LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

JULY 14, 2025

NETWORKED MINDS:
OPINION DYNAMICS AND COLLECTIVE INTELLIGENCE IN SOCIAL NETWORKS

SOCIAL INFLUENCE VS WISE CROWDS

Adrian Haret
a.haret@lmu.de

We've seen that groups can be wise.

FLASHBACK TO THE FIRST LECTURE

FRANCIS GALTON

About 800 tickets were issued, which were kindly lent me for examination after they had fulfilled their immediate purpose… [of which] there remained 787 for discussion.

Now the middlemost estimate is 1207 lb., and the weight of the dressed ox proved to be 1198 lb.

… so the *vox populi* was in this case 9 lb., or 0.8 per cent. of the whole weight too high.

By *middlemost* I mean what you might call today the median.

People have since pointed out that the mean was even more accurate: 1197 lbs.

This result is, I think, more creditable to the trustworthiness of a democratic judgment than might have been expected.

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We've seen that groups can be wise. We've also seen that social influence can derail opinions and interfere with wisdom.

FLASHBACK TO TWO WEEKS AGO

The network grows by adding agents that listen to the central agent 1.

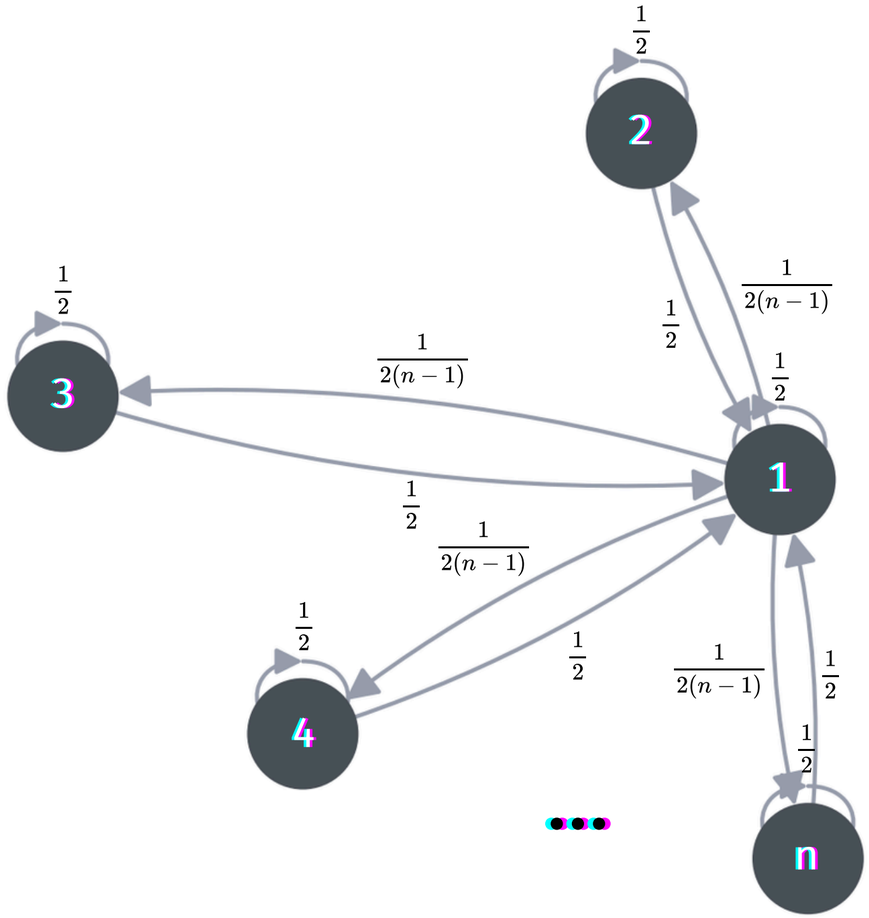
The eigenvector centralities are:

$$\boldsymbol{c} = \left(\frac{1}{2}, \frac{1}{2(n-1)}, \ldots, \frac{1}{2(n-1)}\right)$$

Agent 1 retains a constant share of (network) influence as n grows.

And thus decides the consensus belief.

No bueno.



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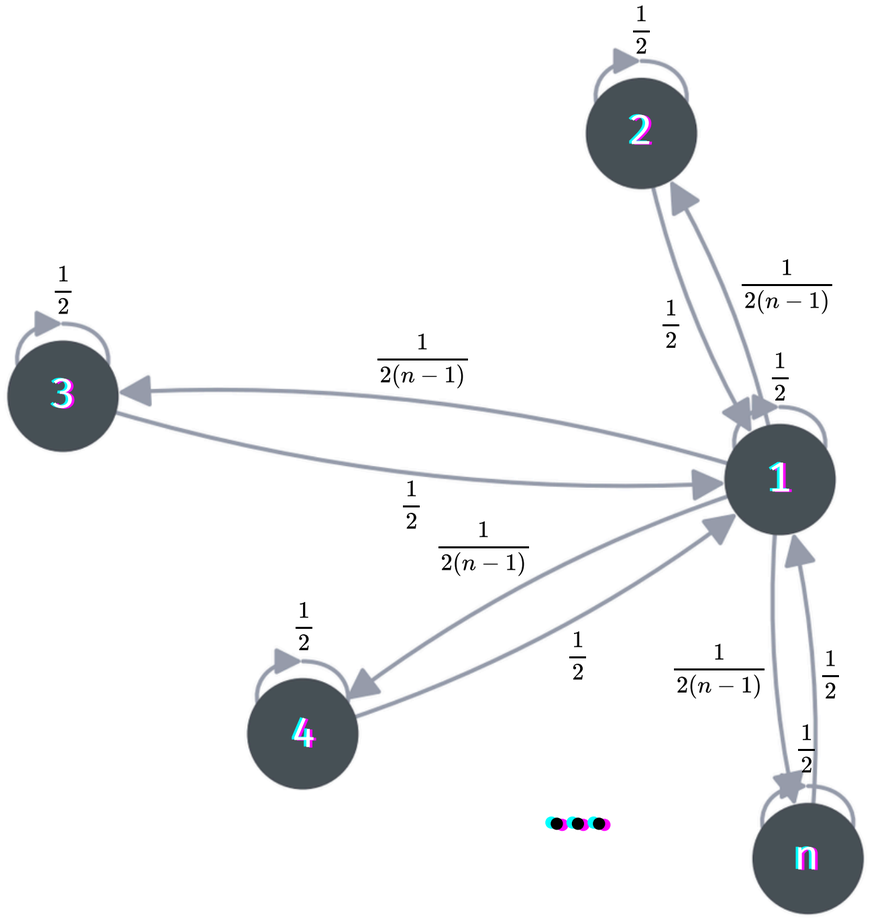


We've seen that groups can be wise. We've also seen that social influence can derail opinions and interfere with wisdom. In theory.

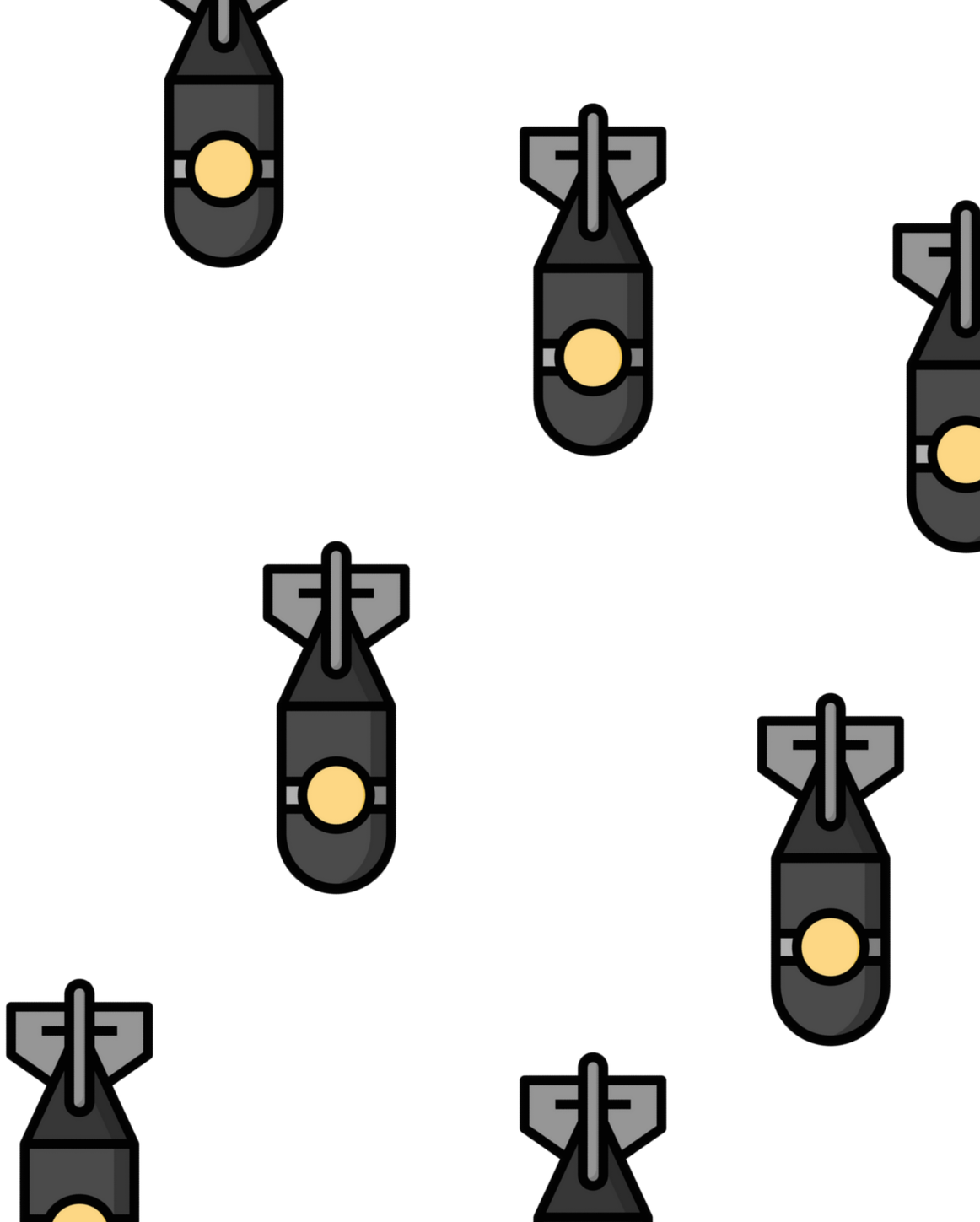
We've seen that groups can be wise. We've also seen that social influence can derail opinions and interfere with wisdom. In theory. But what about in real-world scenarios?…

Quiz time!

How many countries currently have nuclear weapons?*

☑?

*As of July, 2025.



How many countries currently have nuclear weapons?*

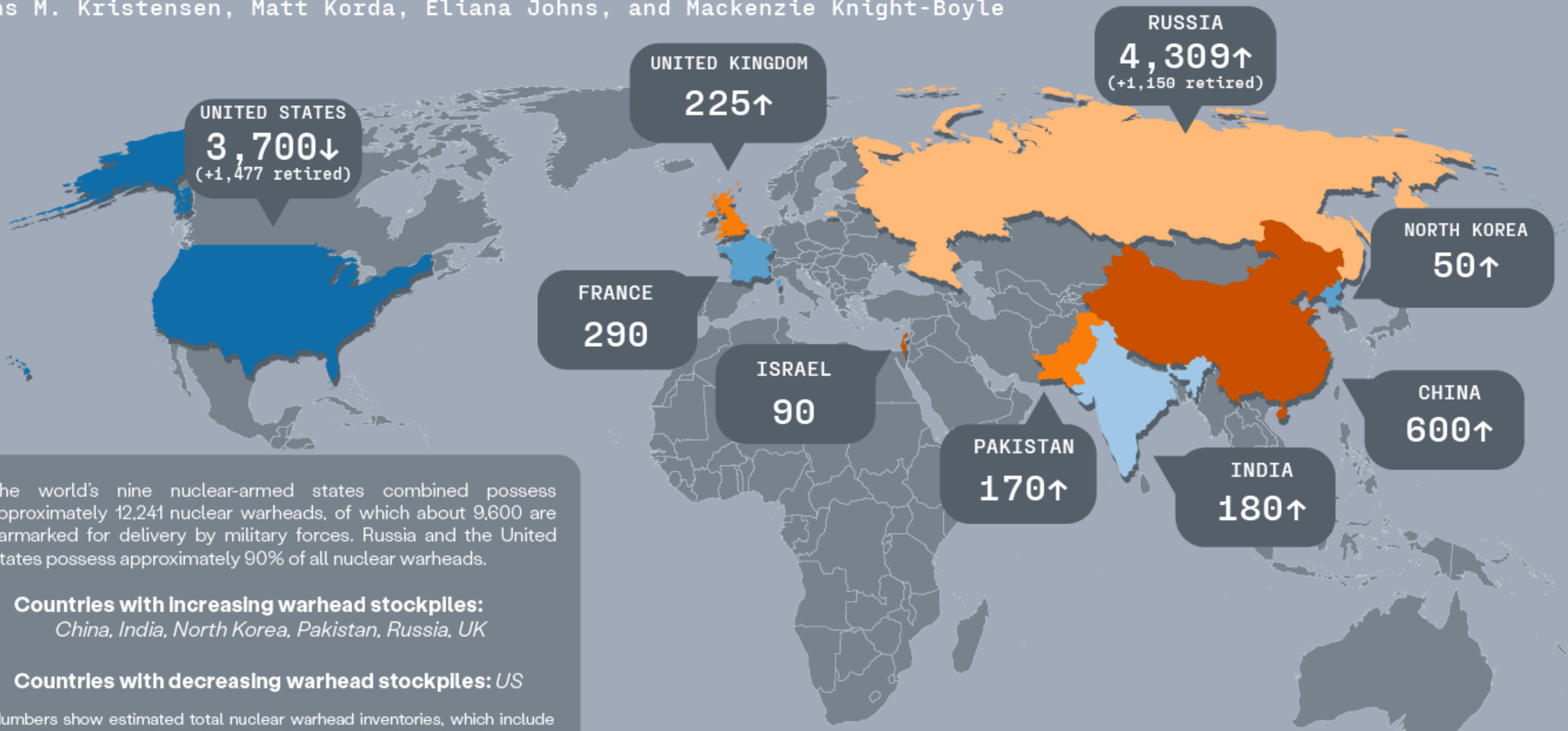
☑?

Say a number, discuss, revise.

*As of July, 2025.

Estimated Global Nuclear Warhead Inventories, 2025

Hans M. Kristensen, Matt Korda, Eliana Johns, and Mackenzie Knight-Boyle



The world's nine nuclear-armed states combined possess approximately 12,241 nuclear warheads, of which about 9,600 are earmarked for delivery by military forces. Russia and the United States possess approximately 90% of all nuclear warheads.

↑ **Countries with increasing warhead stockpiles:**
China, India, North Korea, Pakistan, Russia, UK

↓ **Countries with decreasing warhead stockpiles:** *US*

Numbers show estimated total nuclear warhead inventories, which include stockpiled warheads for use by military forces and warheads held in reserve. Of the 9,600 warheads in the military stockpiles, about 3,900 are deployed on ballistic missiles and bomber bases. Approximately 2,100 warheads on ballistic missiles are on alert and can be launched on short notice.

FAS FEDERATION OF AMERICAN SCIENTISTS

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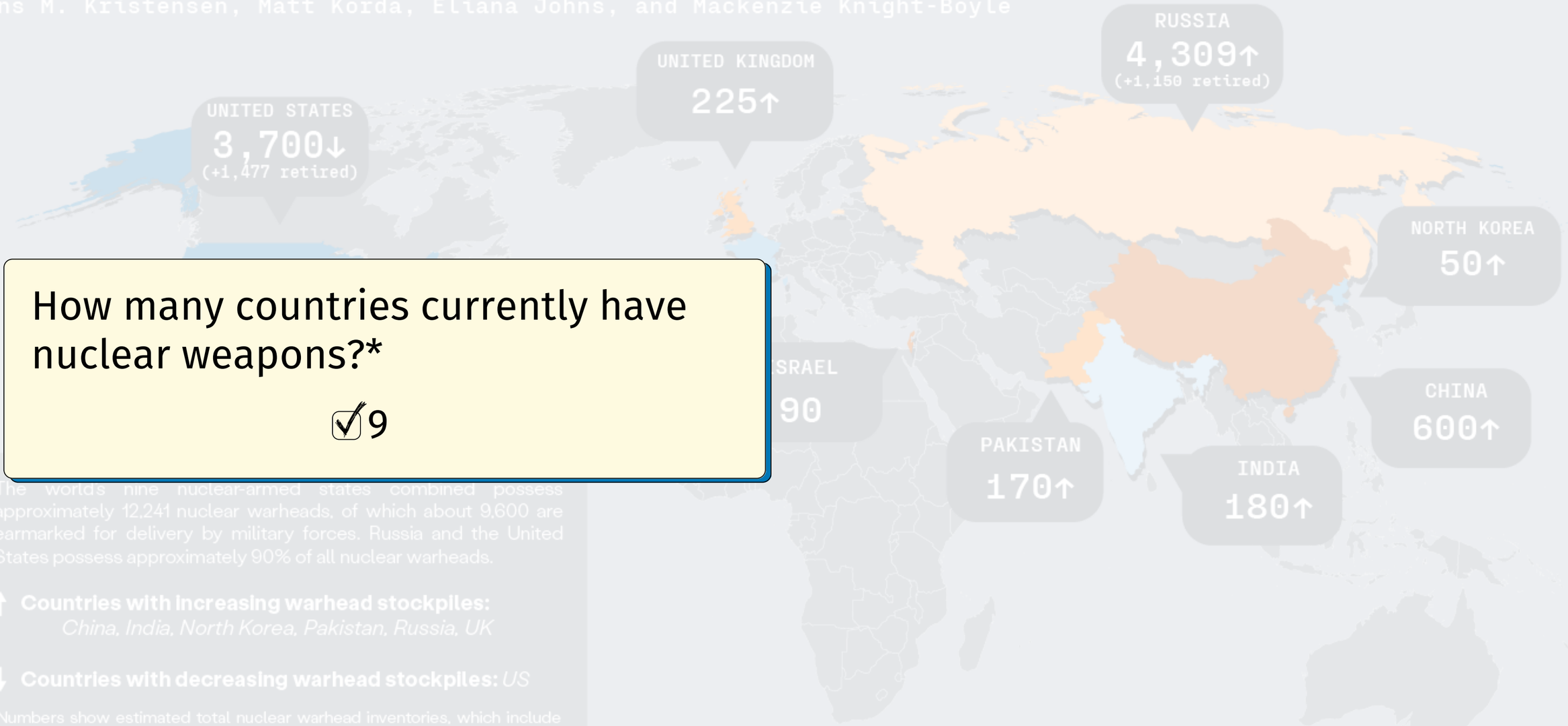

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Lorenz, J., Rauhut, H., Schweitzer, F., & Helbing, D. (2011). How social influence can undermine the wisdom of crowd effect. *PNAS*, 108(22), 9020–9025.

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DIRK HELBING

Our experiment addresses this!

Lorenz, J., Rauhut, H., Schweitzer, F., & Helbing, D. (2011). How social influence can undermine the wisdom of crowd effect. *PNAS*, 108(22), 9020–9025.

ESTIMATION TASKS (WITH A GROUND TRUTH!)

1 What is the population density (people/km^2) of Switzerland?

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4 How many murders were registered in Switzerland in 2006?

☑ 198

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4 How many murders were registered in Switzerland in 2006?

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5 How many rapes were registered in Switzerland in 2006?

☑ 639

6 How many assaults were registered in Switzerland in 2006?

☑ 9,272

PARTICIPANTS

144 students from ETH Zürich.

Divided into 12 groups of 12 each.

PROCEDURE

Each participant answers a given question five times over five rounds.

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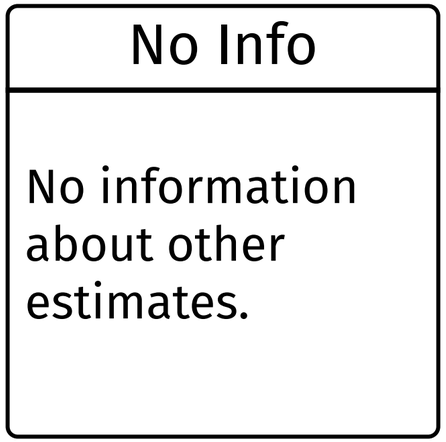
Three treatments, depending on how much information participants get.



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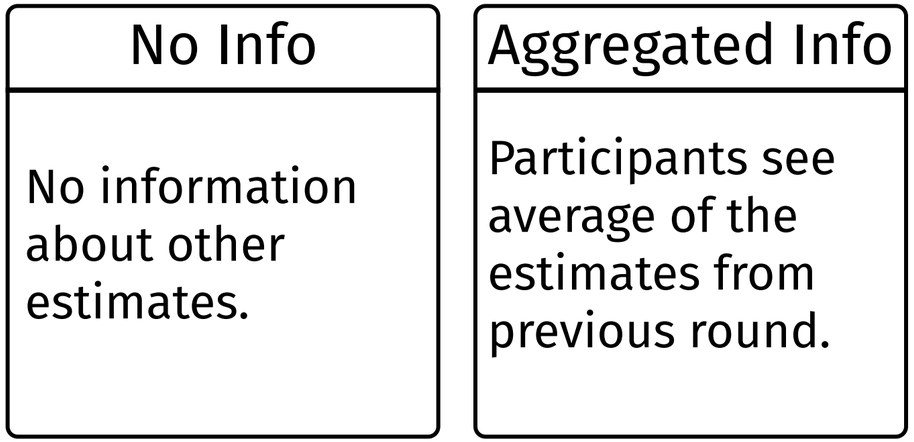

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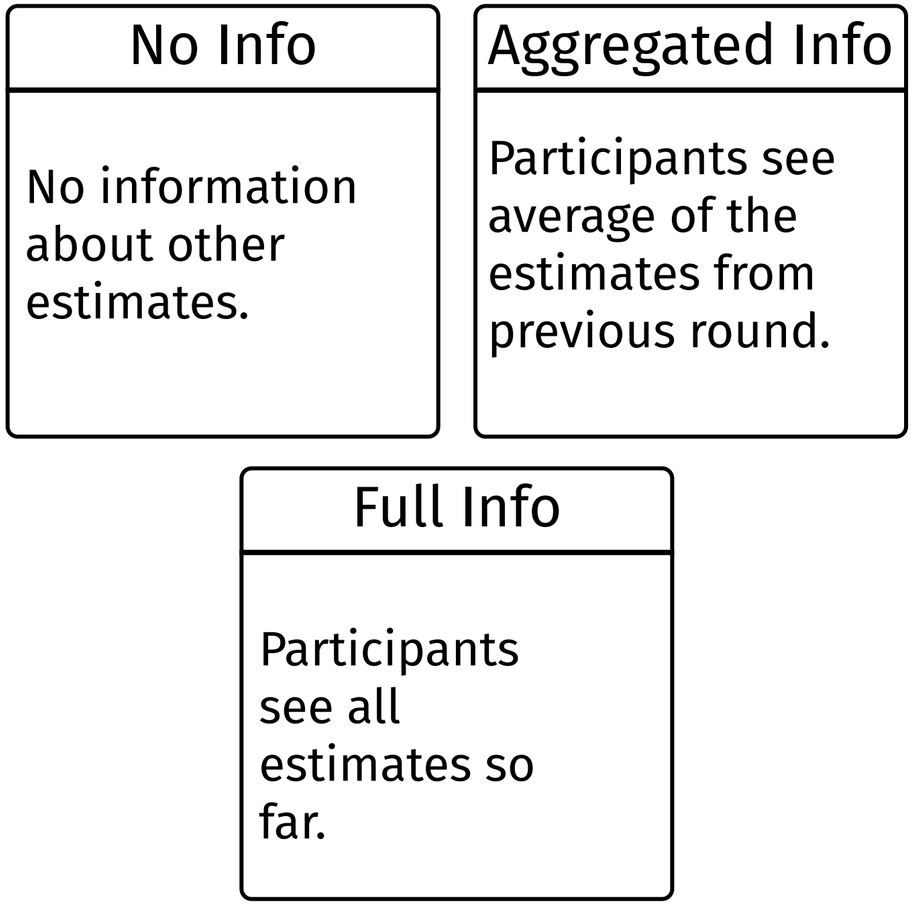

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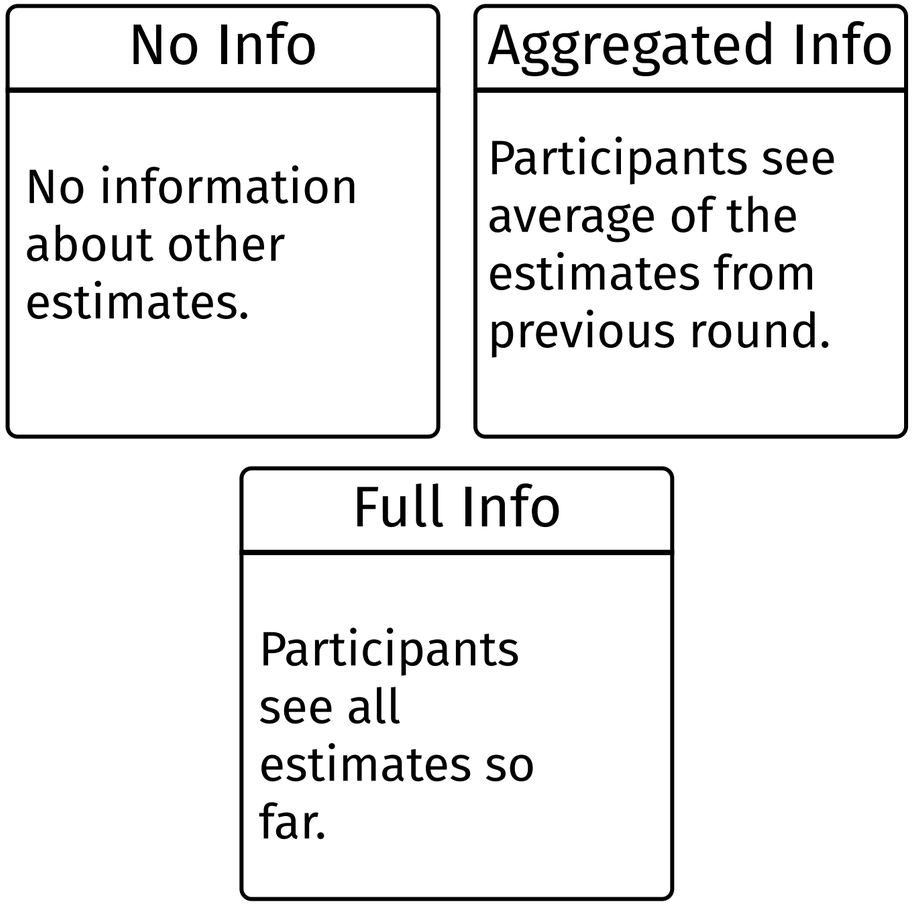
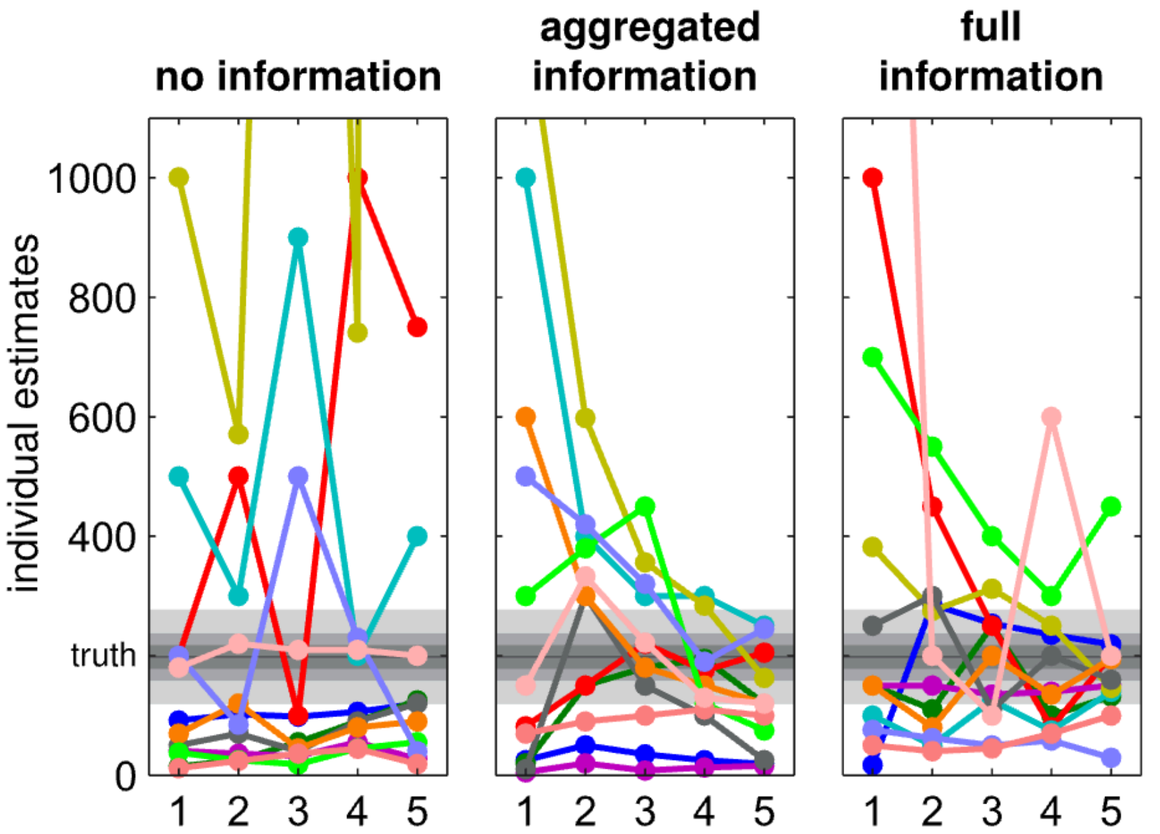
Participants get paid the better their answers are, to discourage BS answers.



So what happened?

SOCIAL INFLUENCE EFFECT

Social influence reduces diversity: opinions get closer to each other...



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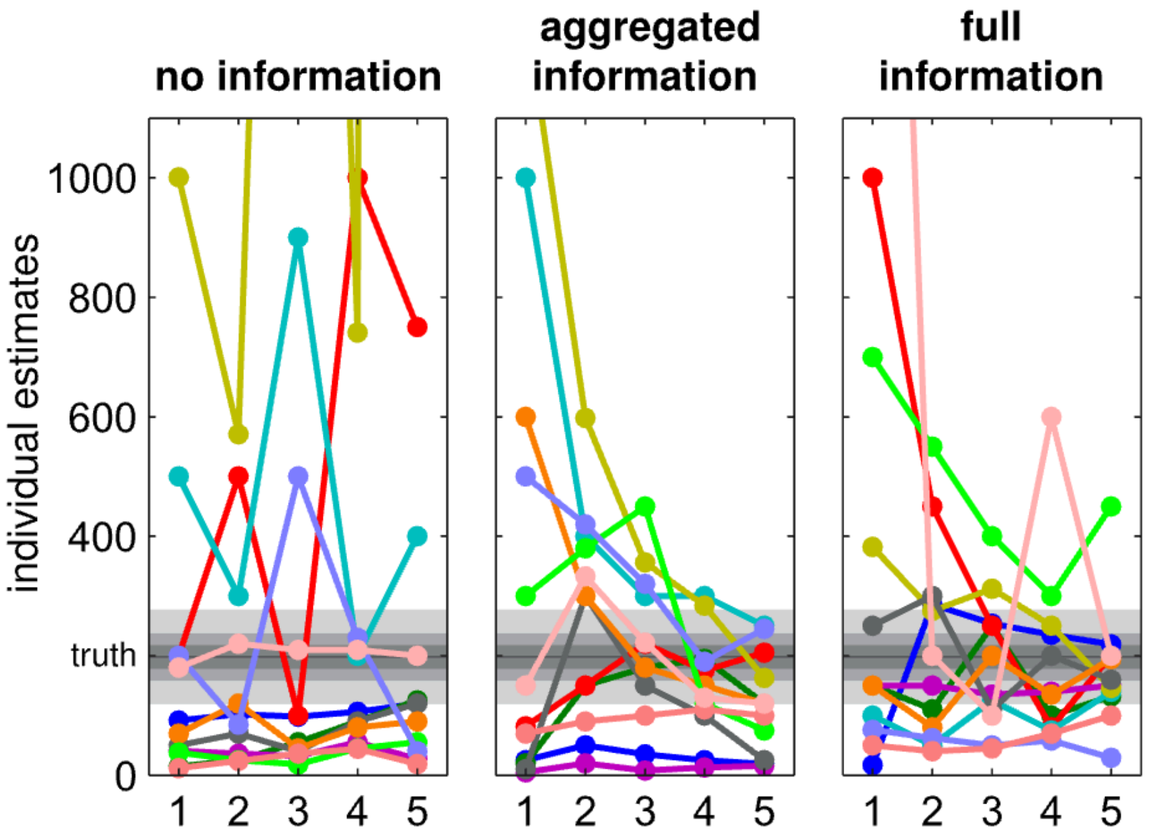

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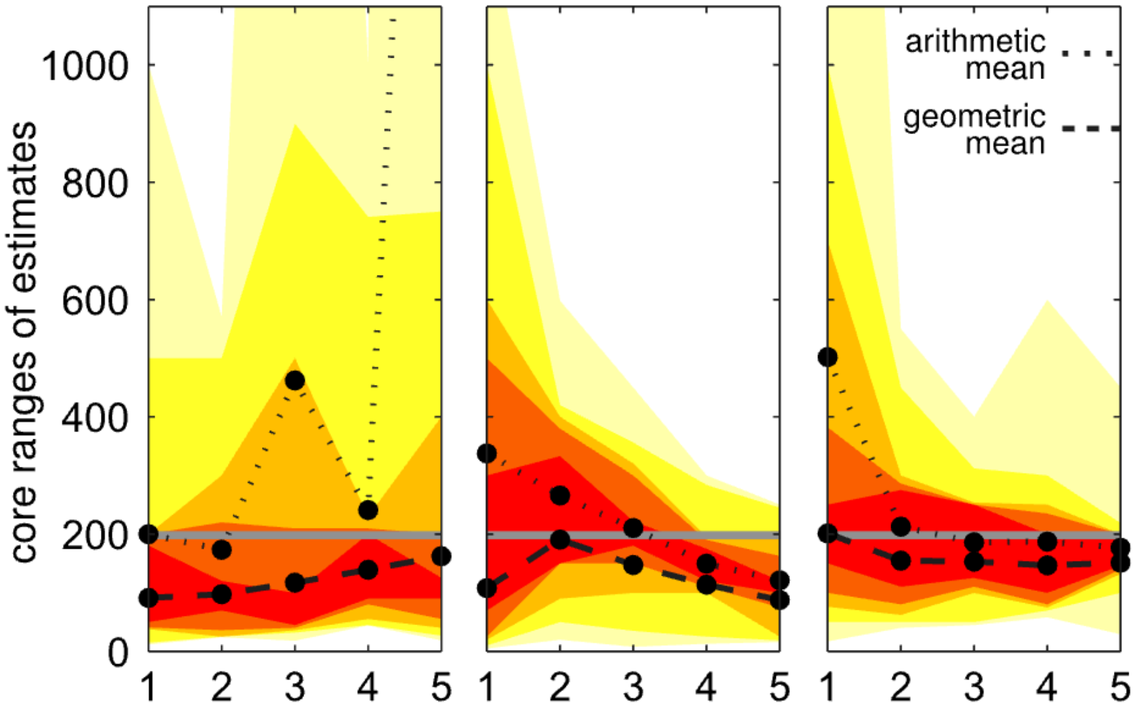

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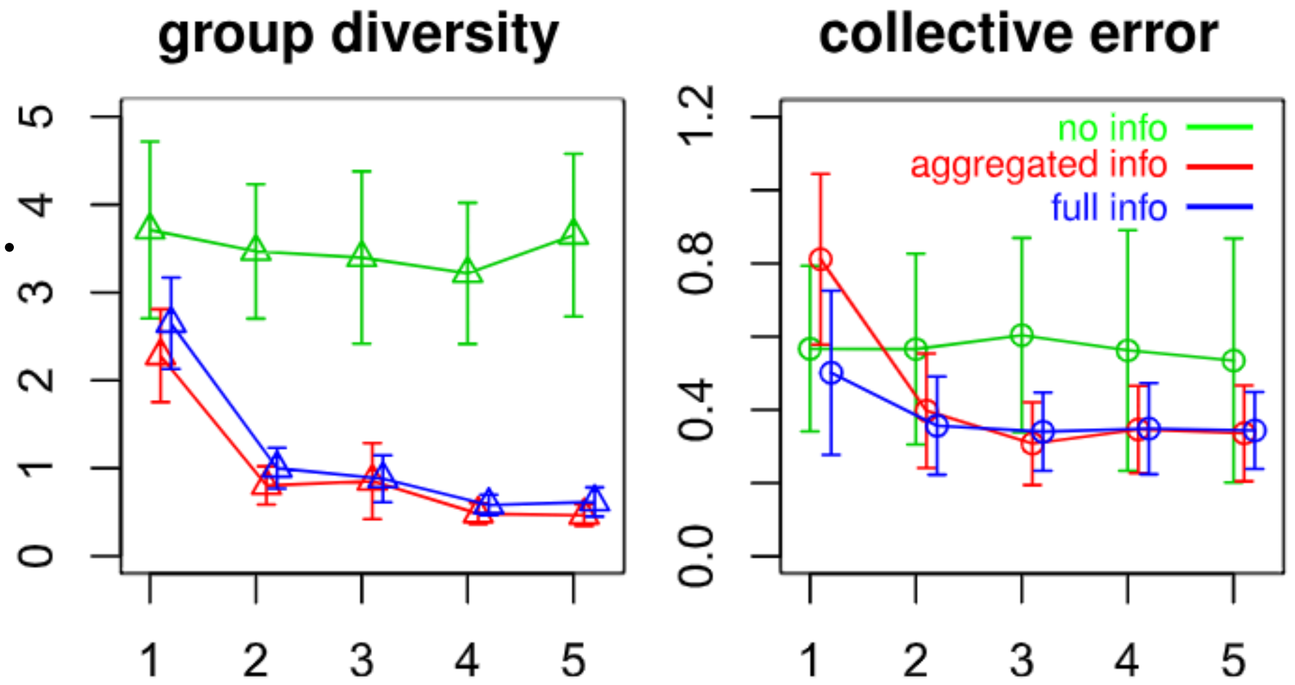

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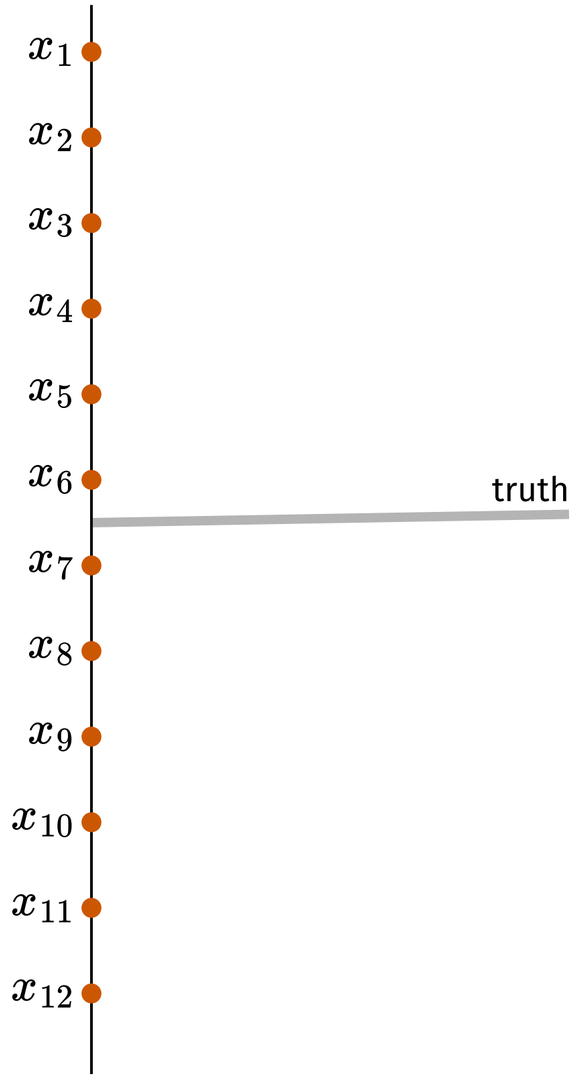
An indicator of wisdom is where the truth lies in the distribution of estimates.



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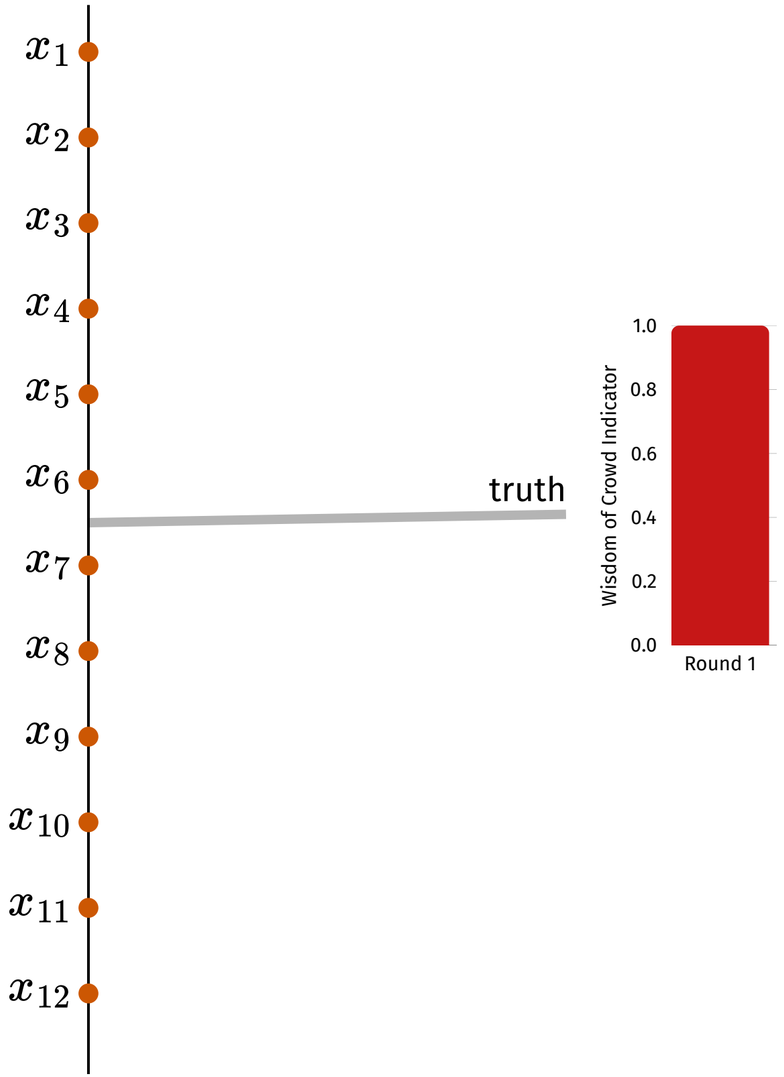
The more central, the wiser the group.



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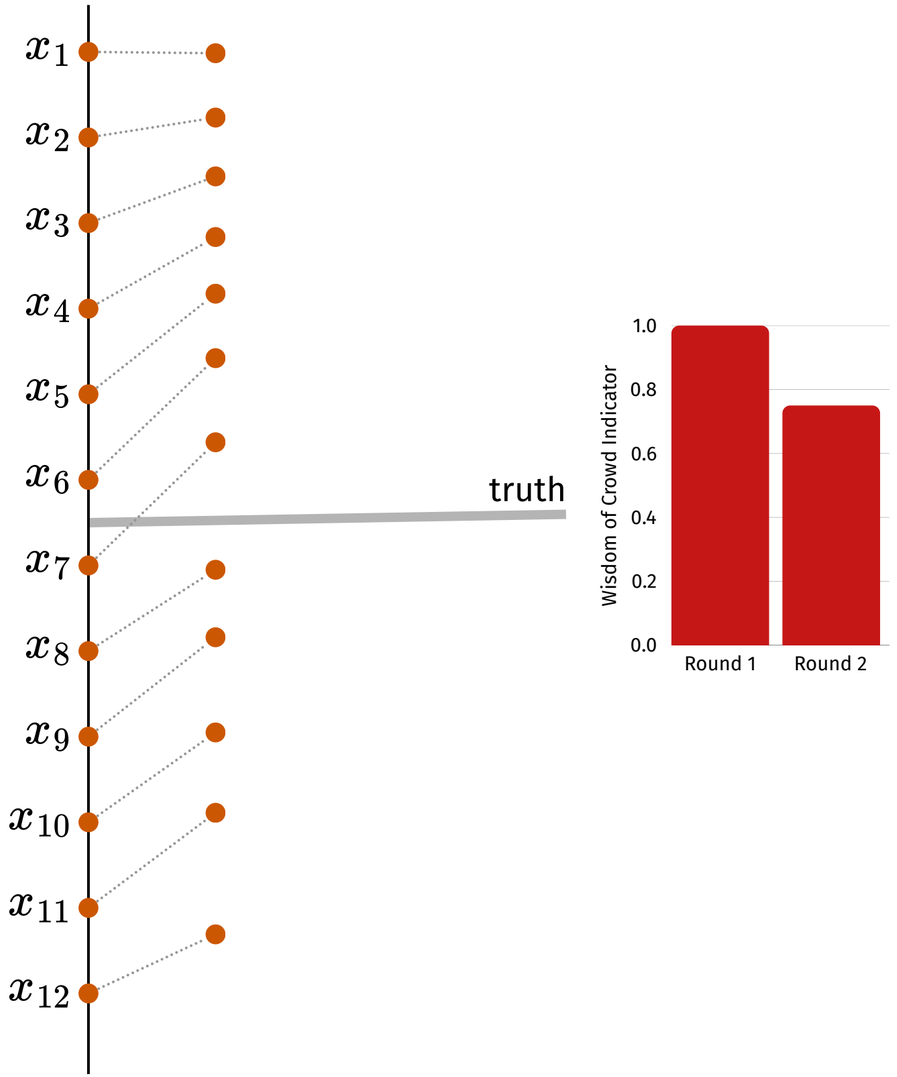

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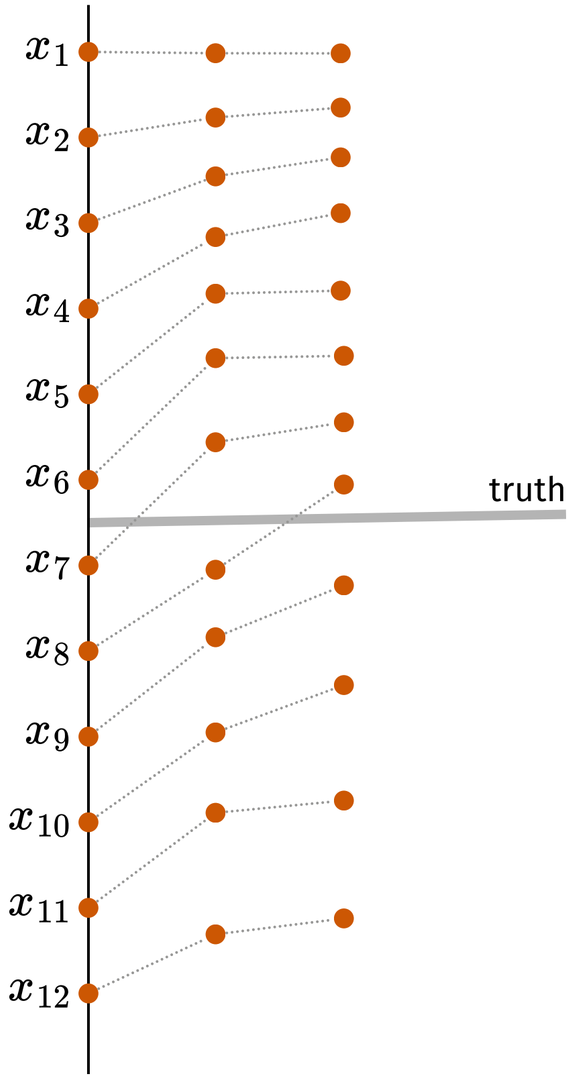

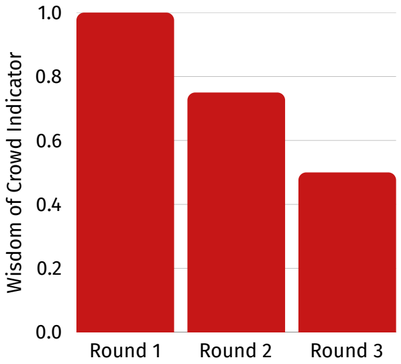

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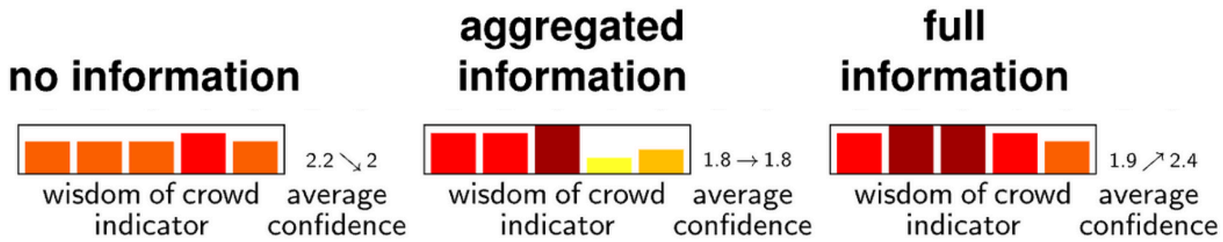
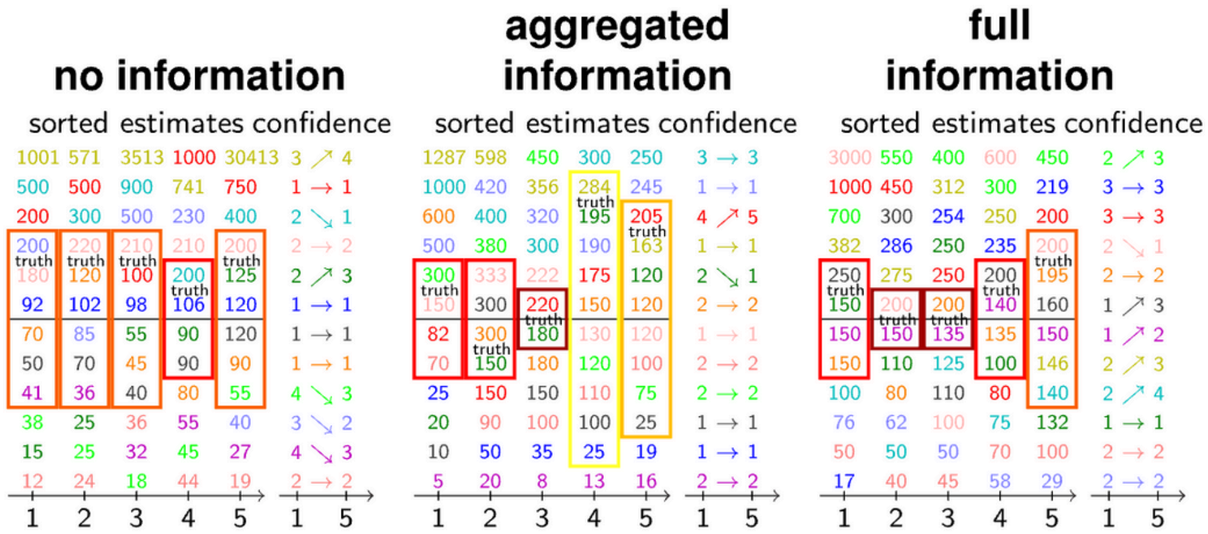
In the experiments social influence reduces the wisdom indicator.



RANGE REDUCTION EFFECT

With social influence, participants become more confident in their estimates.



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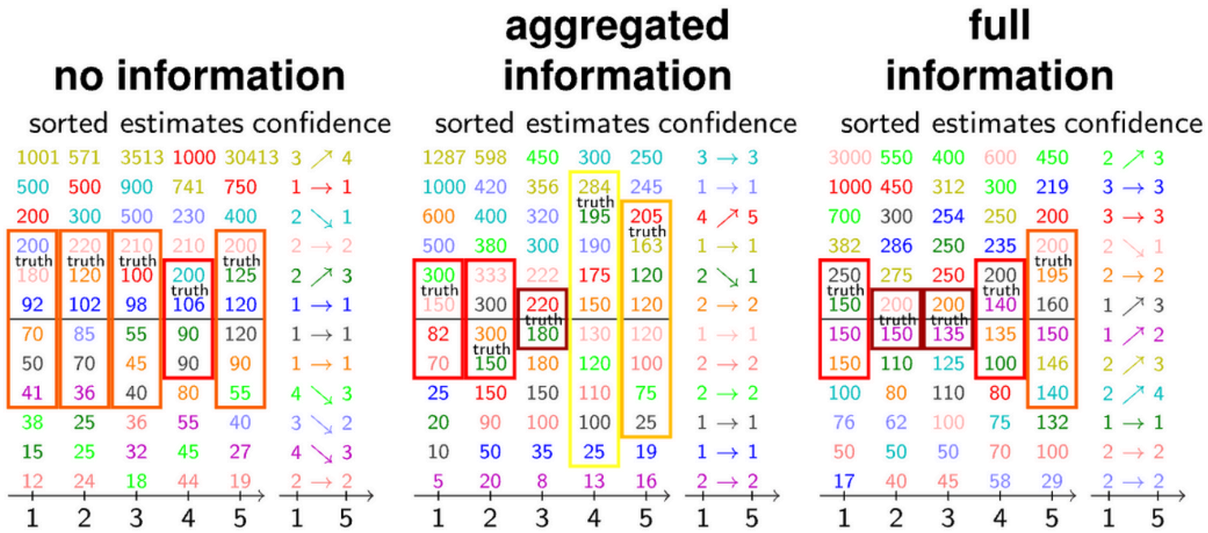
RANGE REDUCTION EFFECT

With social influence, participants become more confident in their estimates.

Though, remember not more accurate!



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NICOLAS CLAIDIÈRE

There are a couple of mechanisms for the wisdom of crowds, but it is not clear if discussion is among them.

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Results are favorable for small-ish groups.

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HUGO MERCIER

Let’s make an experiment!

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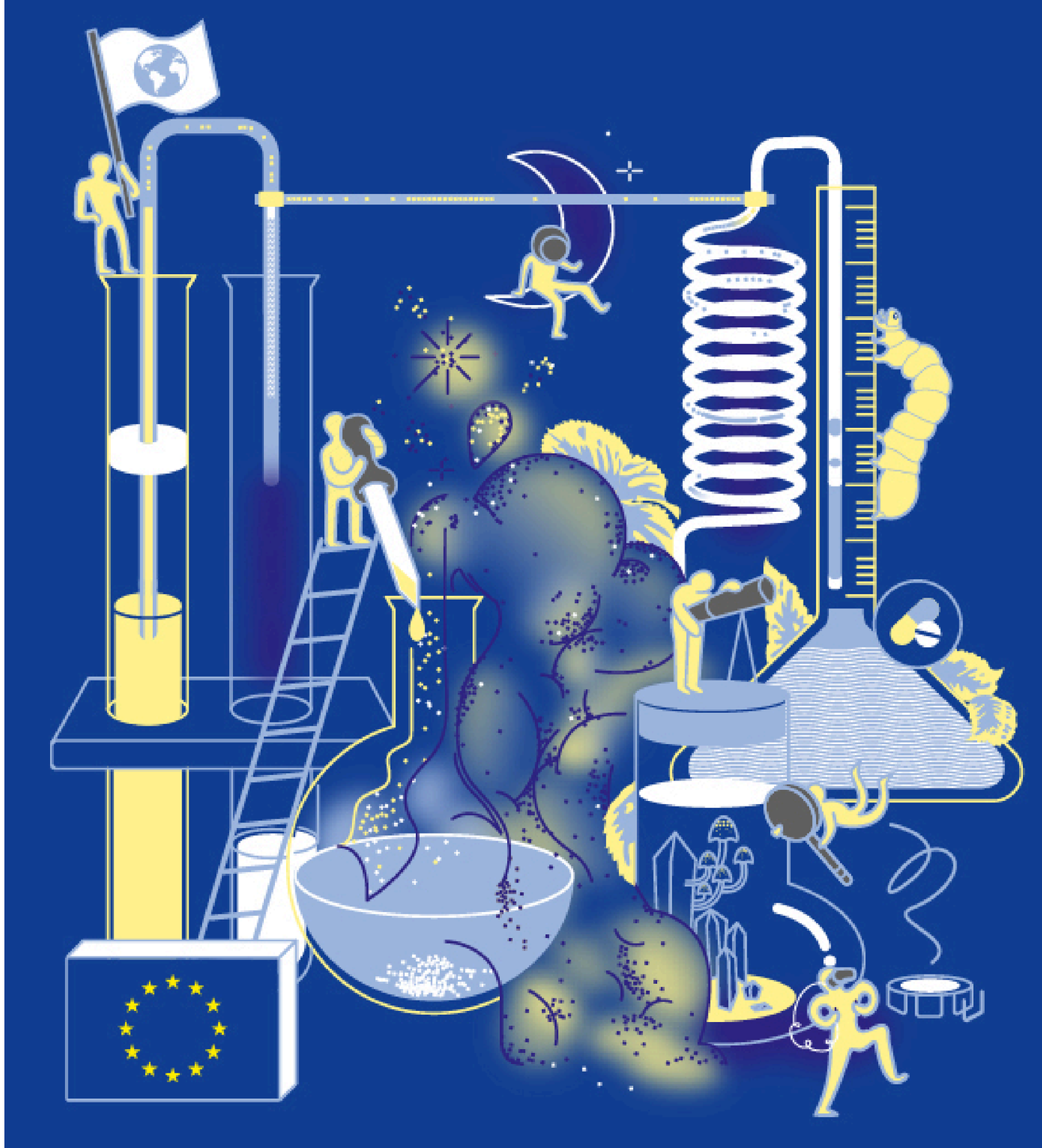
PARTICIPANTS

33 groups, of sizes between 20 to 208 individuals (mean 58).

Selected from visitors at the *European Researchers' Night* in France.



PROCEDURE

Participants answer one of six questions.

First thinking by themselves, then after some discussion.

Answers are periodically recorded, 15 times in total.

QUESTIONS

1 Paul and Linda

DEMONSTRATIVE

Paul looks at Linda. Linda looks at John. Paul is married. John isn’t married. Is someone married looking at someone who isn’t married?

☑ Yes ☐ No ☐ Can’t tell

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2 Bat and Ball

DEMONSTRATIVE

A candy and a baguette cost 1.10€ together. The baguette costs 1€ more than the candy. How much does the candy cost?

- [x] 0.05

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FACTUAL

How many goals were scored in the football world cup of 2010?

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How many elevators are there in New York's Empire State Building?

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ETHICAL

How much money should be awarded to compensate someone who lost a little finger in a workplace accident?

☑ ?

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ETHICAL

How much money should be awarded to compensate someone who lost a little finger in a workplace accident?

☑ ?

6 Worms

ETHICAL

How much money should be awarded to compensate someone who finds they have been eating earthworms in their restaurant meal?

☑ ?

Sidenote, the little finger question was inspired by a psychology paper from the ‘30s.

Edward L. Thorndike

1874 - 1949

> Better knowledge of the attitudes of people toward prospective "disutilities" in the form of pains, discomforts, deprivations, degradations, frustrations, restrictions, and other undesired conditions is obviously important.

Thorndike, E. L. (1937). Valuations of certain pains, deprivations, and frustrations. *The Pedagogical Seminary and Journal of Genetic Psychology*, 51, 227–239.

.....1. Have one upper front tooth pulled out. [$5000; $4500]
.....2. Have all your teeth pulled out. [$1,000,000; $750,000]
.....3. Have one ear cut off. [No sum; $1,500,000]
.....4. Have your left arm cut off at the elbow (right arm if you prefer) [No sum; $2,500,000]
.....5. Have a little finger of one hand cut off. [$75,000; $200,000]
.....6. Have the little toe of one foot cut off. [$10,000; $57,000]
.....7. Become entirely bald. [$750,000; $75,000]
.....8. Have all the hair of your eyebrows fall out. [$100,000; $25,000]
.....9. Have one leg cut off at the knee. [No sum; $40,000,000]
....10. Have both legs paralyzed. [No sum; $40,000,000]
....11. Have small-pox, recover perfectly, except for about 20 large pock-marks on your cheeks and forehead. [No sum; $1,000,000]
....12. Become totally deaf. [No sum; $100,000,000]
....13. Become totally blind. [No sum; no sum]
....14. Become unable to chew, so that you can eat only liquid food. [No sum; $10,000,000]
....15. Become unable to speak, so that you can communicate only by writing, signs, etc. [No sum; $15,000,000]
....16. Become unable to taste. [$1,000,000; $5,000,000]
....17. Become unable to smell. [$300,000; $150,000]
....18. Require 25 per cent more sleep than now to produce the same degree of rest and recuperation. [$100,000; $37,500]
....19. Fall into a trance or hibernating state throughout October of every year. [$300,000; $325,000]
....20. Fall into a trance or hibernating state throughout March of every year. [$200,000; $400,000]
....21. Be temporarily insane throughout July of every year (manic-depression insanity, bad enough so that you would have to be put in an insane asylum, but with no permanent ill effects). [No sum; $2,500,000]
....22. Same as 21, but for two entire years now,[3] with no recurrence ever again. [No sum; $5,000,000]
....23. Have to live all the rest of your life outside of U. S. A. [$200,000; $150,000]
....24. Have to live all the rest of your life in Iceland. [No sum; $1,000,000]
....25. Have to live all the rest of your life in Japan. [$1,000,000; $500,000]
....26. Have to live all the rest of your life in Russia. [$1,000,000; $150,000]
....27. Have to live all the rest of your life in Nicaragua. [$1,000,000; $500,000]
....28. Have to live all the rest of your life in New York City. [$50,000; $25,000]
....29. Have to live all the rest of your life in Boston, Mass. [$100,000; $50,000]
....30. Have to live all the rest of your life on a farm in Kansas, ten miles from any town. [$1,000,000; $300,000]
....31. Have to live all the rest of your life shut up in an apartment in New York City. You can have friends come to see you there, but cannot go out of the apartment. [No sum; $60,000,000]
....32. Eat a dead beetle one inch long. [$5,000; $5,000]
....33. Eat a live beetle one inch long. [$25,000; $50,000]
....34. Eat a dead earthworm 6 inches long. [$5,000; $25,000]
....35. Eat a live earthworm 6 inches long. [$10,000; $100,000]
....36. Eat a quarter of a pound of cooked human flesh (supposing that nobody but the person who pays you to do so will ever know it). [$1,000,000; $100,000]
....37. Eat a quarter of a pound of cooked human flesh (supposing that the fact that you do so will appear next day on the front page of all the New York papers). [No sum; $7,500,000]
....38. Drink enough to become thoroughly intoxicated. [$100; $50]
....39. Choke a stray cat to death. [$10,000; $10,000]
....40. Let a harmless snake 5 feet long coil itself round your arms and head. [$500; $100]
....41. Attend Sunday morning service in St. Patrick's Cathedral, and in the middle of the service run down the aisle to the altar, yelling "The time has come, the time has come" as loud as you can until you are dragged out. [$100,000; $1,000]
....42. Take a sharp knife and cut a pig's throat. [$1,000; $500]
....43. Walk down Broadway from 120th Street to 80th Street at noon wearing evening clothes and no hat. [$200; $100]
....44. Spit on a picture of Charles Darwin. [$20; $10]
....45. Spit on a picture of George Washington. [$50; $10]
....46. Spit on a picture of your mother. [$10,000; $25,000]
....47. Spit on a crucifix. [$300; $5]
....48. Suffer for an hour pain as severe as the worst headache or toothache you have ever had. [$500; $250]
....49. Have nothing to eat but bread, milk, spinach and yeast cakes for a year. [$10,000; $25,000]
....50. Go without sugar in all forms (including cake, etc.), tea, coffee, tobacco, and alcoholic drink, for a year. [$1,750; $2,000]
....51. Lose all hope of life after death. [$6,500; $50]

Thorndike, E. L. (1937). Valuations of certain pains, deprivations, and frustrations. *The Pedagogical Seminary and Journal of Genetic Psychology*, 51, 227–239.

HYPOTHESES & QUESTIONS

Hypothesis 1-a

Discussion improves performance more than solitary thinking for demonstrative questions.

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Hypothesis 1-b

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Research Question

For factual problems, how does discussion affect the average opinion of the group?

NICOLAS CLAIDIÈRE

Off the bat, discussion on ethical issues did not change anything.

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Off the bat, discussion on ethical issues did not change anything.

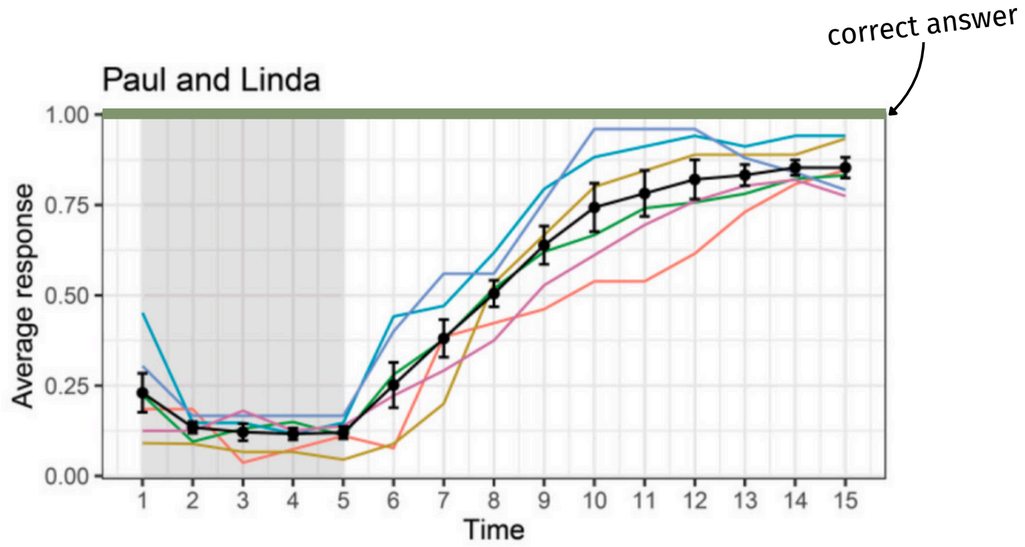
HUGO MERCIER

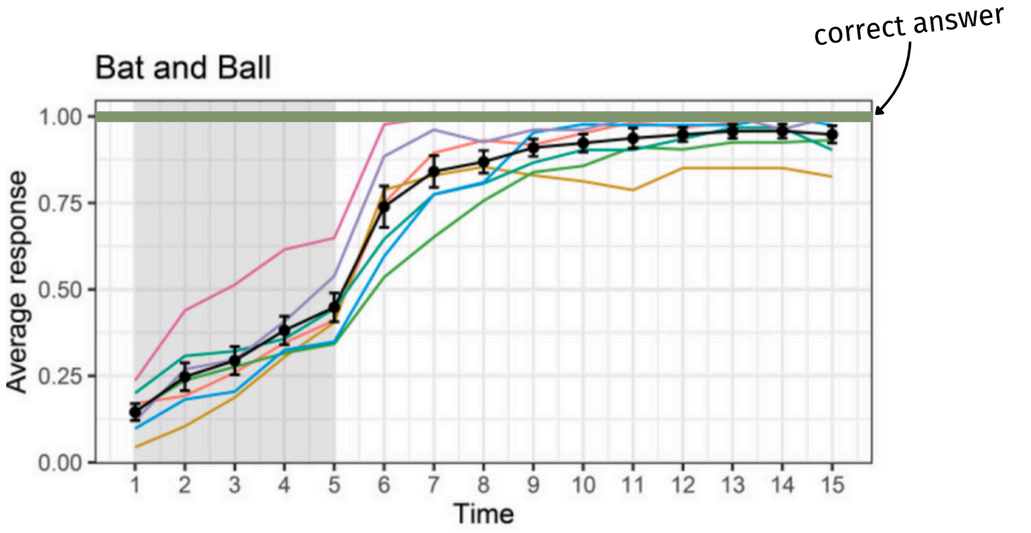
What about the other questions?

INDIVIDUAL PERFORMANCE ON DEMONSTRATIVE QUESTIONS

Average response gets closer to the ground truth (1) in the discussion phase, relative to the silence phase (shaded).

This happens across all groups (the colored lines) and overall (the black line).





NICOLAS CLAIDIÈRE

Individually, people give better answers after discussion.

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Individually, people give better answers after discussion.

HUGO MERCIER

The correct answer disseminates quickly.

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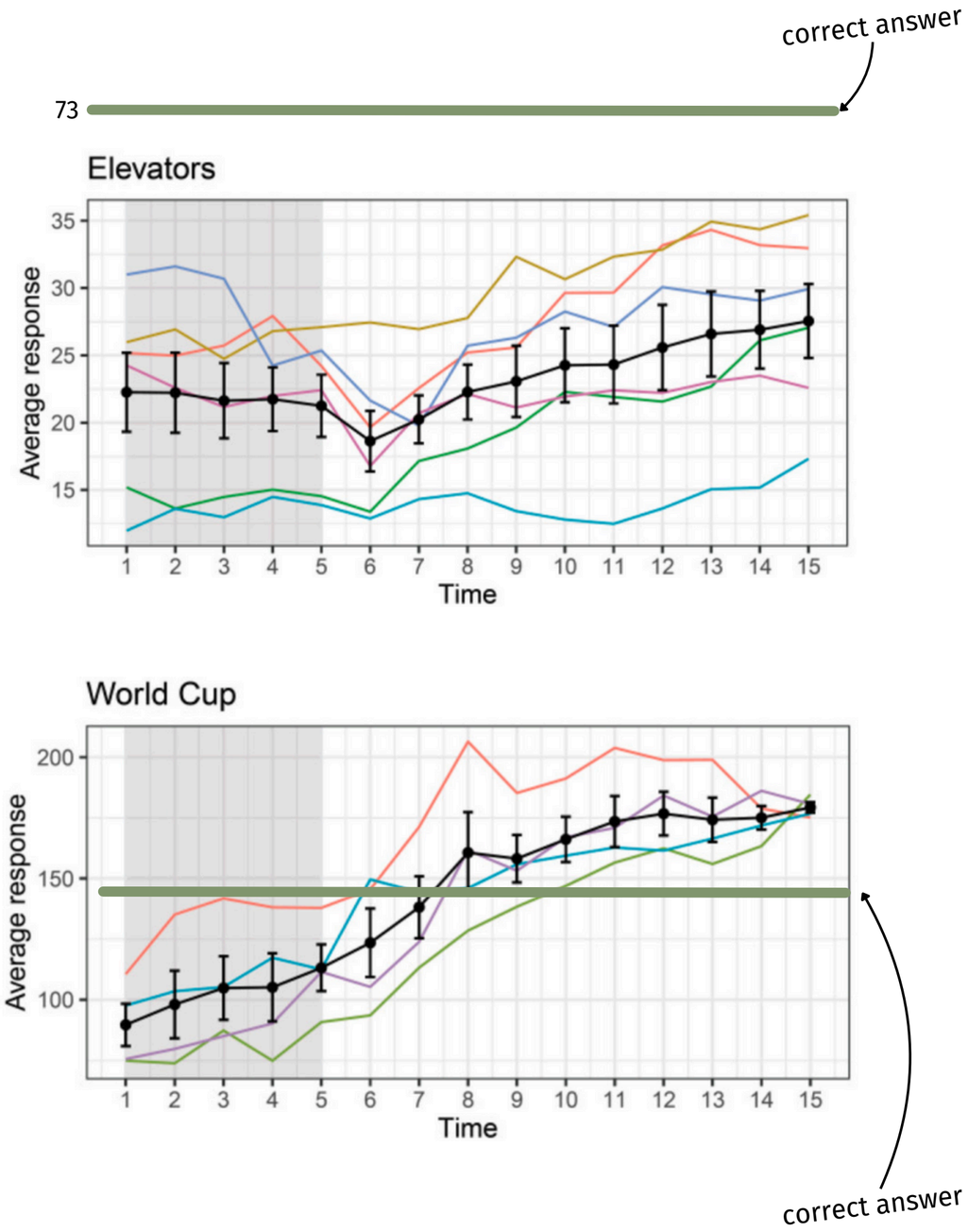
INDIVIDUAL PERFORMANCE ON FACTUAL QUESTIONS

Average response generally gets closer to the truth.

Even though agents overshoot in the World Cup problem.



NICOLAS CLAIDIÈRE

On average, participants get closer to the truth after discussion for factual questions as well.

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On average, participants get closer to the truth after discussion for factual questions as well.

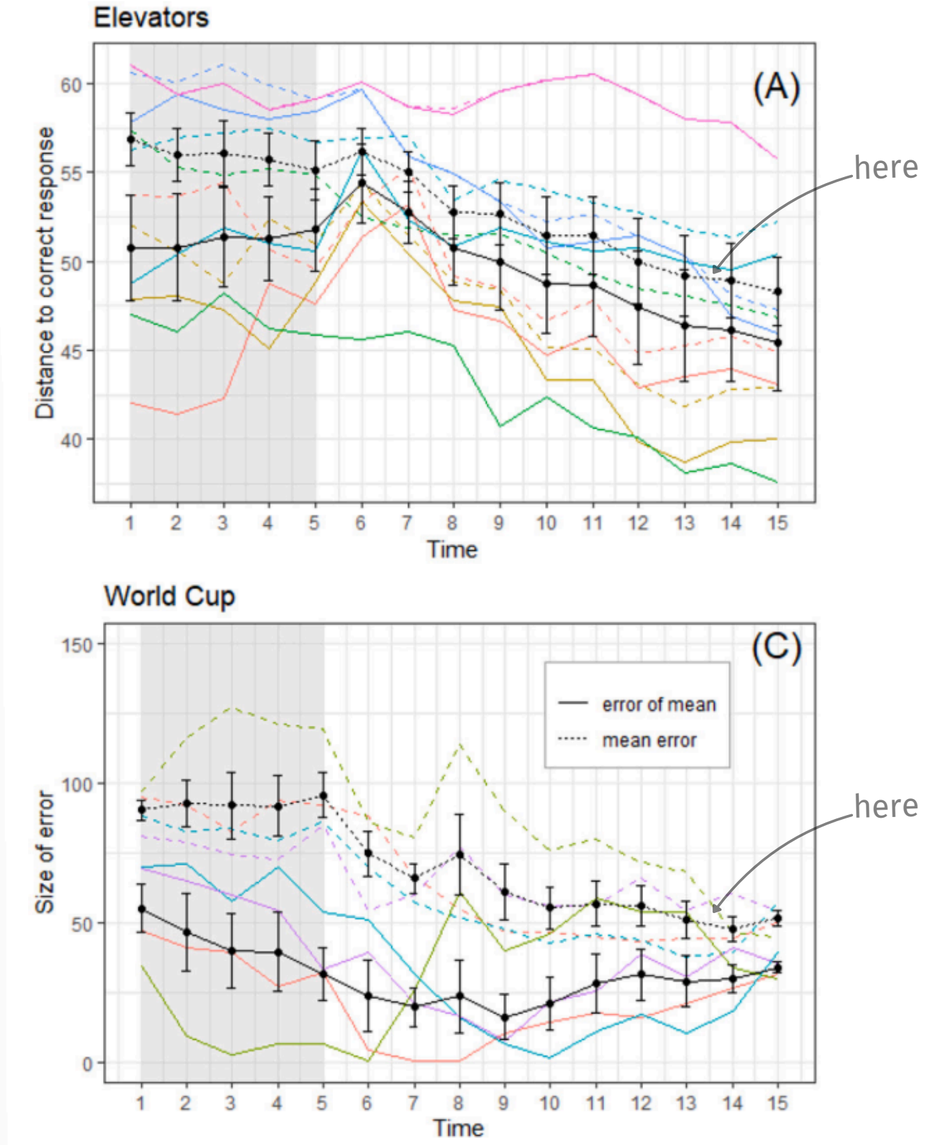
HUGO MERCIER

The effect is less strong than for demonstrative questions, but can be seen when plotting the distance to the ground truth.

INDIVIDUAL PERFORMANCE ON FACTUAL QUESTIONS REVISITED

Note that mean error decreases with discussion (closer to 0 is better).

Admittedly, the improvement is not super-impressive on the World Cup question.



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What about performance for the *group* itself, wisdom-of-crowds-style?

NICOLAS CLAIDIÈRE

What about performance for the *group* itself, wisdom-of-crowds-style?

HUGO MERCIER

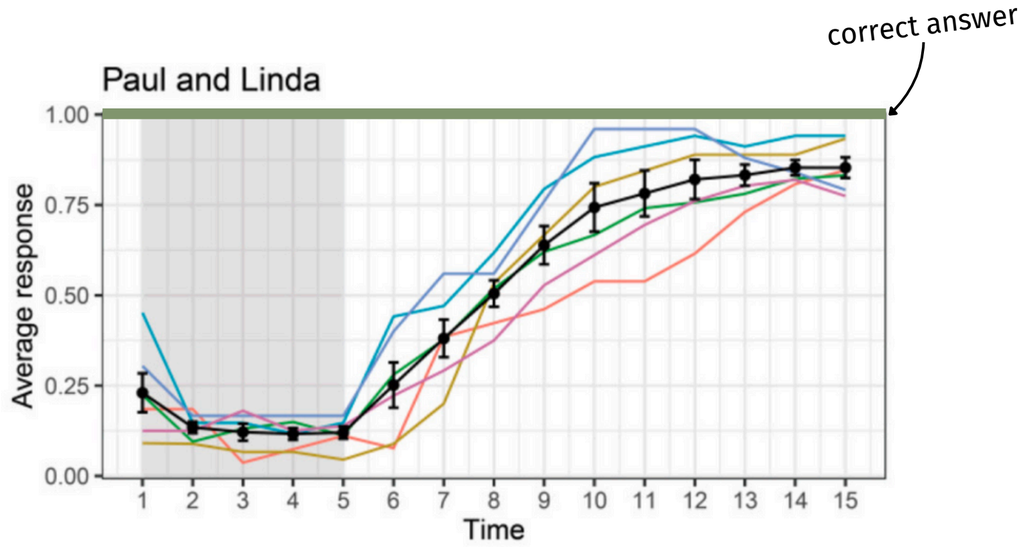
For this we aggregate the estimates by taking the mean, and measure the error of this mean.

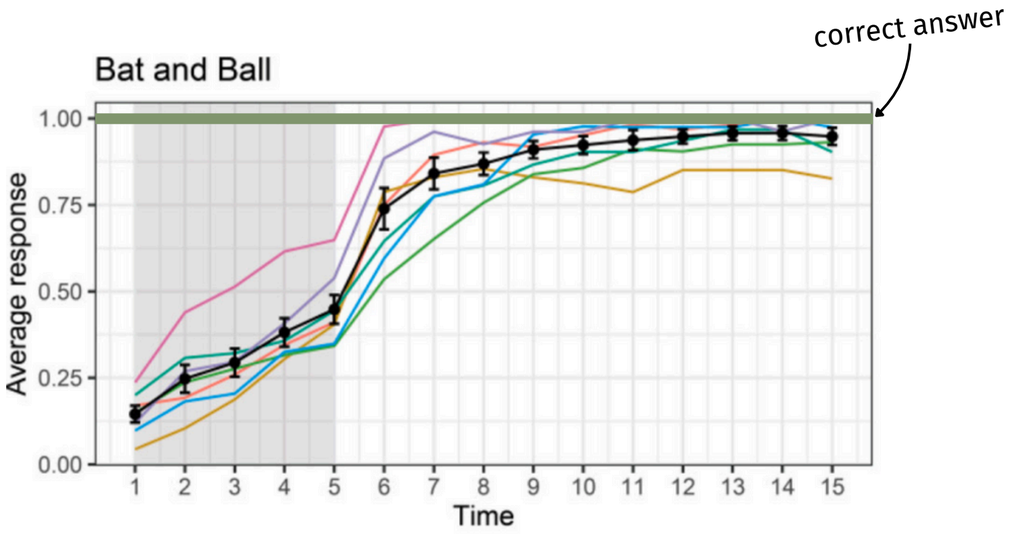
GROUP PERFORMANCE ON DEMONSTRATIVE QUESTIONS

Becomes a yes/no question, where the majority opinion is determined by the average per group.

Majority opinion gets better after discussion!

This happens across all groups (the colored lines) and overall (the black line).





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Research Question

For factual problems, how does discussion affect the average opinion of the group?

GROUP PERFORMANCE ON FACTUAL QUESTIONS

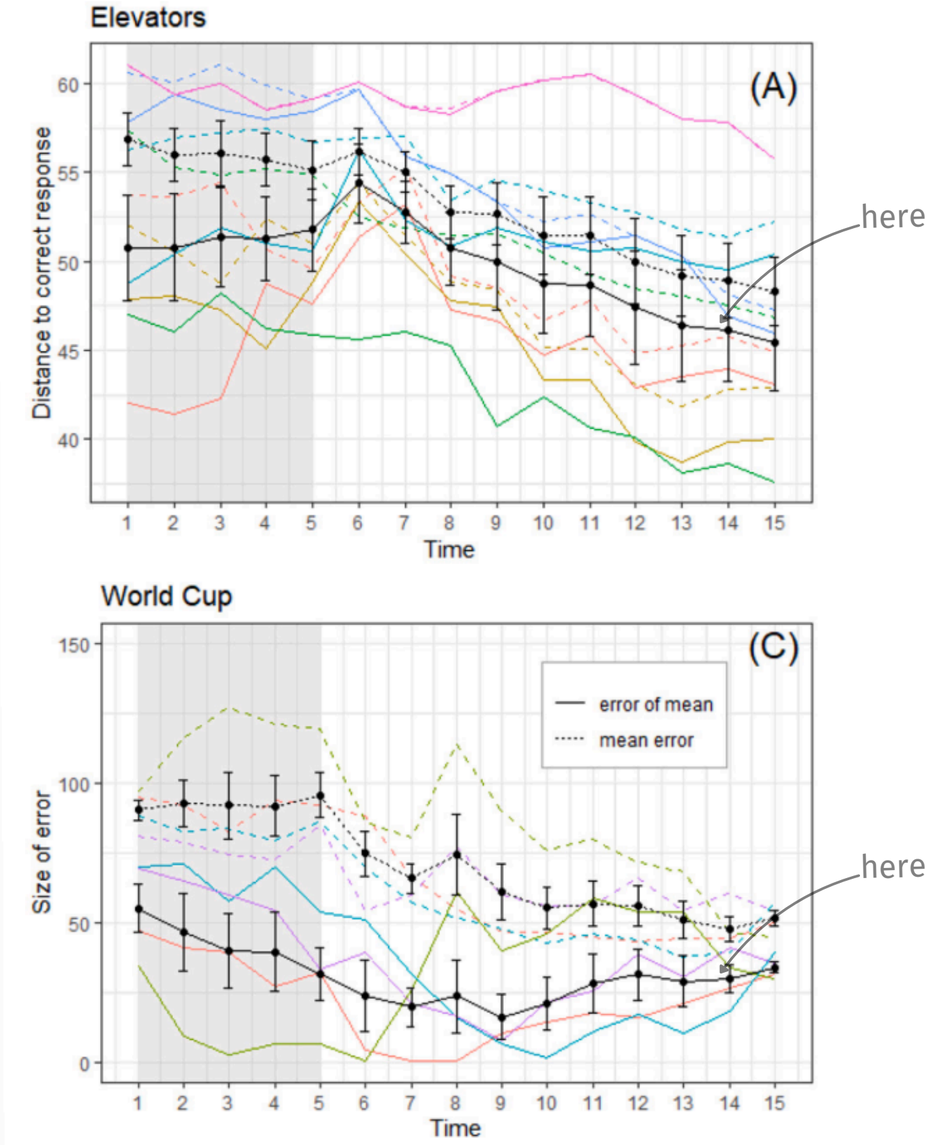
Measure of success for the group is *error of the mean*, with closer to 0 being better.

Results are mixed.

For the Elevators question the group gets better with discussion.

But not for the World Cup question.

Even though, as we saw earlier, individuals get (a bit) better!



NICOLAS CLAIDIÈRE

In the Elevators question, everyone shifts towards the correct answer, taking the mean answer with them.

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HUGO MERCIER

With the World Cup question, something else happens.

Variance decreases, without an improvement on the mean answer.

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Question ¯_(ツ)_/¯

For factual problems, how does discussion affect the average opinion of the group?