**Perspective:** **Reciprocity** (return favour or harm), expected value (Fermat) vs **utility** (Bernoulli) vs **prospect** (Tversky, Kahneman), **heuristics** (Gigerenzer: unpredictable world)

**Criticism:** Caution **comparing blood flow across regions**

-Ideas of fairness differ: are some treated more unfair?

-Both areas involved in many functions, nothing this simple

-Lab based decisions: low relevance, all options available at once, known outcomes, no/little time pressure, few options

**Figure 3**: Acceptance rates vs. right anterior insula activation

**3A:** **Acceptance rates and insula activity are correlated**

-Participants with **higher insula activity to unfair** offers **accept fewer** offers.

**3B:** **Rejected offers** have higher insula signal change than accepted offers.

**dlPFC**: Linked to **goal maintenance** and **executive control.**

-Increased activation -> maintenance of goal (gain money)

-**Unfair offers are harder to accept ->** higher cognitive demands due to strong emotional tendency to reject offer

**The ultimatum game**: tutorial + meet’n’greet other ‘players’

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

-Proposer **proposes a division of $10** (5:5, 7:3, 8:2 or 9:1)

-Responder **decides** whether to **accept** (both gain money) or **reject** (no one gains money)

-**Objective is to earn money**

-**Single-shot**: no one will play each other twice

-All subjects are **responders all the time** and are **paid according** to game earnings

**Post-experiment interviews**: **58%** of participants think 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

**Behavioural economics, neuroeconomics**

-**Altruistic punishment**: taking a personal cost to enforce a social norm (e.g. punish someone who cheats in a game)

**Authors’ conclusions:** dlPFC + anterior insula reflect **‘twin demands’** of ultimatum game: **goal maintenance** and **resisting unfairness** (emotional/insula)

-**Insula activity is predictive of subsequent behaviour**: emotions are important for decision-making -> economic models which include emotion

**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)**

**2C and 2D**

-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 elicit greater BOLD response**

**Results:** Behavioural data (**Fig. 1**)

-**Human unfair** offers (2$, 1$) were **rejected** significantly more often than **the same offers made by a computer**.

-**Stronger emotional** reaction to unfair offers from **humans** than to the **same offers from a computer**

**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.

Sanfey, Rilling, Aronson, Nystrom & Cohen, J. D. (2003). The Neural Basis of Economic Decision-Making in the Ultimatum Game