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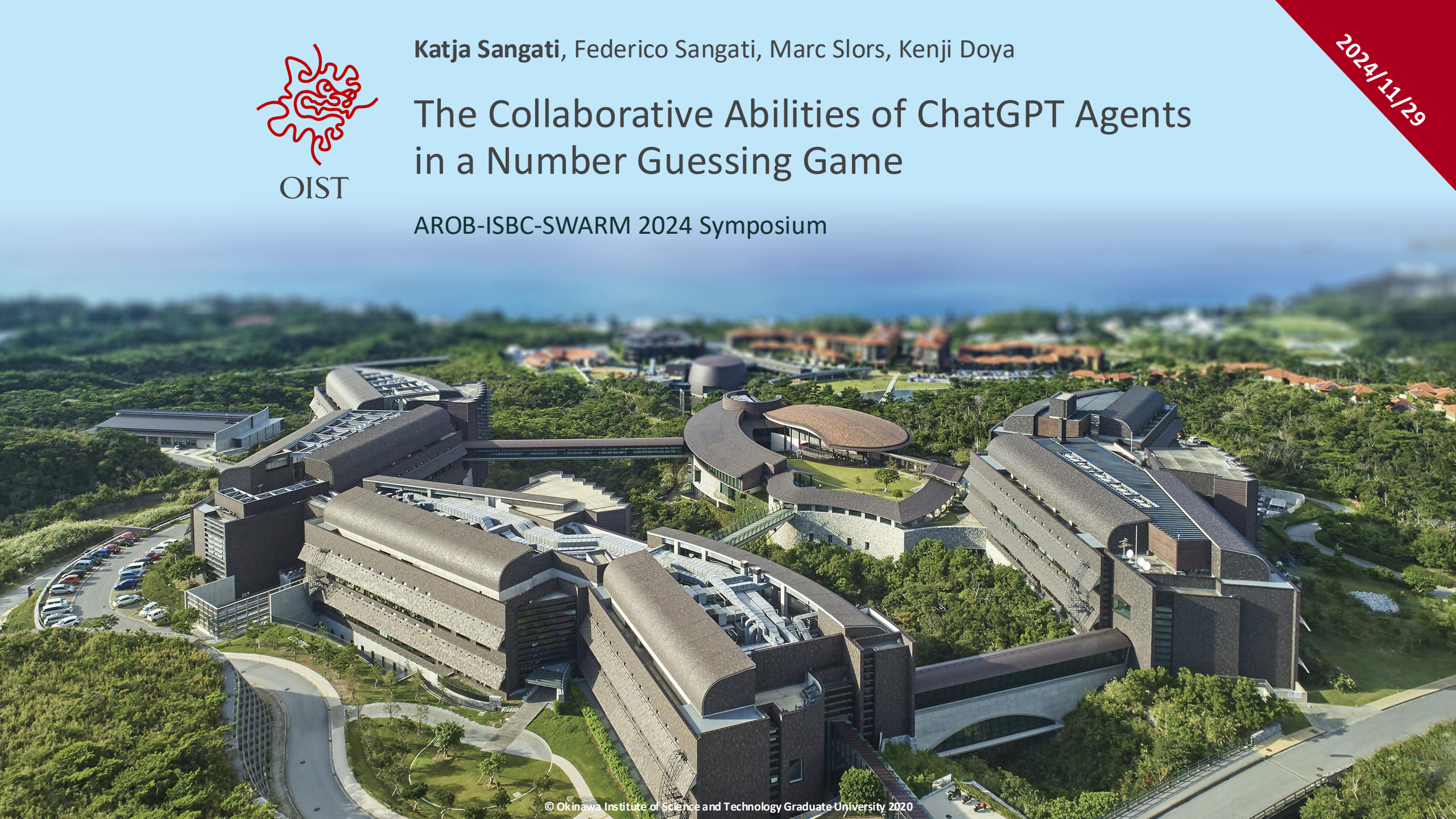
The Collaborative Abilities of ChatGPT Agents in a Number Guessing Game

AROB-ISBC-SWARM 2024 Symposium

2024/11/29



LLM

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LLMs like ChatGPT are claimed to have emergent linguistic and cognitive abilities.

Evaluation:

- benchmarking: NLP tasks
- **machine psychology**: psychological tests
- **situated**: games

Group psychology game task + Multi-agent

Emergent collaborative abilities of ChatGPT agents

Regular number guessing

Player submits a number between 20 and 40.

23

Too low.

Guess the number between 20 and 40.

37

Collaborative number guessing

Guess the number between 20 and 40.

37

Each player submits a number between 0 and 20.

10 11 5

26

The responses are summed:
10 + 11 + 5 = 26

Too low.

Methods

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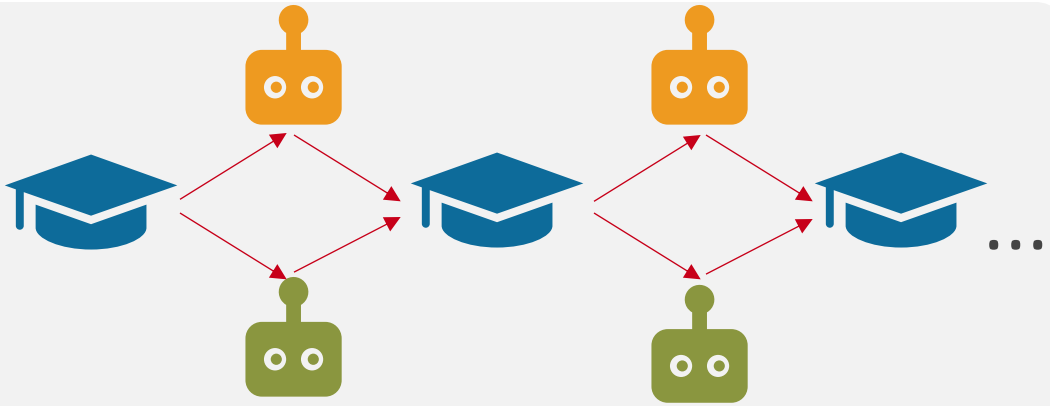
Task

- target between 20 and 40; guess between 0 and 20
- 6 rounds, max 20 attempts
- feedback: too high/low; each player's guess

Players

- GPT 3.5 and GPT 4
- 10 teams each model, 3 players each team

ChatGPT API



+ prompt engineering and error handling

Results

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Behavioral performance

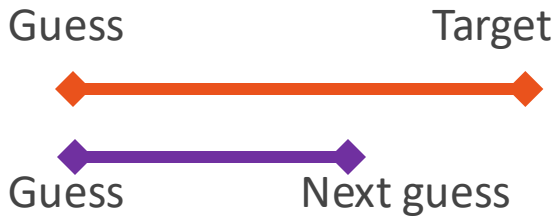
Collaborative strategies

Social reasoning

Human players results

Roberts & Goldsone, 2011

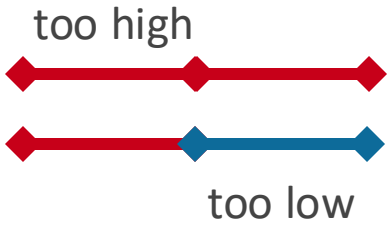
1. Faster solutions when playing repeatedly



2. Groups under-react with respect to actual disparity.

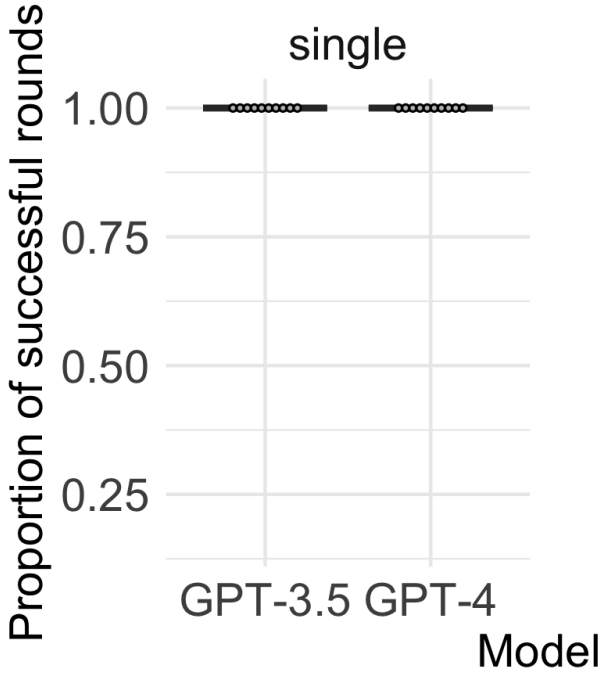
3. Group reactions decrease approaching the solution

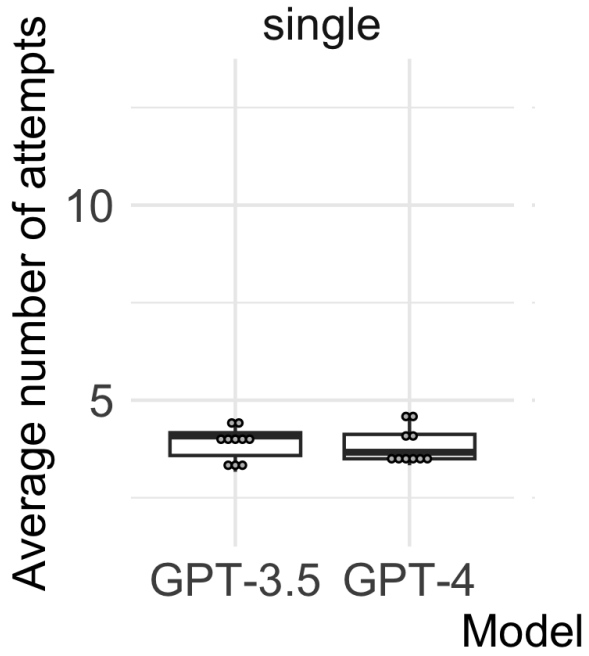
4. Group reactions decrease when feedback direction changes



5. Individual player reaction patterns show increasing within-player predictability and between-player diversity (division of labor)

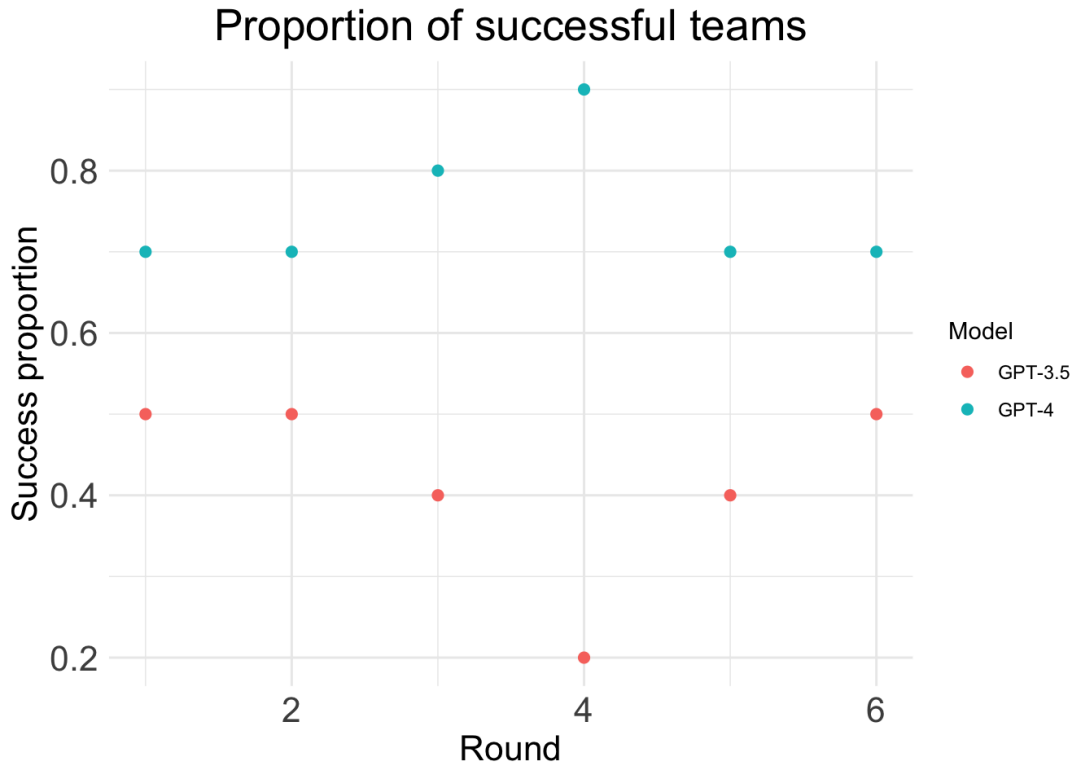
Behavioral performance

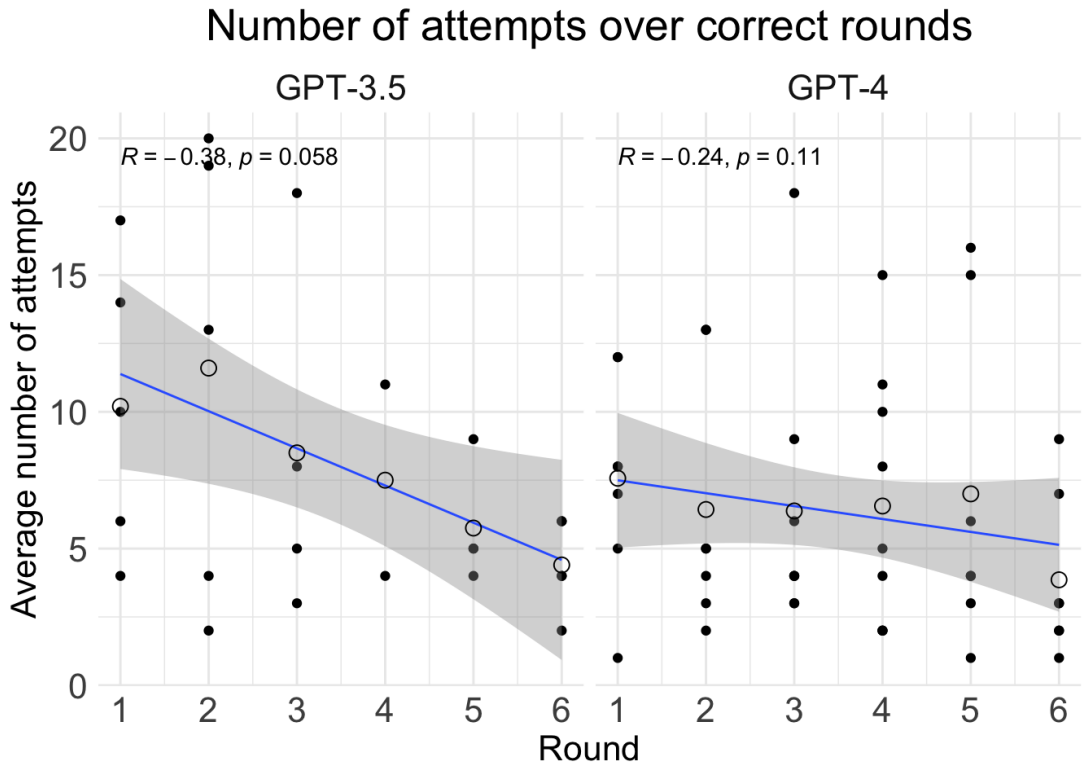




Performance over time

No strong evidence for learning over Rounds





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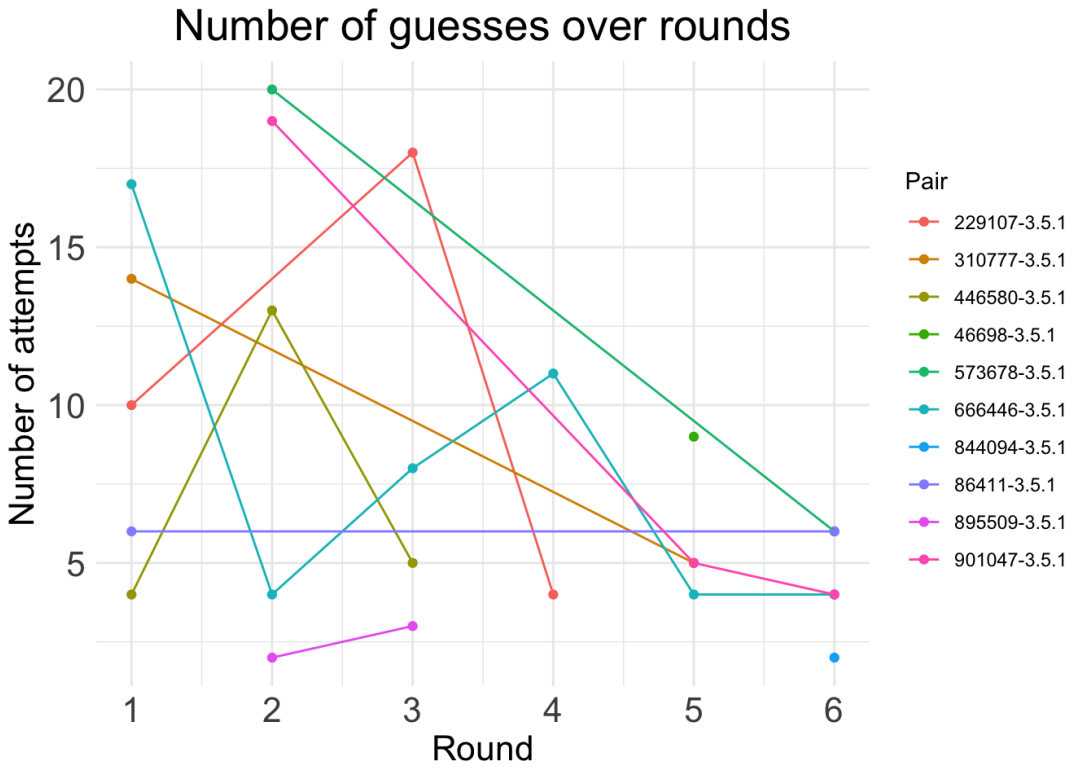
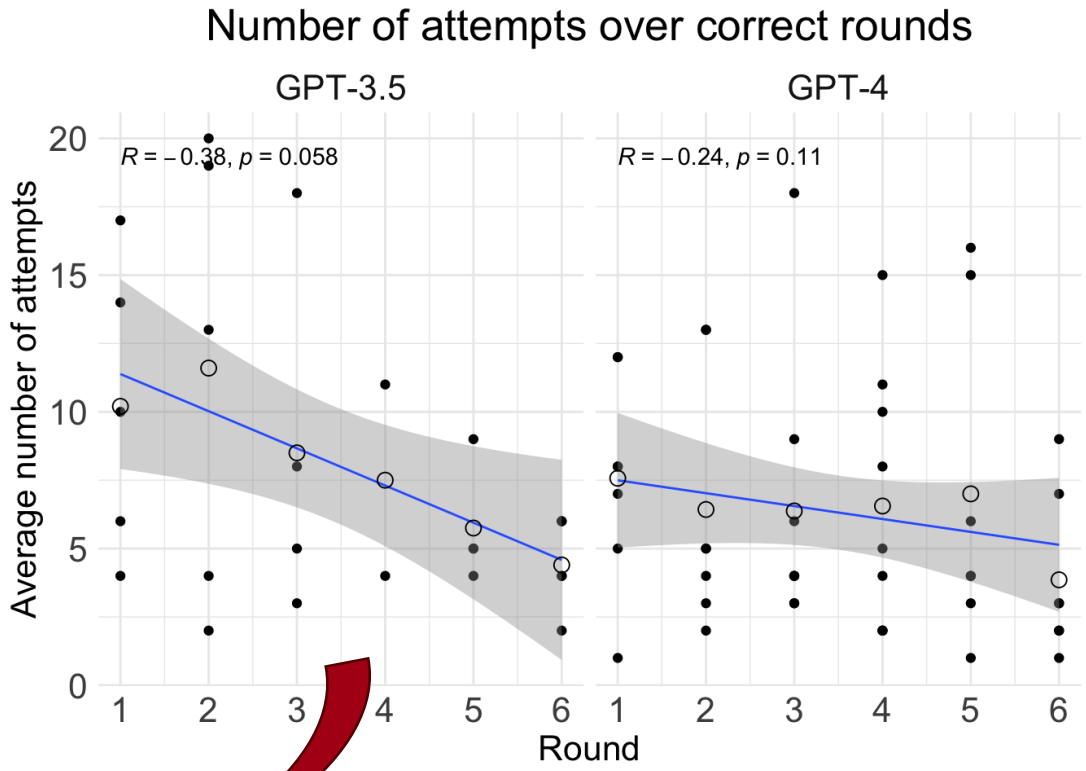
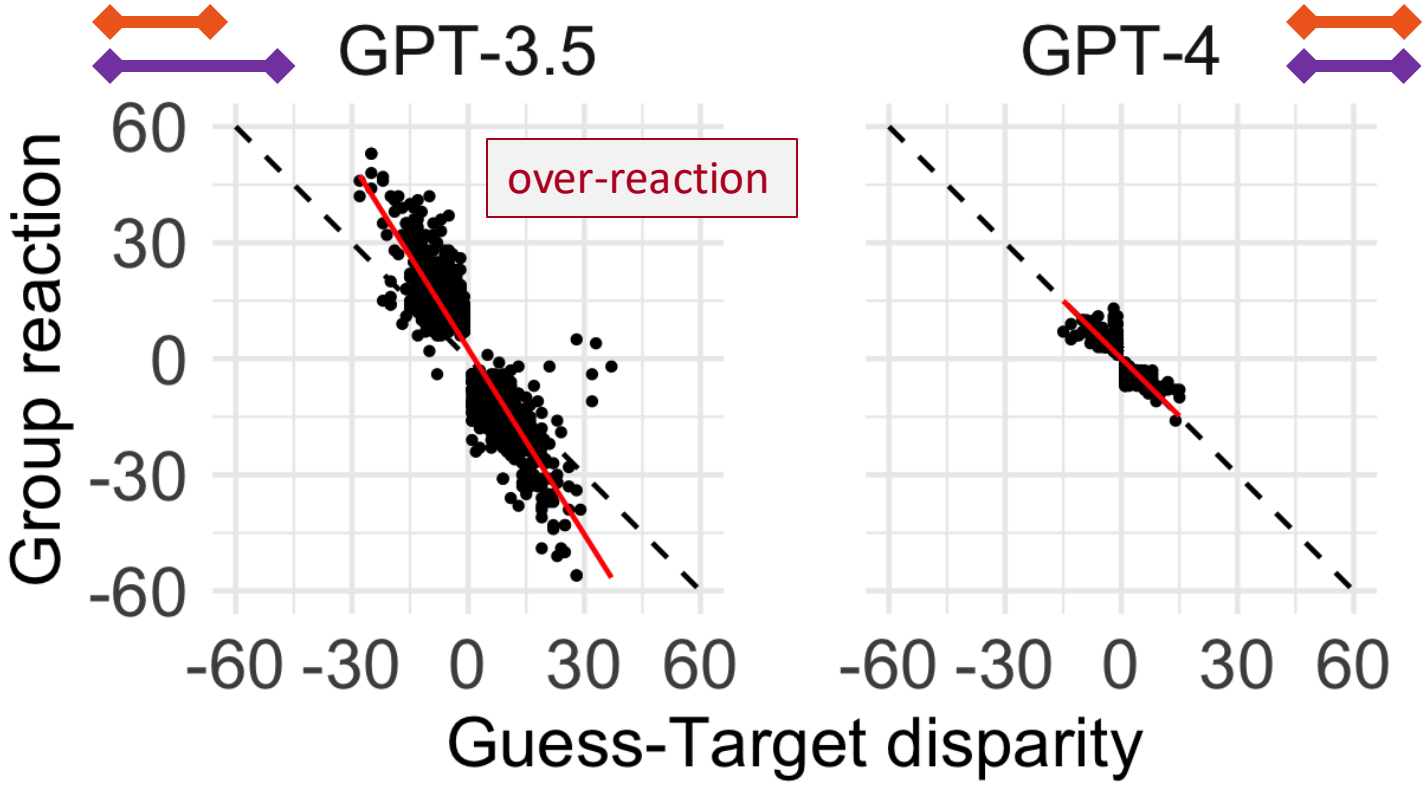




Reactivity strategies



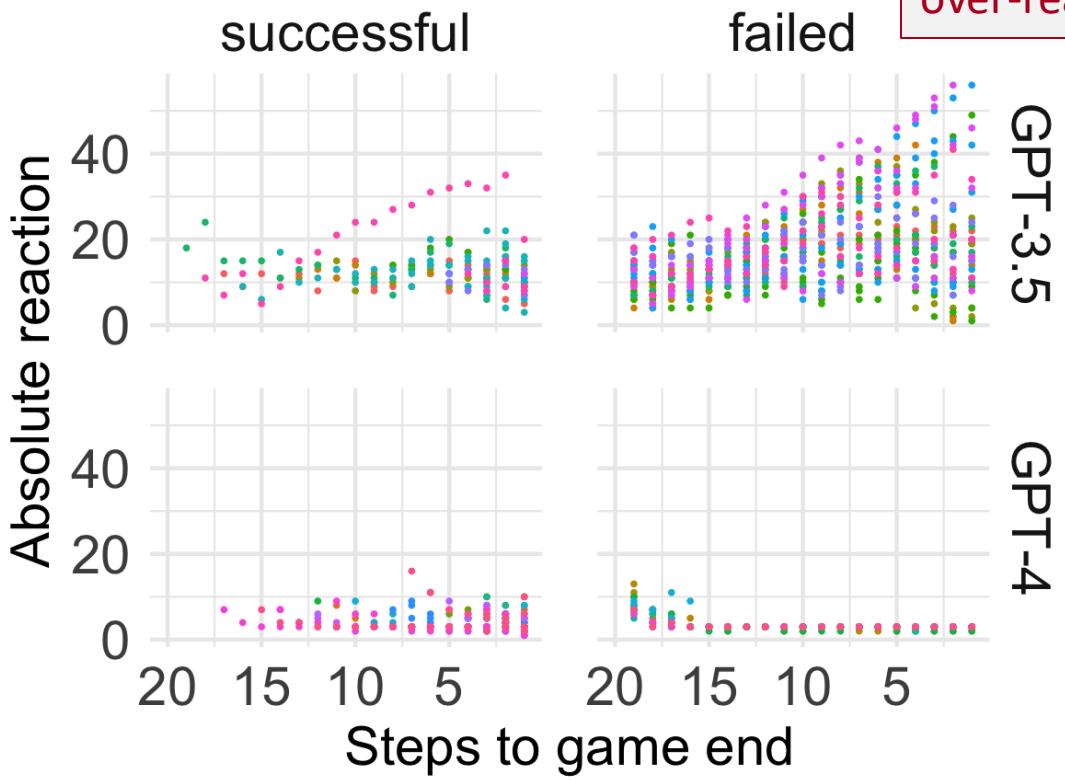
Group guess at next attempt – Group guess at current attempt

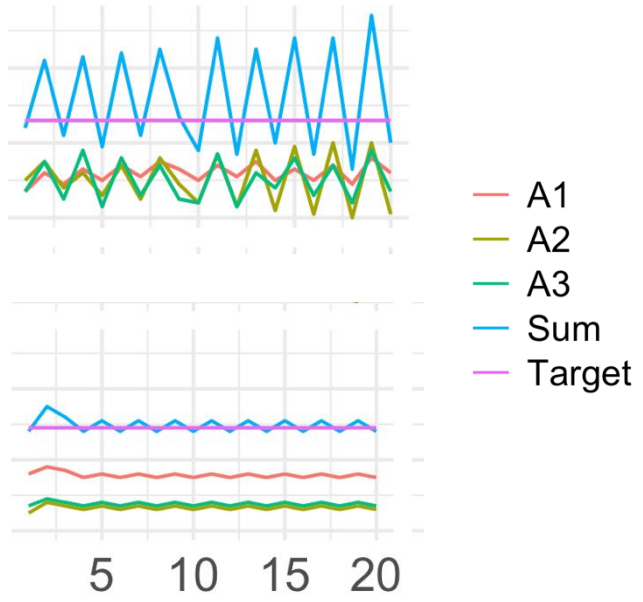
Group guess – Target at current attempt

Reactivity strategies

no trend

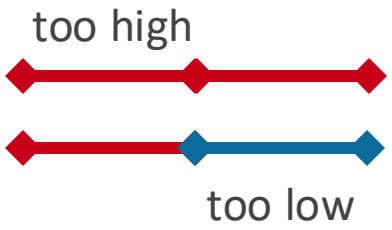
runaway over-reaction



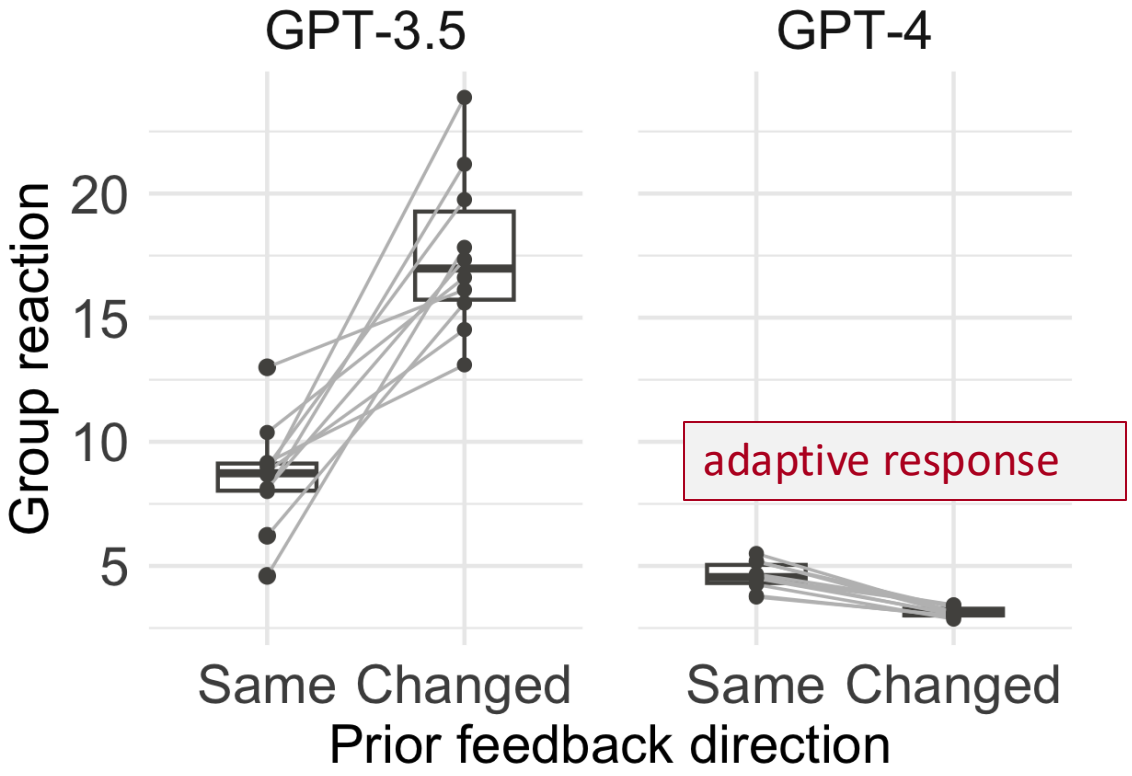


decreasing reaction

lack of variability;
smaller decrease over attempts



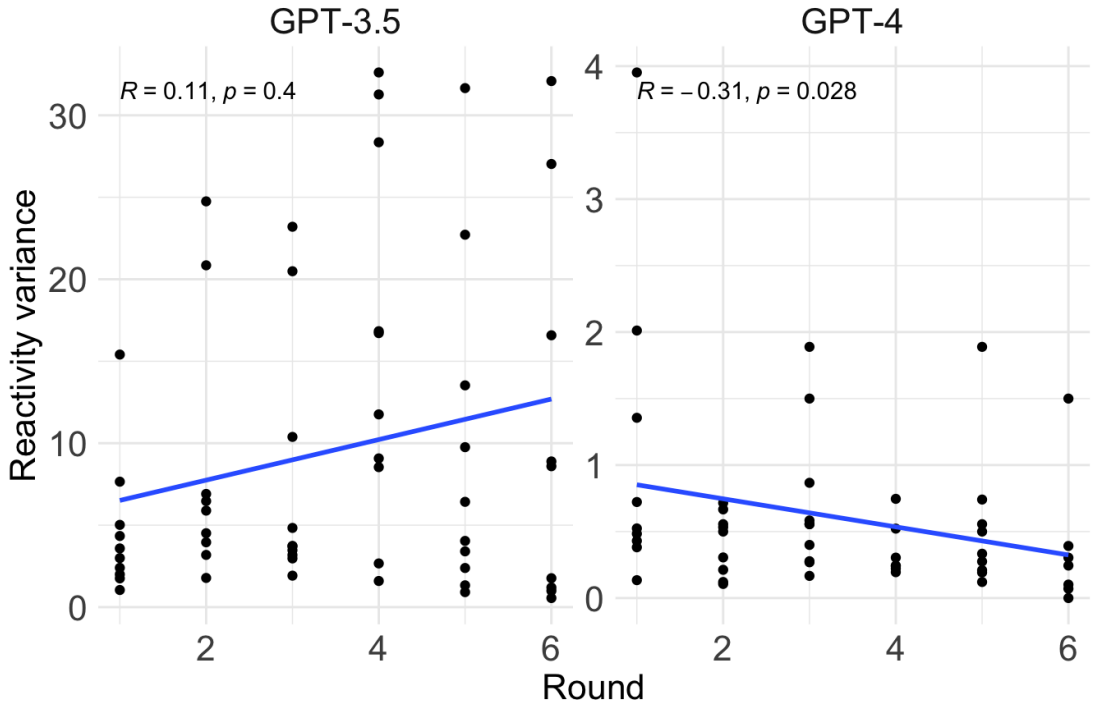
Reactivity strategies



Individual reactivities

$$1/n \cdot \sum_{i=1}^{n} \sigma^2[Rc_{a_i}]$$

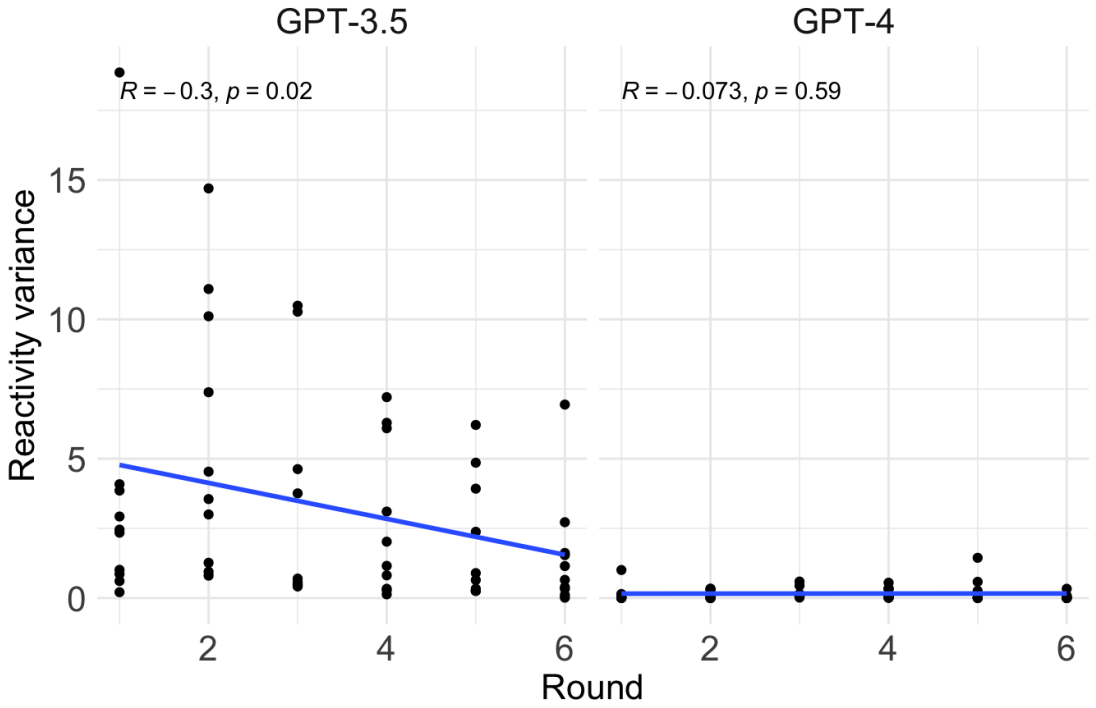
Average of within-agent variances for each group



individuals become more consistent

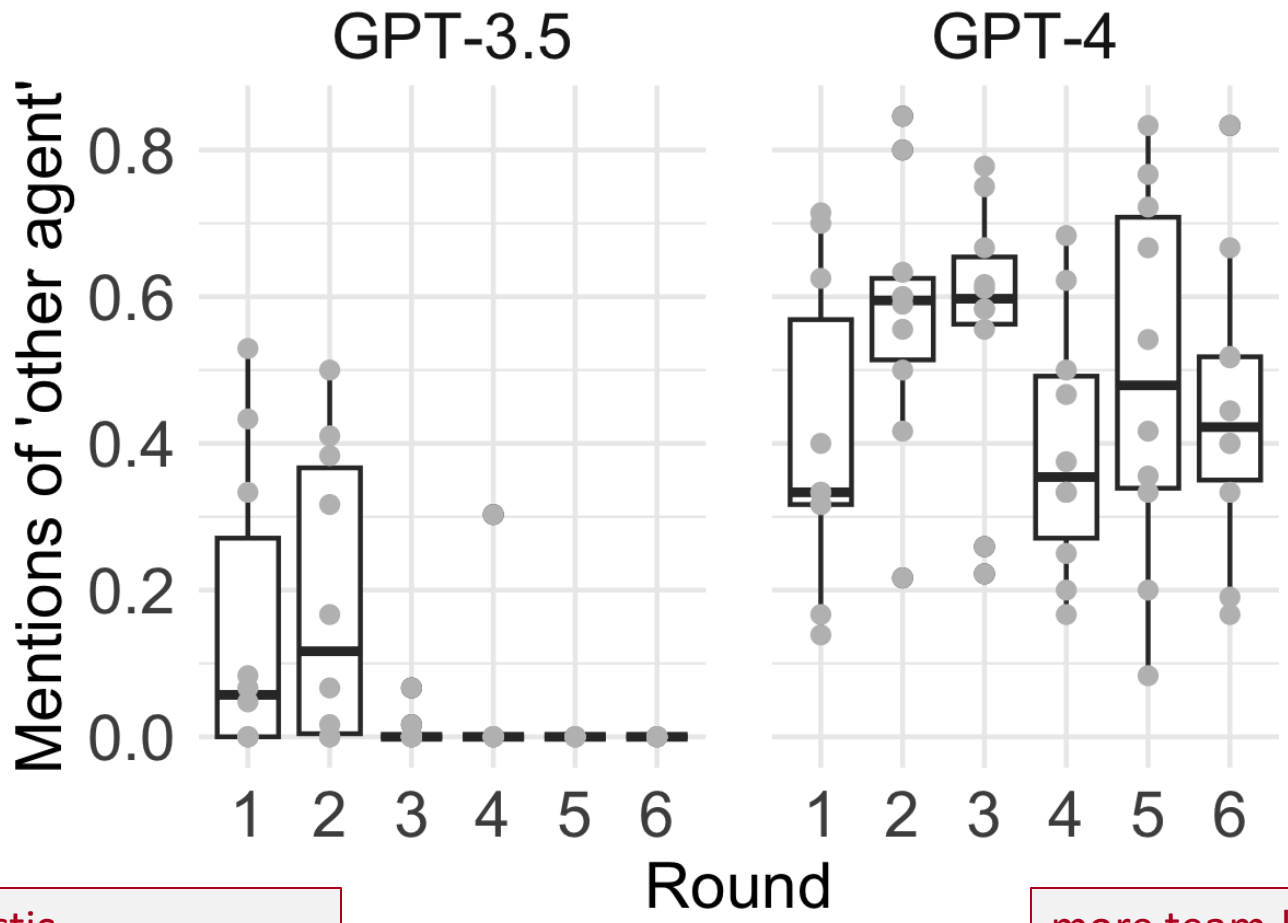
$$\sigma^2[\mu(Rc_{a_1}), \ldots, \mu(Rc_{a_n})]$$

Variance of agent reactivities per group over rounds



groups become or stay homogenous

Social reasoning



more individualistic
1st order social reasoning
short-term social mentions

more team-like
2nd order social reasoning
long-term social mentions

Conclusions and future work

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ChatGPT agents can collaborate out of the box.

GPT4 performs better than GPT 3.5.

However, ChatGPT agents

- don’t adopt human-like strategies
- don’t learn through interaction (by current design)
- have difficulty maintaining conversational coherence

Future studies

- more challenging settings (bigger group, less feedback, wider number ranges)

- more fine-tuning (better prompts, more in-game prompts, model parameters)

- mixed Agent-Human teams

Thank you!