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# A Cognitive/Affective Model of Strategic Behavior - 2-Person Repeated Prisoner's Dilemma Game

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John Q. Public, a computational model of political cognition that incorporates both cognitive and affective mechanisms and both on-line and memory-based processing, is employed to study strategic behaviors in a social dilemma situation. Specifically, two John Q. Publics were employed as players in a 2-person repeated prisoner's dilemma game to simulate the experimental data from Rapoport et al. (1976). Compared to previous studies that simulated the same data, this study has two advantages: 1) it is arguably more psychologically realistic in that it incorporates an affective mechanism and 2) the players are modeled as completely independent agents.

## The Model

### Affective Mechanism

The model is built using ACT-R. Together with the cognitive mechanisms embedded in ACT-R, an affective, attitudinal mechanism was incorporated into the model based on the following axioms;

- (Hot Cognition) Most social concepts in memory are affectively charged. The affective evaluation linked to a concept in long term memory can be positive or negative or close to zero, indicating either a non-attitude or ambivalence. (Abelson, 1963)

- (Attitude Priming) The information in memory that is affectively congruent to the information being processed is more accessible. (Fazio, 1990)

- (Primacy of Affect) Affect can not only be triggered automatically without conscious appraisal of an attitude object, but also is primary in the sense that it comes into working memory before other conscious thoughts and appraisals enter into the judgment process. (Zajonc, 1980, 2001)

- (On-line and Memory-based Processing)
  - (Memory-based Processing) Different, often conflicting considerations and feelings that come to mind on the spot influence the evaluations of objects. The accessibility of situational factors, together with the content and structure of prior beliefs determine what considerations and feelings come to mind on the spot.
  - (Attitude Construction and Colorization) An attitude toward an object is constructed and/or updated continuously in real time. That is, it is colored by those thoughts and feelings that come to mind at the time of information processing.
  - (On-line Processing) An affective summary evaluation (valence) is linked to every object in memory that has been evaluated in the past and is updated continuously on every exposure to new information, thereby reflecting the weighted influence from all momentarily accessible information. That is, the valence of the new information at the time of updating is colored by the respective valence of those thoughts and feelings elicited at the time of exposure.

(For formal presentations and a check of their internal validity in the context of political candidate evaluation, see, Kim, Lodge, & Taber, MPSA 2004 Conference Proceeding.)

### Simulation Framework

A player's behavior in each round of the PD game was modeled as follows:

- At each round of play, the model chooses a strategy that it believes or feels is better at the moment of decision-making.

- Upon receiving the outcome, it adjusts its beliefs about strategies and the opponent based on (its perception of) the realized outcome.

- It goes to the next round of play with the updated beliefs.

Most importantly, given the above cognitive/affective mechanisms, the model chooses a strategy that it believes or feels is better at the moment of decision-making. That is, it chooses strategies based on its attitudes toward the strategies at the moment that are 1) continuously updated reflecting past experiences and 2) constructed on the spot reflecting elicited thoughts and feelings.

Multiple agents were incorporated by running them on multiple, separate lisp processes and allowing them to communicate with one another via the 'socket'.

## Simulation Results

In the experiment conducted by Rapoport et al (1976), each of 10 pairs of subjects (players) repeatedly played 300 rounds of PD game. The payoffs were (-1, -1), (10, -10), (-10, 10), and (1, 1) for the outcomes (Defect, Defect), (Defect, Cooperate), (Cooperate, Defect), and (Cooperate, Cooperate), respectively.

100 simulations were implemented, meaning that each of 100 pairs of agents played 300 rounds of the game. Important parameters specific to the simulation were two. First, the subjective evaluations of the game payoffs (1, 10, -1, and -10) used in the simulation were 0.1, 0.29, -0.1, and -0.29, respectively, on the conventional -1 to 1 attitude scale. Note that objective game payoffs are different from subjective attitudes toward them. Second, the anchoring and adjusting parameter in on-line updating mechanism was set to be 0.93. Other parameters are left to their 'common' values (e.g., $d = 0.5$).

10 simulations that closely resemble the human data were selected for a direct comparison. The Table 1 shows the correlation in mean frequencies of outcomes between human data and model with both 10 and 100 simulations.

Table 1: General Fit : Correlation of Mean Frequencies

| | DD | DC | CD | CC | r | Mean-dev |
|---|---|---|---|---|---|---|
| Human | 30 | 7 | 8 | 55 | | |
| 10 run | 41 | 2 | 1 | 56 | 0.970 | 0.070 |
| 100 run | 44 | 1 | 1 | 53 | 0.944 | 0.084 |

The Figure 1 and 2 show the changes in frequencies of mutual cooperation (CC) and mutual defection (DD) over time in human data and the model runs with 10 simulations, respectively.

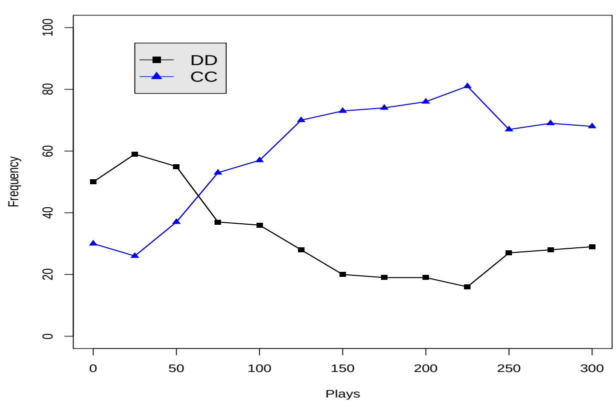


Figure 1: Strategy Shift : Human Data

In all, the simulation results seem to be reasonable in terms of reproducing main observations in the experimental data, namely, the strategy shift, bimodality in outcomes, and a sort of stabilization of outcome frequencies over time. The simulation also provides a coherent explanation for the main observations based on, especially, the role of affective, attitudinal judgements. (For detail, see, Kim & Taber, MPSA 2004 Conference Proceeding.)

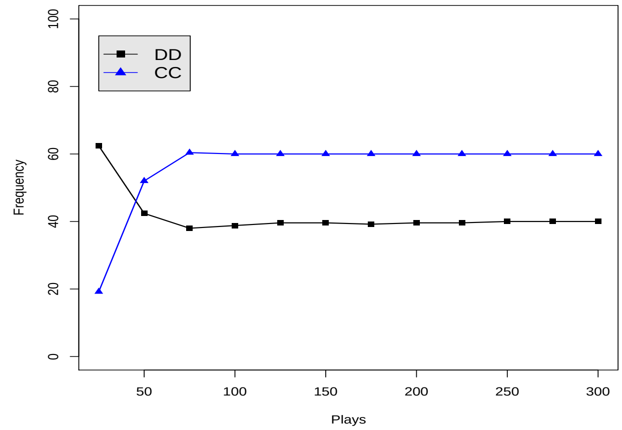


Figure 2: Strategy Shift : Model with 10 simulations

However, the model was not successful in generating enough variance in strategy outcomes; that is, the simulated strategy outcomes were overly bimodal. It seems to be mainly due to the assumed zero variance in players' subjective evaluations of the payoffs. For better simulation, it appears to be necessary to have data where players' subjective evaluations of game payoffs are available.

The model and the simulation framework can be applied to a wide range of different games such as games with more than 2 players or different observational mechanisms.

## Acknowledgments

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## References

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