Decision-making, thinking and problem solving

Weighting: 2/17

Sanfey, A. G., Rilling, J. K., Aronson, J. A., Nystrom, L. E., & Cohen, J. D. (2003). The Neural Basis of Economic Decision-Making in the Ultimatum Game. *Science*, *300*(June), 1755–1758.

# Agenda

* What is decision making, thinking and problem solving?
* The article: The Neural Basis of Economic Decision-Making in the Ultimatum Game
* Motivation and hypothesis
* Method
* Results
* Authors’ conclusion
* Criticism
* Greater perspective™

## What is decision making, thinking and problem solving?

**Behavioral economics** A new social science discipline that combines elements of traditional economics and psychology to explain real-world decisions, including observed biases in choice

**Neuroeconomics:** Also called *decision neuroscience*. An emerging discipline that combines theoretical perspectives from neuroscience and economics, as well as other of the social sciences, in the creation of mechanistic models for behavior.

**Altruistic punishment:** An action taken to harm another individual, at personal cost, in order to enforce a social norm (e.g., sacrificing one’s own money in order to punish someone who cheats in a game).

**Dual-system model** A framework for decision making that posits the existence of two independent systems—typically, a fast emotional system and a slower cognitive system—whose interactions over time predict choices

# The article: The Neural Basis of Economic Decision-Making in the Ultimatum Game

This study applies functional neuroimaging techniques to investigate the relative contributions of cognitive and emotional processes to human social decision-making.

## Hypothesis

We hypothesized that unfair offers would engage neural structures involved in both emotional and cognitive processing, and that the magnitude of activation in these structures might explain variance in the subsequent decision to accept or reject these offers.

## Method

Participants are introduced to 10 other players before the experiment who will play independently of each other

### The ultimatum game

*N* = 19, 30 trails each: 10 computer, 10 human, 10 control.

* A proposer proposes a division of $10 and a responder decides whether to take the offer (they both gain money) or reject it (no one gains money)
* The objective is to earn as much money as possible (payed according to game earnings)
* Single-shot: no one will play each other twice
* All subjects are responders all the time and are paid according to game earnings
* NOTE: Post-experiment interviews: 58% of participants thinks anything less than 5/5 is unfair, 48% thinks anything less than 7/3 is unfair.

### Trial types

* Computer: A computer proposes a division
* Human: A picture of a person that participants met before the experiment proposes a division
* Control: Participants are paid for pressing the button
* Offers can be 5:5, 7:3, 8:2 or 9:1

## Results

* Fig. 1: behavioural data
* Human made unfair offers (2$, 1$) were rejected significantly more often than the same offers made by a computer.
* Suggesting participants had a stronger emotional reaction to unfair offers from humans than to the same offers from a computer

### Figure 2: fMRI data on fair and unfair offers

2A and 2B: 2 images due to placement of areas

* Activation contrast between fair and unfair offers in insula (emotions, norm violations), ACC (conflict monitoring) and right dlPFC (goal maintenance, cost/benefit)

2C and D

* Much greater insula activity with unfair persons. Lesser activity with fair persons. Activity with offers from computers is fairly close regardless of fairness

2E

* Fair offers have no insula activity. The degree of unfairness affects signal % change (BOLD response) so that more unfair offers elicits greater BOLD response

### Figure 3: Acceptance rates plotted against right anterior insula activation

* **3A**: Acceptance rates and insula activity are correlated such that participants with greater insula activity to unfair offers reject more offers.
* **3B**: Rejected offers have higher insula signal change than accepted offers.
* DLPFC: Usually linked to cognitive processes as goal maintenance and executive control.
  + DLPFC increased activation might be due to the representation and active maintenance of the cognitive demands of the task, the accumulating of as much money as possible
  + Unfair offers are harder to accept, and therefore have higher cognitive demands, in order to overcome the strong emotional tendency to reject the offer and get the money.

## Authors’ conclusions

* dlPFC and anterior insula may reflect the ‘twin demands’ of the ultimatum game: goal maintenance (cognitive/dlPFC) and resisting unfairness (emotional/insula)
* Insula activity is predictive of subsequent behaviour: emotions are important for decision-making
* Support economic models which acknowledge emotional influence

## Criticism

* It’s all correlations
* Both areas are involved in *many* functions; is anything really this specific?
* dlPFC has also been related to theory of mind and suppression of selfish behaviour – this might go against current findings?
* Comparing blood fMRI signal across brain regions: general blood flow and anatomical differences
  + Sort of a little bit compensated for by comparing signal % change, but not much
* Few of each (unfair) trial type
* Homogeneous sample, very young (21.8 years old), upper class (Princeton University)
* General problems with lab-based experiments on decision-making:
  + Decisions have low relevance (even now that participants are paid based on decisions, these are not astronomical amounts)
  + Outcomes are certain/known
  + No time pressure (in this experiment they had 6secs to accept or reject the offer)
  + Low number of choices/actions
  + All choices/alternatives available at once
* 58 % of participants think anything less than 5:5 is unfair, 42 % think anything less than 7:3 is unfair. Are there systematic differences in how these “groups” accept/reject offers? One group is treated relatively more unfairly than the other

## Grand Perspective ™

* Heuristics: fast and frugal (satisficing and others…)
  + “Systems thinking” (opposite of heuristics/intuition) – **Gigerenzer**: systems are predictable, real world is not, therefore heuristics prevail over algorithms in most situations
* Rule of reciprocity: people feel inclined to return favours – but also harm
* Endowment effect, framing
* Expected value theory (Fermat) vs expected utility theory (Bernoulli) vs prospect theory (Tversky, Kahneman)
* MAUT (Multi-Attribute Utility Theory)
* Nudging
* Game theory
* Prisoner’s dilemma