, Supplementary Motor Area	-1.144	1.150	1.452	1.410
2	34,-66,44	Right Angular Gyrus, Inferior Paretial Lobe	0.803	0.895	-0.390	1.179
3	-32,22,-4	Left Inferior Frontal Gyrus, Insula	0.614	1.105	-2.273	1.437
4	-36,-74,-46	Left Cerebellum	0.622	0.602	0.529	0.961
5	-38,-56,40	Left Angular Gyrus, Inferior Paretial Lobe	-0.195	1.104	0.418	1.370
6	-40,44,-2	Left Middle Frontal Gyrus	0.375	0.666	-0.467	0.985
7	12,24,-4	Right Caudate Nucleus	0.754	0.948	-1.368	1.170
8	30,28,-4	Right Inferior Frontal Gyrus, Insula	0.566	1.220	-0.193	1.423
9	-14,22,-2	Left Caudate Nucleus	1.599**	0.760	-2.213**	1.086
10	34,-66,-34	Right Cerebellum	-0.121	0.691	0.557	1.035
11	-24,-100,-4	Left Inferior occipital gyrus	0.055	0.776	0.269	1.113
12	-22,46,30	Left Middle Frontal Gyrus	0.410	1.321	0.054	1.614
13	2,-88,2	Left/right Lingual Gyrus	1.249	1.128	-0.833	1.482
14	-46,18,40	Left Middle Frontal Gyrus	0.419	1.134	-0.139	1.431
15	-8,-84,-28	Left Cerebellum	0.441	1.358	-0.966	1.675
16	4,-28,26	Right Posterior Cingulate Gyrus	0.066	1.101	-0.978	1.351
17	40,-86,-10	Right Inferior Occipital Gyrus	0.357	0.946	0.530	1.207
18	-6,54,36	Left Superior Medial Frontal Gyrus	1.260	1.161	-3.356**	1.444
19	46,4,24	Right Inferior Frontal Gyrus	1.623	0.901*	-2.726**	1.249
20	-44,8,28	Left Inferior Frontal Gyrus	2.517**	1.054	-1.426	1.429

This table refers to the regression from the main paper on Prediction 3, on all of the regions selected in the initial whole brain analysis. In the main paper, we report the results for regions 7 and 9. The regions are listed in terms of decreasing numbers of selected voxels. Coordinates are in MNI space.

Table S4: Table 2 estimates in each of the 20 selected regions

				Deviations from			
		Own income		proportionality		equality	
Region	Description	parameter	Std.err.	parameter	Std.err.	parameter	Std.err.
1	Left/right Anterior cingulate gyrus, Supplementary Motor Area	0.299	0.191	1.739	1.753	-1.086	2.298
2	Right Angular Gyrus, Inferior Paretial Lobe	-0.287	0.208	-4.591**	2.071	0.661	1.866
3	Left Inferior Frontal Gyrus, Insula	-0.411*	0.232	3.037	2.150	1.329	2.374
4	Left Cerebellum	-0.134	0.193	-3.140*	1.827	-1.883	1.753
5	Left Angular Gyrus, Inferior Paretial Lobe	0.096	0.196	-2.414	2.084	2.147	2.274
6	Left Middle Frontal Gyrus	-0.065	0.184	1.802	1.799	0.646	1.977
7	Right Caudate Nucleus	-0.632***	0.194	2.833**	1.373	0.468	1.594
8	Right Inferior Frontal Gyrus, Insula	-0.405*	0.220	1.597	2.329	-2.357	2.371
9	Left Caudate Nucleus	-0.645***	0.212	4.708***	1.611	-1.550	1.698
10	Right Cerebellum	-0.074	0.195	-3.436**	1.590	1.483	2.032
11	Left Inferior occipital gyrus	-0.338*	0.198	-0.446	1.554	0.462	1.965
12	Left Middle Frontal Gyrus	-0.237	0.211	-0.220	2.087	0.347	2.476
13	Left/right Lingual Gyrus	0.389	0.243	1.124	1.977	-6.048**	2.626
14	Left Middle Frontal Gyrus	-0.206	0.232	2.118	2.272	-3.062	2.300
15	Left Cerebellum	-0.270	0.194	3.986*	2.372	-1.862	2.541
16	Right Posterior Cingulate Gyrus	0.078	0.198	0.981	1.777	1.445	2.340
17	Right Inferior Occipital Gyrus	-0.340*	0.179	-0.041	1.716	-1.845	2.086
18	Left Superior Medial Frontal Gyrus	-0.017	0.220	2.392	2.218	1.628	2.360
19	Right Inferior Frontal Gyrus	-0.002	0.218	2.740	2.046	-1.352	1.978
20	Left Inferior Frontal Gyrus	-0.364*	0.206	4.231**	1.826	-4.397**	2.149

Table S5: Robustness of results in Table 2

	Subjective ratings	BOLD Caudate Nucleus			
	Absolute	Absolute deviations		With controls	
	deviations	left	right	left	right
Own income (in 100s NOK)	1.119***	0.645***	0.632***	0.626**	0.654***
	(0.116)	(0.212)	(0.194)	(0.249)	(0.231)
Deviation from proportionality (in 100s NOK)	-0.518***	-0.651***	-0.390*	-3.986***	-2.354*
	(0.170)	(0.237)	(0.200)	(1.467)	(1.389)
Deviation from equality (in 100s NOK)	-0.042	0.168	-0.180	0.723	-1.595
	(0.180)	(0.342)	(0.315)	(1.598)	(1.520)
Observations	1175	1175	1175	2585	2585

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table reports OLS regressions of the subjective rating and the BOLD-response in the left and right caudate nucleus on own income, deviation from proportionality and deviation from equality. Deviation from proportionality and deviations from equality are measured in absolute terms (in 100s of NOK) in the first three columns, whereas in the main paper it is measured relative to the max deviation (which differs by condition). BOLD outcomes are measured in units of 1/10 standard deviation. In the last two columns, indicators are also included for each of the 11 rating levels and for the trial being a control trial (these are left out of the table). In all specifications, individual level fixed effects are included but not reported in the table.

Table S6: Correlates of share given

Variable correlated with share given	p-value
Subjective rating	0.03
BOLD: Right caudate nucleus	0.02
BOLD: Left caudate nucleus	0.04

Note: Reported are p-values for tests that the correlation between the variable and the share given in the post-scanner dictator game is different from zero. The BOLD measures are summarized at the individual level by the regression coefficient of the outcome and own income (at or above the fair level). The regressions are run for one individual at a time, with the variance of outcome variables standardized.

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12/15 June, **Kurt R. Brekke**, Tor Helge Holmås, Karin Monstad, and Odd Rune Straume, "Socioeconomic Status and Physicians'Treatment Decisions".

13/15 June, **Bjørn L. Basberg**, "Commercial and Economic Aspects of Antarctic Exploration - From the Earliest Discoveries into the 19th Century".

14/15 June, **Astrid Kunze** and Amalia R. Miller, "Women Helping Women? Evidence from Private Sector Data on Workplace Hierarchies"

15/15 July, **Kurt R. Brekke**, Tor Helge Holmås, Karin Monstad, Odd Rune Straume, «Do Treatment Decisions Depend on Physicians Financial Incentives?"

16/15 July, **Ola Honningdal Grytten**, "Norwegian GDP by industry 1830-1930".

17/15 August, **Alexander W. Cappelen**, Roland I. Luttens, **Erik Ø. Sørensen**, and **Bertil Tungodden**, «Fairness in bankruptcy situations: an experimental study».

18/15 August, **Ingvild Almås, Alexander W. Cappelen, Erik Ø. Sørensen**, and **Bertil Tungodden**, "Fairness and the Development of Inequality Acceptance".

19/15 August, **Alexander W. Cappelen**, Tom Eichele,Kenneth Hugdah, Karsten Specht, **Erik Ø. Sørensen**, and **Bertil Tungodden**, "Equity theory and fair inequality: a neuroconomic study".

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