# Availability of Information and Representation Effects in the Centipede Game

Marco Mantovani
(with Paolo Crosetto)

CEREC seminar

Nov 23, 2012

# The centipede game

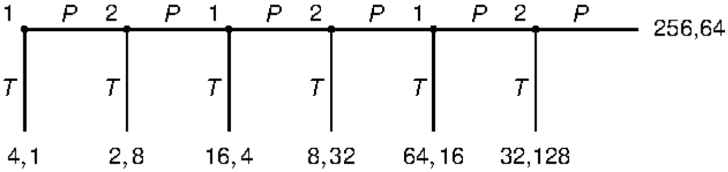



Figure: The six-leg centipede in McKelvey and Palfrey (1992)

# Research questions

- How does environmental complexity affect strategic behavior in sequential games?
- Does behavior respond to preference-eliciting and/or to preference-neutral manipulations?

# Research questions

- How does environmental complexity affect strategic behavior in sequential games?
- Does behavior respond to preference-eliciting and/or to preference-neutral manipulations?

## Aim

We exploit two institutional-format manipulations to investigate the role of preferences and cognitive limitations in shaping taking behavior in the centipede game.

# Why sequential games?

- Specific features of strategic reasoning in dynamic games
  ▸ Race Game.

# Why sequential games?

- Specific features of strategic reasoning in dynamic games ▸ Race Game.
- Peculiar interaction between environmental complexity and strategic reasoning in dynamic games:
  - Impact on the use of information distant from the current node.

# Why sequential games?

- Specific features of strategic reasoning in dynamic games ▸ Race Game.
- Peculiar interaction between environmental complexity and strategic reasoning in dynamic games:
  - Impact on the use of information distant from the current node.
- Response to enhanced complexity can shed light on behavior in the base game. ▸ Centipede

# Race Game (Mantovani, 2012)

## The race game

1. Start in 1.
2. $i$ adds a number between 1 and $6$.
3. $j$ adds a number between 1 and $6$. And so on.
4. The player who arrives at 66 wins, the other loses.

# Race Game (Mantovani, 2012)

## The race game

1. Start in 1.
2. *i* adds a number between 1 and *6*.
3. *j* adds a number between 1 and *6*. And so on.
4. The player who arrives at 66 wins, the other loses.

- Small prize at 40: identify reasoning on restricted game tree.

# Race game/3

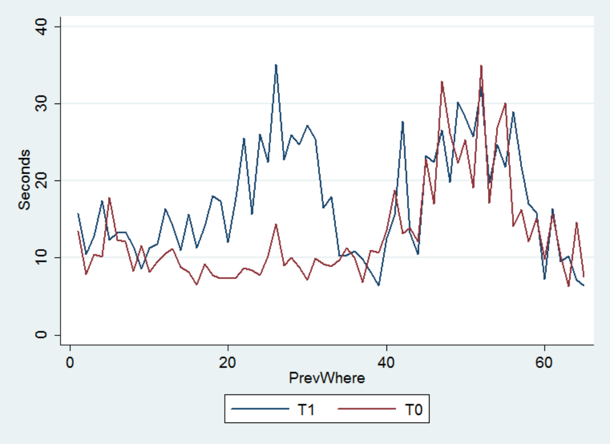
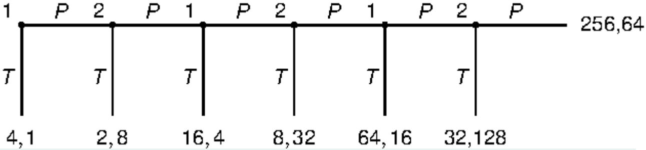



Figure: Average time to reach a decision

# The Centipede Game



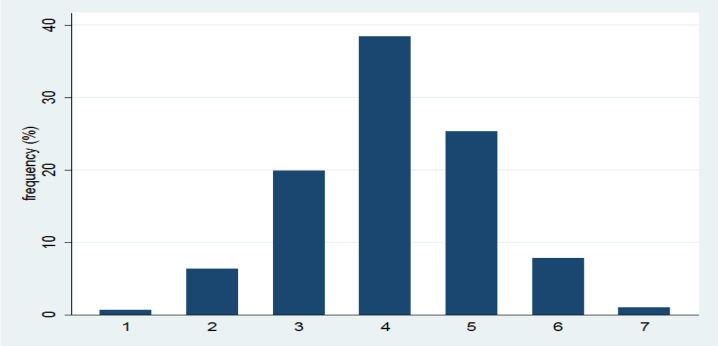




Table: Endnode in the CG from McKelvey&Palfrey (1992)

# Explanations

- Preferences (e.g., Dufwenberg and Kirchsteiger, 2004).
- Bounded strategic thinking (e.g., Palacios-Huerta and Volij, 2009; Kawagoe and Takizawa, 2008)
- A combination of the two (e.g., McKelvey and Palfrey, 1992; Maniadis, 2011; Zauner, 1999).

# Cox and James, 2012 (Econometrica)

- Switch format between Dutch auction (DA) and Centipede game (CG).
- Auction format $\rightarrow$ early “takes”: SPE in CG, over-pricing in DA. Tree format $\rightarrow$ late “takes”: PBE in DA; no SPE in CG.
- Interpretation: limited availability of information in the auction format induces myopia (no use of information regarding future terminal histories)

# Cox and James, 2012 (Econometrica)

- Switch format between Dutch auction (DA) and Centipede game (CG).
- Auction format $\rightarrow$ early "takes": SPE in CG, over-pricing in DA. Tree format $\rightarrow$ late "takes": PBE in DA; no SPE in CG.
- Interpretation: limited availability of information in the auction format induces myopia (no use of information regarding future terminal histories)
- Peculiar CG: initial private value + value increase/price decrease common to everybody; zero-payoff for the sucker.

# The CG as a repeated trust game

- Preferences can be affected by the institutional format.
- For example: high cooperation in the *decomposed prisoner's dilemma* (e.g. Pruitt 1967).
- We highlight the "Give/Take" nature of the CG, obtaining a repeated trust game.

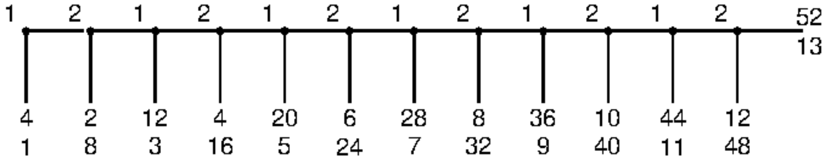
# General plan

- We perform two manipulations on a baseline CG (*Tree*) that reduce the availability of information regarding the payoffs:
    i. preference-neutral: subjects need to compute payoffs (*Formula*);
    ii. preference-eliciting: subjects need to compute payoffs + trust-game representation (*Decomposed*)

# General plan

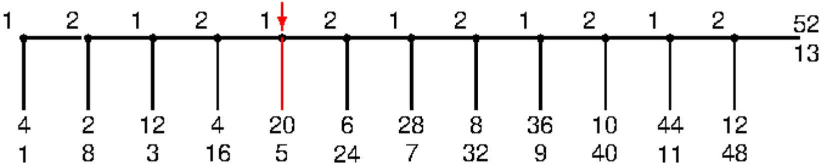
- We perform two manipulations on a baseline CG (*Tree*) that reduce the availability of information regarding the payoffs:
    i. preference-neutral: subjects need to compute payoffs (*Formula*);
    ii. preference-eliciting: subjects need to compute payoffs + trust-game representation (*Decomposed*)
- Do we observe myopia or hampered backward induction?
- Does eliciting other-regarding preferences have an additive effect?

# The Game



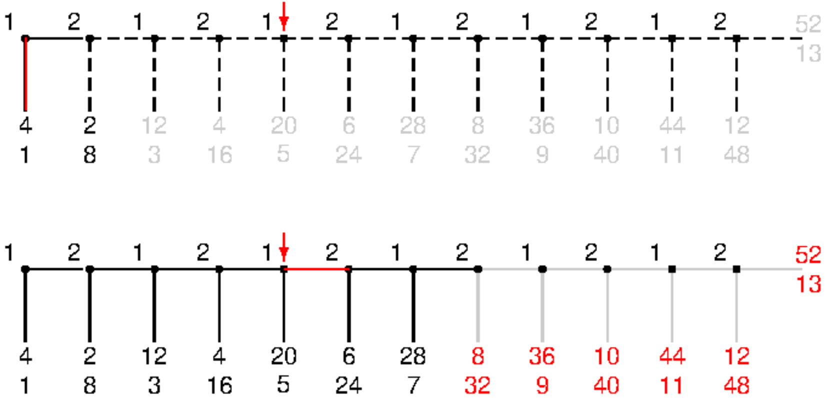

- Twelve-legs centipede.
- Arithmetic progressions, same range of MKP92.
- Availability of the information regarding the payoffs is manipulated

# The Game

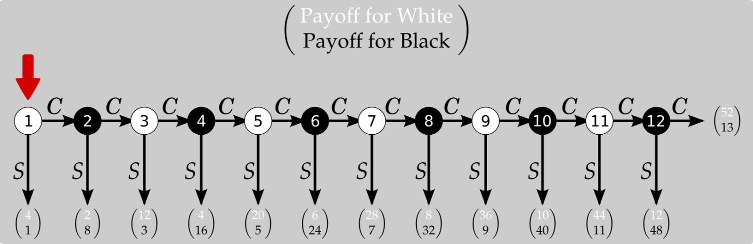



- Twelve-legs centipede.
- Arithmetic progressions, same range of MKP92.
- Availability of the information regarding the payoffs is manipulated.

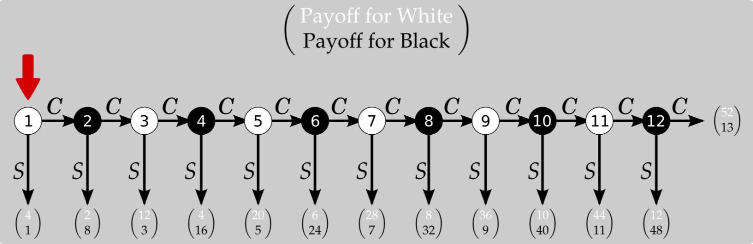
# Effects of enhanced complexity



# Base game: condition *Tree*



# Base game: condition *Tree*




*"The game starts from the utmost left. The color of the circles identifies which player has to decide; the numbers in the circle represent the decision round; the numbers in the brackets represent the final payment, in ECU, obtained by each action."*

# Preference-neutral: condition *Formula*

- Information only about the progression of the payoffs throughout the game + final payoffs if ending the game now.
- Players have to compute the final payoffs for future decision nodes(if they so wish).
- At node $r$, the payoffs are $(4r, r)$

# Preference-neutral: condition *Formula*

- Information only about the progression of the payoffs throughout the game + final payoffs if ending the game now.
- Players have to compute the final payoffs for future decision nodes(if they so wish).
- At node *r*, the payoffs are $(4r, r)$

"*When a player chooses STOP at round = r, the value for him is 4 times the current round, that is:*

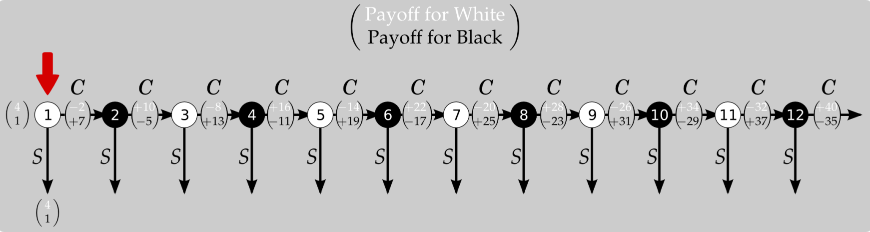
$$V_{STOP} = 4 \cdot r$$

*The value for the other player is 1 times the current round, that is*

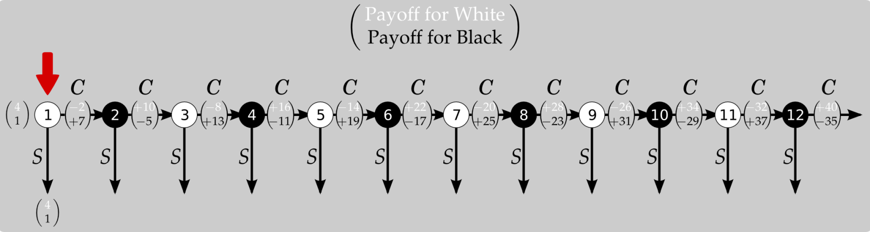
$$V_{OTHER} = 1 \cdot r$$

"

# Preference-eliciting: condition *Decomposed*



# Preference-eliciting: condition *Decomposed*




"*The game starts from the utmost left. The color of the circles identifies which player has to decide; the numbers in the circle represent the decision round; the numbers in the brackets represent the change in payments, in ECU, on top of what you have already earned, resulting from each action. The amount you have earned so far will always be visible on your screen.*"

# Hypothesis

**Hypothesis 1.1.** In conditions *Formula* and *Decomposed*, the subjects choose “Stop” earlier than in the *Tree* condition, due to myopia.

**Hypothesis 1.2.** In conditions *Formula* and *Decomposed*, the subjects choose “Stop” later than in the *Tree* condition, due to hampered backward induction.

# Hypothesis

**Hypothesis 1.1.** In conditions *Formula* and *Decomposed*, the subjects choose "Stop" earlier than in the *Tree* condition, due to myopia.

**Hypothesis 1.2.** In conditions *Formula* and *Decomposed*, the subjects choose "Stop" later than in the *Tree* condition, due to hampered backward induction.

**Hypothesis 2.** In condition *Decomposed*, the subjects choose "Stop" later than in the *Formula* condition, due to enhanced reciprocity.

# Design and procedures

- *Between* protocol: different subjects in different treatments.

# Design and procedures

- *Between* protocol: different subjects in different treatments.
- 12 repetitions, perfect stranger matching.

# Design and procedures

- *Between* protocol: different subjects in different treatments.
- 12 repetitions, perfect stranger matching.
- Fixed roles

# Design and procedures

- *Between* protocol: different subjects in different treatments.
- 12 repetitions, perfect stranger matching.
- Fixed roles

- The experiment was run in Jena, in Jun 2012.
- 210 subjects, 12 € on average.
- Identical procedure: instructions - control questions - experiment - questionnaire.

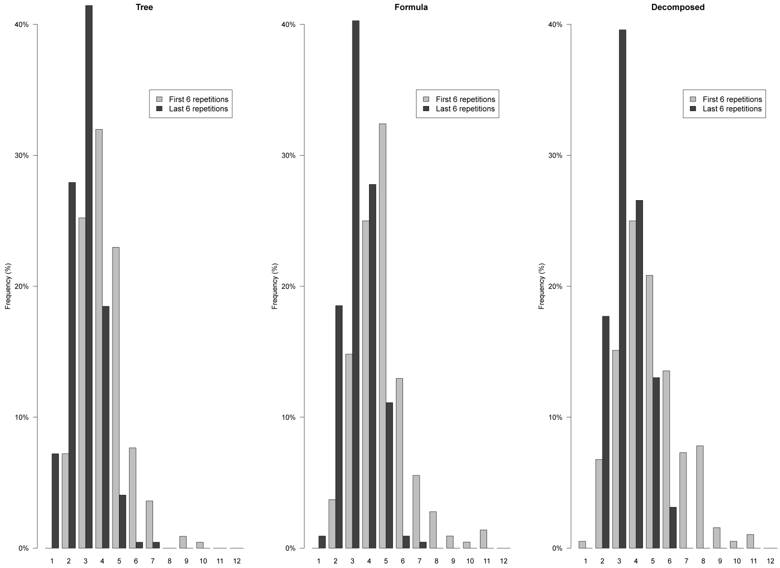



Figure: Endnode in the first and second half, by treatment

# Aggregate dynamics

**Result 1.1**

In all treatments, the distribution of endnodes shifts to the left and becomes less dispersed through repetitions.

# Aggregate dynamics

## Result 1.1

In all treatments, the distribution of endnodes shifts to the left and becomes less dispersed through repetitions.

## Result 1.2

Wrt the literature, we observe relatively “early” endnodes, likely due to the progression (and monetary relevance) of the payofffs.

# Treatment effects/1

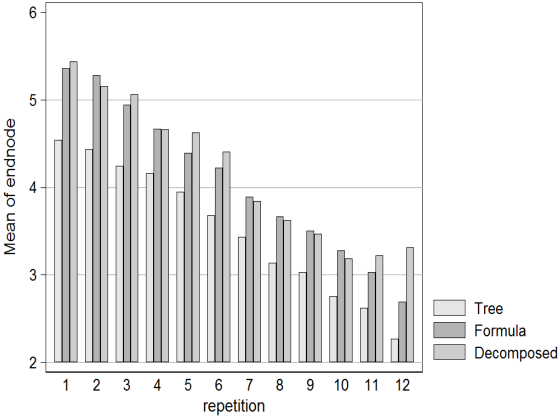



Figure: Mean endnode by treatment and repetition

# Treatment effects/2

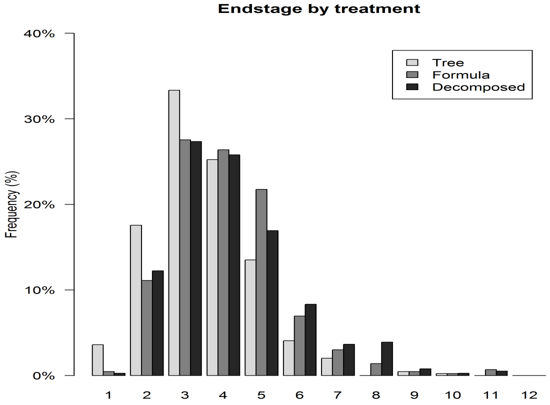



Figure: Aggregate distributions comparisons

# Treatment effects/3

**Result 2.1**

The mean endnode is significantly higher both in *Formula* and in *Decomposed* wrt *Tree*.

**Result 2.2**

The distribution of endnodes is significantly different both in *Formula* and in *Decomposed* wrt *Tree*.

**Result 2.3**

The are no significant differences between *Formula* and *Decomposed*.

# Complexity measures

| | N | Complexity (0-10) | Errors (num) | Time (sec) |
|---|---|---|---|---|
| **Tree** | 74 | 2.32 | 0.51 | 104 |
| **Formula** | 72 | 2.44 | 0.55 | $148^{*}$ |
| **Decomposed** | 64 | $2.89^{*,**}$ | $0.95^{*,**}$ | $257^{*,**}$ |

significant with respect to: $^{*}$ row above; $^{**}$ two rows above

Table: Self-reported and objective measures of complexity

# Summing up

**Treatments** We reduce the availability of information using a preference-neutral and a preference-eliciting manipulation.

# Summing up

**Treatments** We reduce the availability of information using a preference-neutral and a preference-eliciting manipulation.

**Main Effect** The subjects respond to both manipulation, resulting in later takes. No evidence of response to preference elicitation.

# Summing up

**Treatments** We reduce the availability of information using a preference-neutral and a preference-eliciting manipulation.

**Main Effect** The subjects respond to both manipulation, resulting in later takes. No evidence of response to preference elicitation.

## Preferences vs cognition

Support for cognitive-based explanations of behaviors in the CG, doubts on preference-based ones.

# Summing up

**Treatments** We reduce the availability of information using a preference-neutral and a preference-eliciting manipulation.

**Main Effect** The subjects respond to both manipulation, resulting in later takes. No evidence of response to preference elicitation.

## Preferences vs cognition

Support for cognitive-based explanations of behaviors in the CG, doubts on preference-based ones.

## Interpretation

Stark contrast with Cox and James (2012): reduced availability of information may have non-monotonic effects, inducing (more) limited strategic reasoning or myopic behavior, depending on the baseline complexity.

# THANK YOU!