Levels of Reasoning

Keynesian beauty contest

- "It is not a case of choosing those [faces] that, to the best of one's judgment, are really the prettiest, nor even those that average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practice the fourth, fifth and higher degrees." (Keynes, *General Theory of Employment, Interest and Money*, 1936).

- 2/3 guessing game introduced by Nagel (1995)

- **Level-k predictions**
  - Level-0: Random in [0,100]
  - Level-1: 31.8181 (notice subject's number is counted in the average)
  - Level-2: 20.236364
  - Level-3: 12.877686
  - Etc

- **Nagel's classification (for human-human treatments)**
  - Level-0: 45 to 50
  - Level-1: 30 to 37
  - Level-2: 20 to 25
  - Level-3: 13 to 16

Agranov, et al (2012)

- **Basic idea**: to see if information about other people can shift players' beliefs in a beauty contest game
- **Classroom experiments**: envelopes handed out before class, instructions read, envelopes collected, payment at the end
- "All the experiments lasted less than 10 minutes in total, including reading the instructions."
- 3 **between-subjects** treatments:
  - Control
  - Computer
  - Graduate
- One within-subjects treatment (Combo)

- **Control:**

"Choose a number between 0 and 100. You will be put into groups of 8 people. The winner is the person whose number is closest to $\frac{2}{3}$ times the average of all chosen numbers of the people in your group. The winner gets a fixed prize of $10. In case of a tie the prize is split among those who tie."

- **Graduate:**

"Choose a number between 0 and 100. You will win $10 if your chosen number is closest to two thirds times the average of all chosen numbers of the people in your group.

Your group: 8 graduate students in the Department of Economics, who have training in these types of games, played this game a few days ago. You will replace one of them. So your group is YOU and 7 of those graduate students.

You will win $10 if your chosen number is closest to $\frac{2}{3}$ times the average of all chosen numbers (yours and 7 graduate students). In case of a tie the prize is split. Notice you are not playing against people in this room. Each of you is playing against 7 graduate students. So, all of you may earn $10 and none of you may."

- **Computer**

"Choose a number between 0 and 100. You will win \$10 if your chosen number is closest to $\frac{2}{3}$ times the average of all chosen numbers of the people in your group.

Your group: Your group consists of you and 7 computers. Each of those computers will choose a random number between 0 and 100, each number being equally likely. So your group is YOU and 7 computers.

You will win \$10 if your chosen number is closest to $\frac{2}{3}$ times the average of the numbers in your group (yours and the 7 random numbers chosen by the computers). Notice you are not playing against people in this room. Each of you is playing against 7 computers. So, all of you may earn \$10 and none of you may."

- **Combo**

Strategy method: a choice made for each possible X, where X is the number of computers and 7-X the number of graduate students in your group.

X=0, 1, 2, 3, 4, 5, 6 and 7

At the end of the experiment, one X chosen for payment

Hypotheses

Hypothesis 1. As the population of opponents faced by any subject in our experiment becomes more sophisticated (i.e., moves from being composed of all computers to all graduate students) the distribution of choices observed in our experiment should shift to the left.

Hypothesis 2. Subjects who adhere to either a Level-K model of behavior or Cognitive Hierarchy theory and have a level of sophistication of at least one should choose 31.8 in the Computer treatment.

Results

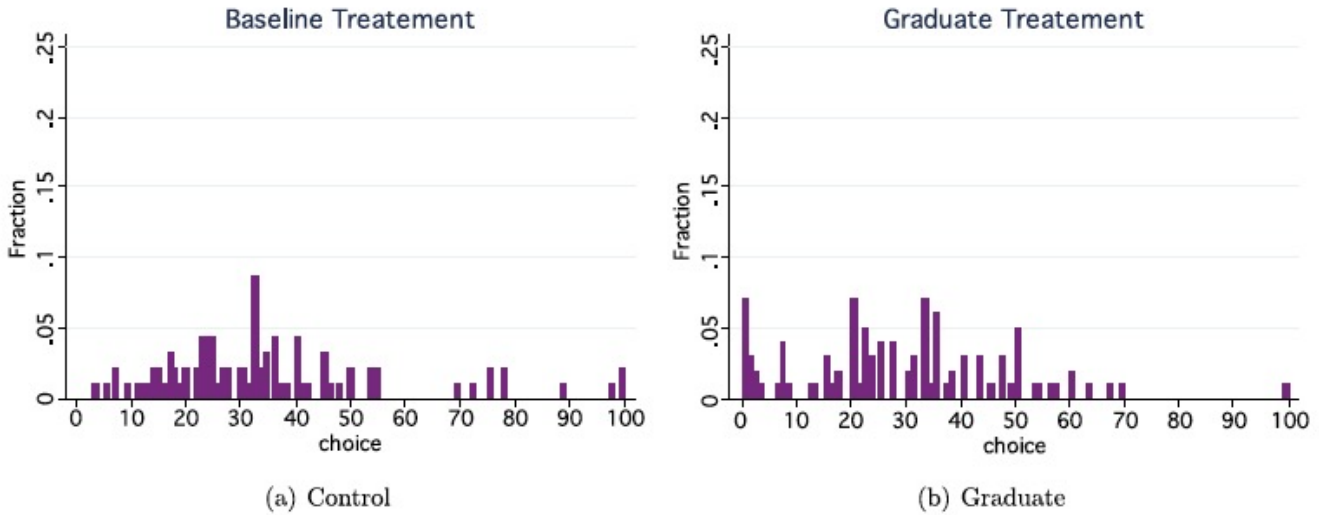
Table 1
Summary statistics for the Control treatment.

	Mean choice	Median choice	Std. dev.	Group size
Control treatment	35.1	33	21	8
Nagel (1995)	37.2	33	20	14–16
Ho et al. (1998)	38.9	*NA*	24.7	7
Agranov et al. (2012)	36.4	33	20.2	8

Table 2
Level classification according to Nagel (1995).

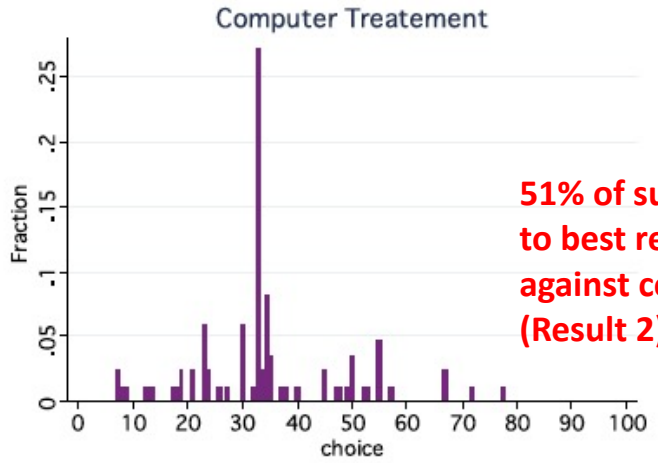
	Control treatment	Nagel's data
Level 0	8%	7.5%
Level 1	25%	26%
Level 2	18%	24%
Level 3	8%	2%
Fraction captured by Nagel's classification	59%	59.5%

Result 0: Behavior in the Control treatment is similar to the behavior reported in other experimental studies of the 2/3 guessing game



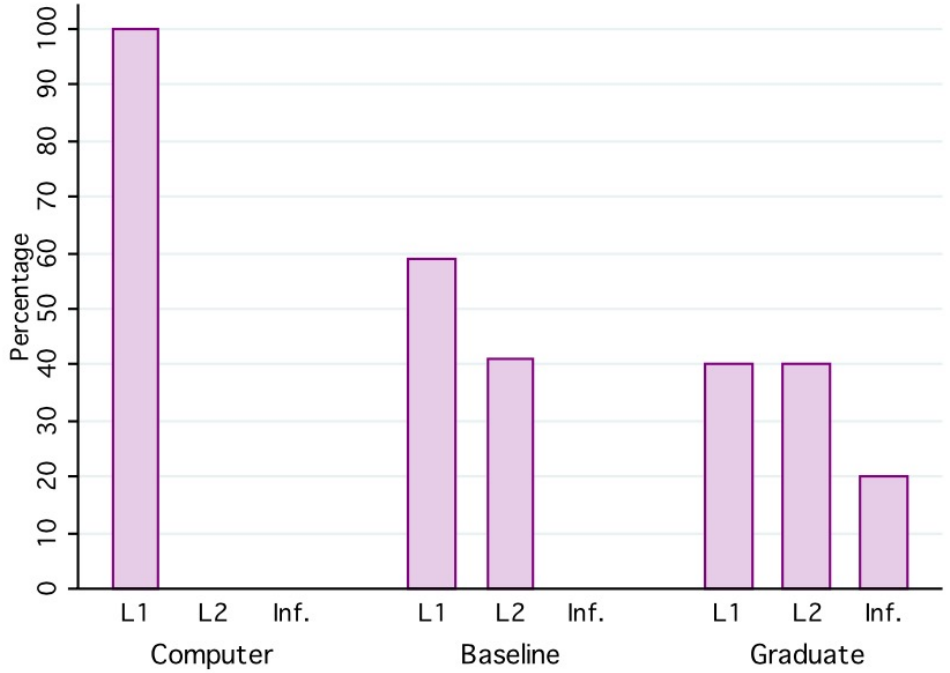
(a) Control

(b) Graduate



(c) Computer

51% of subjects fail to best respond against computer (Result 2)



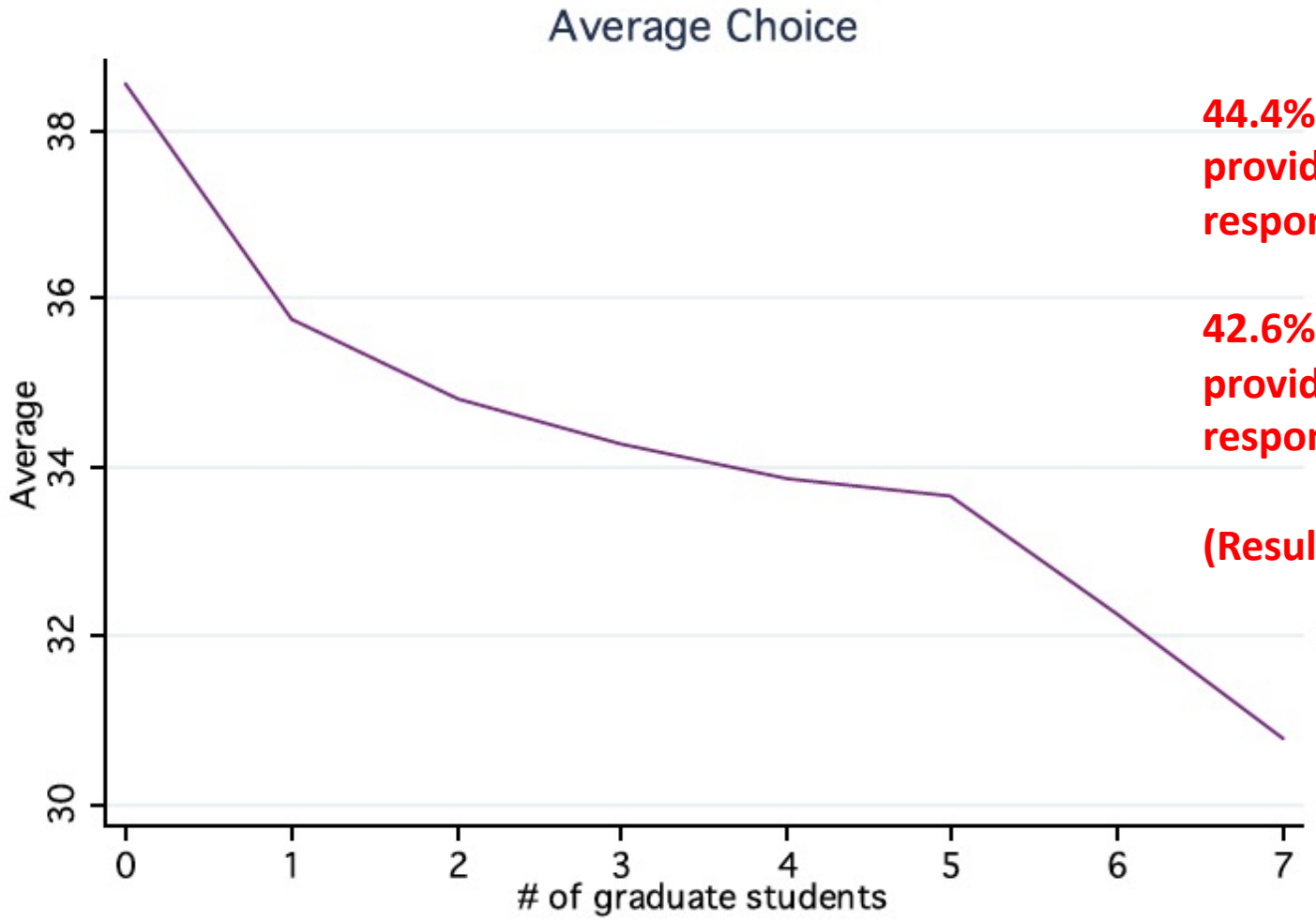
Result 1a: The distribution of observed cognitive levels in the Graduate treatment is shifted towards higher cognitive levels compared with the Control treatment. The opposite is true in the Computer treatment.

Distributions of levels

Table 4
Level classification of Nagel (1995) in the Control, Graduate and Computer treatments.

	Control	Graduate	Computer
Level 0	8%	10%	9%
Level 1	25%	20%	49%
Level 2	18%	20%	
Level 3	8%	5%	
Level ∞	0%	10%	
Fraction captured by Nagel's classification	59%	65%	58%
Fraction not classified	41%	35%	42%

By far not everyone realizes graduate students are different



44.4% of subjects provide non-monotonic responses (“random”)

42.6% of subjects provide decreasing responses

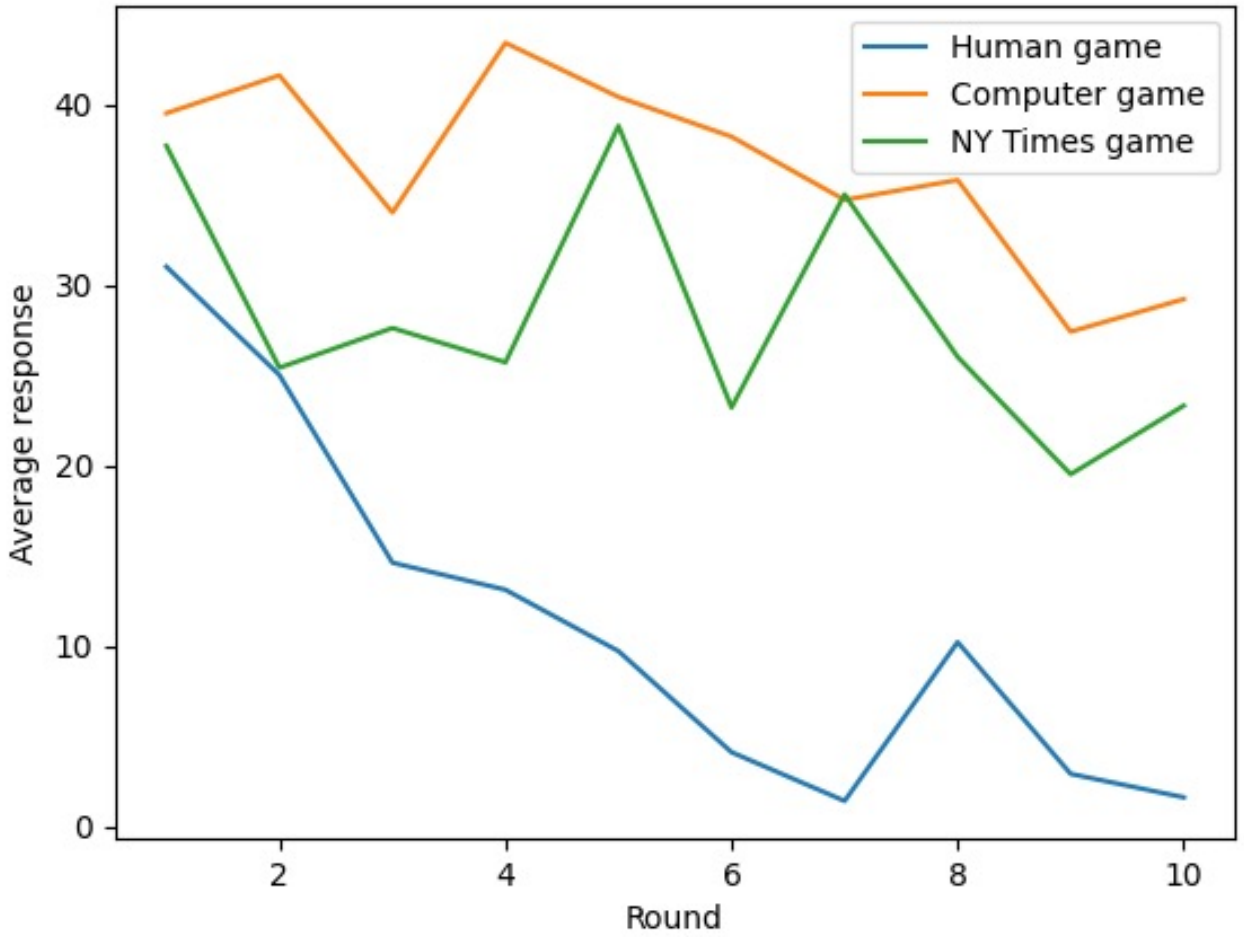
(Result 3)

Result 1b: In the Combo treatment, the average choice of subjects decreases as the number of graduate students increases.

Summary

- Providing subjects with information about their partners affects behavior in a guessing game
  - A large fraction of subjects thinks strategically
  - But an equally large fraction doesn’t!

Class experiment on 1/12



Histograms of responses