Cooperative behaviour in experimental games: Qualitative methods speak volumes

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Overview of talk

• Game theory
  – History
  – Prisoners Dilemma
  – Coordination games

• Experimental Methods – traditional
  – Colman, Pulford, & Lawrence (2014)

• Qualitative approach to games
  – Concurrent Protocols
  – Thematic analysis
Game Theory

- Conceptual Background
  - Game theory is a theoretical framework for studying **interactive** decisions – those in which the outcomes depend on the decisions of **two or more** decision makers.
  - Almost whenever two or more people interact, a game is being played.
Conceptual Background

- Choosing between job offers, or washing powders in a supermarket, are *individual* decisions.

- Choosing which way to move when another person is walking towards you is an *interactive decision*, hence a *game* – the outcome depends on choices of *both* of you.
Terms used in Game theory

- Decision makers are called **players** (people, committees, governments, animals – any decision-making agents)
- Each player has two or more ways of acting = **strategies**, and the outcome depends on the decisions of both or all the players.
- The players have consistent preferences among the possible outcomes - we can assign numerical **payoffs**, indicating these preferences.
Historical Background

- All began in 1928 with von Neumann- minimax theorem
- 1950: John Nash - Nash equilibrium
- 1957: Luce & Raiffa, Games and Decisions: Introduction and Critical Survey
- Includes chess and poker; also interpersonal, economic, political, and military conflicts.
John Nash (Nobel prize 1994)

1957

2007
“Nash Equilibrium”

- Caren and Andrew are in Nash equilibrium if Caren is making the best decision she can, taking into account Andrew’s decision, and Andrew is making the best decision he can, taking into account Caren’s decision.

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<td>D</td>
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</table>
Interactive Decisions

- Game theory applies to interactive decisions
  - competitive game (e.g. Prisoner’s Dilemma)
  - mixed-motive game
  - coordination game
Experimental Games

- Prisoner’s Dilemma game (1950)
  - from 1960s in social psychology
  - from 1973 in evolutionary biology
  - from late 1980s in behavioural economics, political science

- Used to study cooperation and competition
  - Trust and trustworthiness
  - Risk taking and caution
  - Altruism and spite
  - Threats, promises, commitments
### Prisoner’s Dilemma game

**Flood & Drescher 1950**

<table>
<thead>
<tr>
<th></th>
<th>Prisoner B stays silent (<em>cooperates</em>)</th>
<th>Prisoner B betrays (<em>defects</em>)</th>
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<tbody>
<tr>
<td><strong>Prisoner A stays silent (<em>cooperates</em>)</strong></td>
<td>Each serves 1 year</td>
<td>A: 3 years  B: goes free</td>
</tr>
<tr>
<td><strong>Prisoner A betrays (<em>defects</em>)</strong></td>
<td>A: goes free  B: 3 years</td>
<td>Each serves 2 years</td>
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</tbody>
</table>

Regardless of what the other decides, each prisoner gets a higher pay-off by betraying the other (defecting). But cooperation is preferential to both defecting (1 < 2).
Coordination Games

- Introduced by Schelling (1960) – The Strategy of Conflict
- **Rendezvous Dilemma** (Alpern 1976):
  e.g. Meeting your date in a park:
  (a) When and
  (b) Where?

- Hyde Park - Big Wheel
- Lunch time 12 noon
Pure Coordination Games

• “Virtually all” choose the salient focal point for time. (Schelling, 1960; Mehta, Starmer, & Sugden, 1994)

• Many chose the focal point for location - 38% (Mehta, Starmer, & Sugden, 1994)

• Called pure coordination games because interests coincide perfectly – no conflict – players are motivated to coordinate actions and expectations.
General Methodology of Experimental Games

- Matrix games
  - One-shot games
  - Iterated (repeated) games
  - Points, tokens, or real money
  - Communication between players (Y / N)
  - Lifelike games or matrices
  - Sequential games (vs both choose simultaneously)
Popularity of Experimental Games

- Strict control
- Pure strategic behaviour
- Rigorous conceptualization of cooperation
- Ease of data collection
- But methodological problems
  - External and ecological validity
  - Incentives
Problems with Experimental Methods

• Game theory is unable to justify strategic coordination between individuals in circumstances where common interests coincide.

Colman, Pulford, & Lawrence (2014)
– Cognitive Hierarchy
– Stackleberg Reasoning
– Team Reasoning
Cognitive Hierarchy Theory

• Camerer, Ho, & Chong (2004)
  – Level-0 players choose randomly
  – Level-1 players choose best replies to Level-0
  – Level-2 choose best replies to Level-1
  – etc.

Strong Stackelberg Reasoning

• Players act as if they believe that their co-players will anticipate their choices and will choose best replies to them.
Team Reasoning

• Players sometimes motivated to maximize collective payoff:

  • Instead of:

    “What do I want, and what should I do to achieve it?”

  • We have:

    “What do we want, and what should I do to play my part in achieving it?”

Sugden (1993); Bacharach (1999, 2006)
Our Experimental Games

Published in Decision – used quantitative research methods
Procedure

- 68 participants

- Eight 3 x 3 games; four 4 x 4 games
  - “You will be paired with another randomly selected participant in this room for each of your 12 decisions.”
  - One-shot strategy choices, no feedback

- Main DV: Choice of strategy, A, B, C, or D
Choice of Strategy Frequencies

- Cognitive hierarchy Level-1 reasoning predominated, especially in more complicated games
- Strong Stackelberg reasoning mainly in simple games
- Team reasoning especially in the more complicated games
Qualitative approaches
Qualitative approaches

Pulford, Colman, & Lawrence (2014) - retrospective protocols explanations for strategy choices

- (1) Avoiding the worst payoff: “I chose rows with the aim of avoiding zero payoffs”

- (2) Strong Stackleberg reasoning: “I chose rows by trying to predict or anticipate the most likely choices of the other person and then choosing the rows that would give me the highest payoffs if my predictions were correct”

- (3) Team reasoning: “I chose rows with the aim of maximising the total payoff to both me and the other person”
Retrospective Protocols

• However this study used a questionnaire rated on a Likert scale which was constructed using retrospective protocols from a previous pilot study to measures strategy choices.

• Retrospective protocols are subject to inaccuracies as reports rely on memory retrieving implicit processes.

• Didn’t really find anything new!
So ... Use Concurrent Protocols

• Concurrent verbalisations are collected in such a way as to minimise reconstructions on the part of the participants.

• Produced as the participants play the matrix games.

• Better indicators of cognitive processing in task performance than retrospective protocols.

  (Ericsson & Simon, 1993)

• Involves a serious investment of time and resources.
Current study: Method [1]

- 8 Pairs of participants (8 males, 8 females)
  - Randomly allocated to each other (Red and Blue player)
  - Screened: over phone under the guise of setting up an appointment.
  - To ensure that individuals who responded to an advert in the staff bulletin were articulate, readily engaging and unreserved in their communication.
Method [2]

• Payment
  – Randomly selected one of the matrix games to pay out on - win up to £5 based on pair’s decisions.
  – Participants were also paid £10.00 show up fee.
  – Tested individually & separately at same time - never met each other
    • no deception
Method [3]

- 12 games
- reverse order to half of the participants to prevent possible order effects.
  - each Red Player chose between columns, each Blue Player chose between rows.
Materials - Example Games

Please remember that you must think aloud so that we can record your thoughts.

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<tr>
<th>A</th>
<th>B</th>
<th>C</th>
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<td>D</td>
<td>1, 3</td>
<td>4, 1</td>
<td>1, 0</td>
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</tbody>
</table>
Procedure: Understanding the rules of the game

If you choose A and the other person chooses C, what would you receive? What would the other person receive?

If you choose C and the other person chooses B, what would you receive? What would the other person receive?

<table>
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<th>A</th>
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<tbody>
<tr>
<td>A</td>
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<tr>
<td>B</td>
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<tr>
<td>C</td>
<td>5,5</td>
<td>1,4</td>
<td>2,2</td>
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</table>
Procedure- training

• Training session in giving consistent and informative verbal protocols.

• We followed the standard training procedure outlined by Trickett and Trafton (2007)
  – during the training, if a participant was silent for more than 3 seconds the researcher would prompt the participant with the line “Please keep talking”
This session was recorded so that participant was orientated in giving verbal protocols.

Also to check that DVR worked!
Transcribing, segmenting, encoding and categorising the data.

Two qualitative methodologies of participants’ concurrent verbalisations when thinking aloud:

- **Thematic analysis.**
  - a bottom-up approach to identify themes that relate to thoughts or decisions that occur in strategic selection.

- **Protocol analysis.**
  - A top-down approach as “a description of the activities ordered in time, which a subject engages in while performing a task” (Hayes & Flower, 1980, p200).
Thematic Analysis

- 3 Overarching themes evolved
  - Outcomes for the individual.
  - Considering the Other Player.
  - Strategies.

- Inter-rater reliability after double coding ranged from 85% to 100% which is considered excellent reliability (Cohen, 1960).
### Themes and Subthemes

<table>
<thead>
<tr>
<th>Themes</th>
<th>Sub Themes</th>
<th>Number of codes</th>
<th>Number of transcripts coded</th>
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<tbody>
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<td><strong>CONSIDERING THE OTHER PLAYER</strong></td>
<td>Best outcome for other player</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Hoping the other player is a team player</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Other player anticipating individual’s choice</td>
<td>12</td>
<td>2</td>
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<tr>
<td></td>
<td>Thinking the other player is competitive</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Worst outcome for other player</td>
<td>19</td>
<td>4</td>
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<tr>
<td><strong>OUTCOME FOR THE INDIVIDUAL</strong></td>
<td>Best outcome for the individual</td>
<td>46</td>
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</tr>
<tr>
<td></td>
<td>Difficult choice</td>
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<tr>
<td></td>
<td>Guaranteed payoff</td>
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<td>4</td>
</tr>
<tr>
<td></td>
<td>Worse outcome for the individual</td>
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<td>4</td>
</tr>
<tr>
<td><strong>STRATEGIES</strong></td>
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<tr>
<td></td>
<td>Compromise</td>
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<td>5</td>
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<tr>
<td></td>
<td>Fairness</td>
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<td>4</td>
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<tr>
<td></td>
<td>Risk taking</td>
<td>7</td>
<td>3</td>
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<tr>
<td></td>
<td>Calculations</td>
<td>11</td>
<td>3</td>
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Protocol Analysis

• Categorisation of the text was carried out by three researchers well versed with common theories of strategic coordination - Top down process

• The coders focused on encoding each segment of verbalisation into protocols that represent extant theories of strategic coordination.
Promiscuous use of strategies!

- Team reasoning
- Maximax
- Stackleberg Reasoning
- Cognitive Hierarchy
- Avoid the Worst
- Equality Seeking
- Relative Payoff Maximisation
“there’s one where if I choose column B, we both get 3, If I chose column A and he chooses row A then I would get what I get for my first choice, but he gets one extra as well, otherwise it’s looking like if I get more, he gets absolutely nothing, so he is unlikely to go for that, so I’m gonna choose column A in this instance”

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<th>A</th>
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<td>0,0</td>
<td>2,0</td>
<td>1,0</td>
<td>1,1</td>
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</table>
Maximax- RED player Perspective

“I can see that some have 2 columns that will allow me to get 5 points, but again if I choose B or C, those are the ones that will give me Maximum points… .”
“a better option for the red player would be if I chose A and he chose A, he would get 5. I don’t think he would risk that as I could have chosen C which would give me 4. The person in the other room if he is thinking like me would go for B B!.
“Ok we have 5,2,1 in A, we have 3,1,1 in B and 3,2,1 in C. Now instantly I can kind of see that A is looking the best by a mile, 3,1,1 is worse off than 3,2,1 so B is worse of than C and 3,2,1 in the C is worse off than 5,2,1 in the A so I choose A”
Avoid the worst- Blue Perspective

“Ok so, immediately I’m drawn to B to not choose cause I’d only get zero if they choose A, zero if they chose C and then if they chose B I wouldn’t gain anything, so I’m gonna discount B”
“but I’m quite a fair person and I wouldn’t want to choose A because I think the other person will only win a pound then and that’s not really fair, so I think… I’m not very greedy so I think at the moment at this stage in the test I’ll go for B so where we will both win 3 pounds”
Relative payoff maximisation - Blue Player

“But I don’t really want them to be getting 5 points and so if I was to think that they were going to go for A I’d go for A, but then it could be that they have chosen B or C so in which case… I’d actually still be better if they chose C and I’d chosen A, but with B they’d be £2 better off”
<table>
<thead>
<tr>
<th></th>
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<th>MM</th>
<th>VMM</th>
<th>RPM</th>
<th>BRMM</th>
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<td>TR</td>
<td>VMM</td>
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<td>VCH1</td>
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<td>MM</td>
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<td>MM</td>
<td>TR</td>
<td>MM</td>
<td>EQ</td>
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We don’t simply choose and stick to 1 strategy
Summary

• Verbal Protocols are an effective methodology for studying strategic selection, decision making and problem solving in game theory.

• The present study attempted to unearth strategy selection in matrix games.

• Findings show that we really are promiscuous in our choice of strategies.

• This is a finding that usual methods would not have revealed.
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School of Psychology

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