Cognitive Ability and Strategic Sophistication in School Choice Games*

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November 10, 2026

Abstract

This paper examines the three most prominent school choice mechanisms, Deferred Acceptance (DA), Immediate Acceptance (IA) and Top Trading Cycles (TTC), in a complete information setting where preferences over assignments and school priorities are common knowledge. In the manipulable IA mechanism, Zhang (2021) predicts the probability of focal equilibrium play decreases in level-k reasoning. Ranked-order strategies support the model's predictions and eye-tracking data similarly corroborate levels of sophisticated play. I further confirm previous findings of Basteck & Mantovani (2018) that subjects who score higher on the Raven's Progressive Matrices (RPM) task are more (less) likely to report truthfully in the strategy-proof (manipulable) DA (IA) mechanism and extend their results by showing a similar pattern for the strategy-proof TTC. While high-performing subjects on the RPM task receive higher payoffs in the TTC due to the strategic complements of the algorithm, distributional concerns that low-performing types are overrepresented at the worst schools do not arise provided that ability types are uniformly distributed across provisional assignments, furthering the agenda for the implementation of strategy-proof mechanisms.

JEL classification: C90, D47, D82, D87, I24

Keywords: cognitive ability, eye-tracking, level-k reasoning, matching, school choice

*I am grateful to Alexander Brown for invaluable guidance and support. I also thank Clayton Featherstone, Rustamdjan Hakimov, Silvana Krasteva, Marco Palma, Daniel Stephenson, Rodrigo Velez and the experimental research group at Texas A&M University for their insightful feedback. Natalia Valdez Gonzalez, Jasmine Cobb and Elizabeth Harrison provided valuable assistance in conducting experiments.

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1 Introduction

School choice mechanisms play an important role in determining the placement and educational outcomes of students around the world. These mechanisms can serve as a tool for granting disadvantaged groups access to high-quality schools. In developing effective student-to-school matching markets, policymakers have often relied on theoretical principles such as efficiency, fairness and strategy-proofness to justify the preference for certain mechanisms over others. For example, the classical "Boston" mechanism (also known as "Immediate Acceptance," IA) was phased out in Boston, Chicago and New York City as it may have disadvantaged certain populations due to its manipulability. This shift occurred as matching theorists and experimentalists advocated for the adoption of the Deferred Acceptance (DA) mechanism, primarily because of its strategy-proofness. This property encourages participants to report preferences truthfully (Abdulkadiroğlu et al., 2005; Y. Chen & Sönmez, 2006; Pathak & Sönmez, 2013).

Addressing concerns that ability differences may disadvantage applicants in school choice games, Basteck & Mantovani (2018) use performance on the Raven's Progressive Matrices (RPM) task as a measure of cognitive ability and correlate it with strategizing in the DA and IA mechanisms. The study uses a four-player, four-school game in which induced preferences are common knowledge with almost full consensus on the rank-order preference of schools and with priority orderings being randomly determined according to a centralized lottery that determines a student's (same) priority at all schools. They find that high scoring subjects on the RPM task strategize better in the IA through non-truthful reports and, therefore, earn more. This difference leads to a greater representation of low scoring subjects at the worst schools under the IA mechanism, creating segregation concerns. In the strategy-proof DA, high scoring subjects on the RPM are more likely to report preferences truthfully. In contrast to IA, however, payoff differences between ability types based on performance on the RPM are reduced if not entirely eliminated. Additionally, low-performing subjects on the RPM are not more likely to be represented at the worst schools in the DA, further supporting the hypothesis that strategy-proof mechanisms create a level playing field.

In field settings, applicants typically know very little about priority orderings at different schools since they are determined based on automatic priority (i.e., based on sibling attendance laws, or residing in proximity zones) and random lotteries. In these settings, however, there is large consensus on the desirability of schools, with often a select few being viewed as highly desirable. Reporting preferences truthfully in IA presents a risk when one is uncertain about her/his own

priority order at the best school. For this reason, it may be optimal to report the second-best school first especially when one is certain of obtaining a seat at that school due to automatic priority. Hence, studying school choice games in a complete information setting allows one to examine systemic deviations from equilibrium play based on sophistication levels. Recognizing the heterogeneous sophistication of applicants, Zhang (2021) makes use of a complete information environment in IA to characterize equilibrium strategies according to level-k reasoning. Level-k reasoning in IA suggests that applicants run a variant of DA in their minds to determine the optimal first choice, where applicants of higher levels run more steps. At the first level, namely Level-0, the applicants are naive, lack strategic reasoning, and report preferences truthfully; thereafter, incentives arise to report the next best achievable alternative as the first choice with each consecutive rejection. Eventually, after a certain level of sophistication is reached by all applicants, assignments do not exhibit justified-envy and converge to the same allocations as those obtained through truthful revelation in the DA.

This paper examines the three most prominent school choice mechanisms, the Deferred Acceptance (DA), Immediate Acceptance (IA) and Top Trading Cycles (TTC). Gale & Shapley (1962) describe the DA mechanism. Shapley & Scarf (1974) describe the TTC mechanism. Ergin & Sönmez (2006) characterize Nash equilibria of the IA mechanism.

The experiment induces a particular four-player game and valuation structure under three school choice mechanisms in a complete information setting. The valuation structures and priority orderings were specifically chosen to test for systemic failures in reporting equilibrium strategies in IA based on level-k reasoning (Zhang, 2021) and to test whether performance on the Raven's Progressive Matrices (RPM) task (Raven, 2000) is correlated with reporting preferences truthfully in another strategy-proof mechanism, namely the TTC (Basteck & Mantovani, 2018). Additionally, the valuation structures were chosen to test whether subjects identify and value the elimination of justified-envy, or alternatively, care about and physiologically react to justified-envy compared to envy without justification (Vitaku et al., 2026).

The results align with previous findings on the role of strategic sophistication (Zhang, 2021) and cognitive ability (Basteck & Mantovani, 2018) in school choice games. In the manipulable IA mechanism, the probability of focal equilibrium play decreases in level-k reasoning and eye-tracking data similarly corroborate levels of sophisticated play. I further find that subjects who perform above the median level on the Raven's Progressive Matrices (RPM) task – a test used to measure fluid intelligence – are more (less) likely to report truthfully in strategy-proof (manipulable)

mechanisms. I show that unlike in the DA mechanism where median ability classification based on performance on the RPM task does not impact payoffs, above median subjects receive higher payoffs under the TTC due to the strategic complements of the algorithm, a finding that had not been previously examined. Additionally, I show that segregation concerns on low-performing subjects on the RPM task being overrepresented at the worst schools do not arise in the TTC provided that ability types are uniformly distributed across provisional assignments (i.e., schools at which students have automatic priority), furthering the agenda for the implementation of strategy-proof mechanisms.

Consistent with previous experimental findings, the comparative statics of theory do not quite hold. The TTC mechanism achieves Pareto efficient outcomes in 45.9% of observations compared to 53.8% under the IA and 11.1% in the DA. The DA eliminates justified-envy in 88.9% of observations compared to 43.2% in the TTC and 15.4% in the IA. Focal equilibrium assignments are attained in 66.7%, 15.4% and 45.9% of cases in the DA, IA and TTC mechanisms, respectively.

Related Literature. Extensive experimental literature suggests that subjects frequently fail to report optimal strategies in both strategy-proof and manipulable mechanisms. Y. Chen & Sönmez (2006) provide the first experimental study comparing the three school choice mechanisms, DA, IA, and TTC, in an incomplete information setting. They find that the DA outperforms TTC in truthful preference revelation, despite the strategy-proofness of both mechanisms. Furthermore, they show that the TTC does not outperform DA in efficiency, although theoretically TTC is efficient whereas DA is not. Among the three mechanisms, the IA performs the worst in terms of truthful preference revelation and efficiency. While a stability comparison is not presented in Y. Chen & Sönmez (2006), using the same experimental setting, Calsamiglia et al. (2010) find that the DA is more stable than TTC, which in turn is weakly more stable than IA. Y. Chen et al. (2016) compare the performance of the three mechanisms using the same design as Y. Chen & Sönmez (2006) under a complete information setting. They find that the TTC outperforms DA, which in turn outperforms IA in truth-telling. Consistent with theory, the TTC outperforms both DA and IA in efficiency, whereas DA and IA generate similar efficiency levels. In terms of stability, the DA outperforms TTC and IA by a large margin, whereas IA and TTC achieve the same level of stability. Pais & Pintér (2008) find results that are consistent with theory – the TTC mechanism outperforms both the DA and IA mechanisms in efficiency and it is slightly more successful than DA in truthful reports, whereas manipulation is stronger under the Boston mechanism. Pais & Pintér (2008) find that under the DA and IA mechanisms the amount of information has a significant effect on the

average efficiency achieved by participants, while under the TTC mechanism average efficiency does not depend on the implemented information setting. In comparing stability between the DA and TTC, they find that the DA is more successful than TTC as theoretically expected. Most school choice experiments provide feedback to subjects on their assignments only after all reports have been finalized. Stephenson (2022) finds all three mechanisms achieve more equilibrium assignments under real-time assignment feedback than discrete feedback although real-time feedback did not reliably increase the frequency of truthful reporting in strategy-proof mechanisms. Guillen & Hakimov (2018) find that top-down advice increases the rate at which subjects truthfully report their top choice in the TTC.

The remainder of the paper is organized as follows. Section 2 characterizes the simplified and stylized school choice game that I will study in both a theoretical setting and its experimental application. Predictions are found in Section 3 and results follow in Section 4. Section 5 concludes.

2 School Choice Mechanisms and the Experiment

In a school choice problem, there is a finite number of students and schools. Each student has a strict preference over all schools, whereas each school has a maximum capacity and a strict priority ordering of all students. School priorities are imposed by the school district based on state and local laws, and a random lottery. The outcome of a school choice problem is referred to as a matching, which is an assignment of seats to students such that each student is assigned one seat and no school assigns more seats than its capacity. The experiment concerns three mechanisms: Deferred Acceptance (DA), Immediate Acceptance (IA) and Top Trading Cycles (TTC). Both DA and TTC are strategy-proof, IA is not.[1] The dominant strategy equilibrium implemented by DA eliminates justified-envy; the dominant strategy equilibrium implemented by TTC is efficient.[2] It is well known that no mechanism can generate a Pareto efficient outcome and simultaneously eliminate justified-envy in equilibrium (Abdulkadiroğlu & Sönmez, 2003). IA eliminates justified-envy in equilibrium. The following is a general description of the three matching algorithms.

[1] That is, reporting preferences truthfully is a (weakly) dominant strategy in both DA and TTC. IA is manipulable.

[2] Justified-envy occurs when a student prefers a school assigned to another student (causing envy) and has a higher priority at that school than the student currently assigned to it (making the envy justified).

2.1 Deferred Acceptance

DA asks applicants to submit a list of schools in rank order. Each student initially applies to her first reported choice. Each school tentatively accepts students in priority order until it runs out of seats and the remaining students are rejected. Students whose applications were rejected apply to their next highest reported choice. Each school then pools together the new applicants with those who are tentatively accepted. It then rejects the lowest ranked students in priority in excess of its capacity. This process repeats until no rejections are issued and each school is then matched with the students who are tentatively accepted.

2.2 Immediate Acceptance

IA asks applicants to submit a list of schools in rank order. Each student initially applies to her first reported choice. Each school accepts applicants in priority order until it runs out of seats and the remaining students are rejected. Students whose applications were rejected apply to their next highest reported choice. Each school accepts applicants in priority order for its remaining capacity and any rejected students apply to their next highest reported choice. This process repeats until every student is assigned to a school.

2.3 Top Trading Cycles

TTC asks applicants to submit a list of schools in rank order. The top trading cycles mechanism constructs a directed graph based on school priorities and submitted reports. Each school points to its highest priority student and each student points to her first reported choice. Since there are a finite number of schools and students, the directed graph will have at least one cycle. Students who are part of a cycle are assigned to the school they point to. The remaining applicants point to their highest reported choice that still has open seats. Each school points to their highest priority student among those that remain unassigned. Since there are a finite number of schools and students, the directed graph will have at least one cycle. Students who are part of a cycle are assigned to the school they point to. This process repeats until every student is assigned to a school.

2.4 The Experimental Game and Nash Equilibria

The experiment featured a 4-player game with four students and four schools. Each student had unique and strict preferences over schools that can be expressed in monetary terms (Table 1).

School priorities were fixed over the four students (Table 2) with each school having a capacity of one.

Table 1: Student Preferences over Schools for the 4-person Game

Utility of Assignment				
	School A	School B	School C	School D
Player 1	\$20	\$14	\$7	\$0
Player 2	\$20	\$14	\$0	\$7
Player 3	\$14	\$20	\$7	\$0
Player 4	\$14	\$20	\$0	\$7

Table 2: School Priorities

Priority Ranking				
	School A	**School B**	**School C**	**School D**
First	Player 3	Player 2	Player 4	Player 1
Second	Player 4	Player 3	Player 1	Player 2
Third	Player 2	Player 1	Player 3	Player 4
Fourth	Player 1	Player 4	Player 2	Player 3

Both the DA and TTC mechanisms implement a game where truth-telling is a (weakly) dominant strategy Nash equilibrium. Under the DA mechanism, the following assignment of students to schools occurs when all players play dominant (i.e., truthful) strategies,

$$\mu = \begin{Bmatrix} 1 & 2 & 3 & 4 \\ & & & \\ C & B & A & D \end{Bmatrix}. \tag{1}$$

In the focal equilibrium assignment of DA, μ, Player 1 is assigned to School C, Player 2 is assigned to School B, Player 3 is assigned to School A and Player 4 is assigned to School D. Under the TTC mechanism, a different assignment of students to schools occurs when all players play dominant (i.e., truthful) strategies,

$$\mu' = \begin{Bmatrix} 1 & 2 & 3 & 4 \\ & & & \\ C & A & B & D \end{Bmatrix}. \tag{2}$$

In this matching, μ', Players 1 and 4 are assigned to the same schools as in matching μ, but Players 2 and 3 are assigned to strictly better schools. While matching μ' Pareto dominates μ, it does not eliminate justified-envy. Player 4 prefers School A over School D, and has a higher priority

at School A than Player 2.

In its focal equilibrium, IA implements the focal equilibrium assignment of DA, namely μ. To illustrate this outcome, I use the level-k framework proposed by Zhang (2021) in which applicants run a variant of DA in their minds to determine the optimal first choice, where applicants of higher levels run more steps. At the first level, namely Level-0 (L0), the applicants are naive, lack strategic reasoning, and report preferences truthfully; thereafter, incentives arise to report the next best achievable alternative as the first choice with each consecutive rejection.[3] I assume that every Lk player believes that all the others are L$k-1$ (Stahl & Wilson, 1994, 1995; Nagel, 1995; Crawford & Iriberri, 2007a,b). For the complete information game described above, these levels can be characterized based on the first choice in the ranked-order report as follows:

- **Level 0:** Applicants report preferences truthfully.

  i) Players 2 and 3 are assigned to schools A and B, respectively.

  ii) Players 1 and 4 are assigned to their third-best choices, namely schools C and D, respectively.

- **Level 1:** Players 1 and 4 report their second choice first. 2, 3 respectively report A, B as the first choice.

  i) Player 1 applies to School B but has a lower priority than its current assignment (Player 3). Player 1 is assigned to her third-best choice (School C), the best possible alternative after two rejections.

  ii) Player 4 is assigned to School A which in turn leads to Player 2 being assigned to her third-best choice (School D).

- **Level 2:** Player 1 reports her third choice first and Player 2 reports her second choice first. 3, 4 respectively report B, A as the first choice.

  i) Player 1 applies to School C and since she is the only applicant, she is assigned to it.

  ii) Player 2 applies to School B and since she has a higher priority than its current assignment (Player 3), Player 2 is assigned to it. Player 3 is assigned to her fourth-best choice (School D).

- **Level 3:** Player 3 reports her second choice first. 1, 2, 4 respectively report C, B, A as the first choice.

  i) Player 3 applies to School A and since she has a higher priority than its current assignment

[3]The implied DA variant posits that an applicant cannot reapply at the same school after a rejection in a previous step.

(Player 4), Player 3 is assigned to it. Player 4 is assigned to her third-best choice (School D), the best possible alternative after two rejections.

- **Level 4:** Player 4 reports her third choice first. 1, 2, 3 respectively report C, B, A as the first choice.

  i) Player 4 applies to School D and since she is the only applicant, she is assigned to it.

- **Level $k \geq 5$:** 1, 2, 3, 4 respectively report C, B, A, D as the first choice at all levels higher than 4.

While level $k \geq 4$ summarizes the focal equilibrium outcome, it does not fully summarize equilibrium strategies. It should be noted that in the equilibria of IA, players 2 and 3 *Skip-the-Top* and report their second choice first. Player 4 similarly *Skips-the-Top* in equilibrium by reporting her second choice first with a further imposition that she also reports her third choice ahead of her fourth choice in the focal outcome.[4] For Player 4, it suffices that she reports her third choice ahead of her fourth in this equilibrium. Characterizing reasoning levels in the focal equilibrium, it suffices for Player 1 to exhibit L0 reasoning,[5] Player 4 to exhibit L1 reasoning, Player 2 to exhibit L2 reasoning, and Player 3 to exhibit L3 reasoning. Further, it should be noted that in DA, Player 4 is assigned to School D for any reasoning level she may have if other players report their weakly dominant (truthful) strategies. Moreover, an Lk Player 4 for $k \leq 3$ prevents players 2 and 3 from being assigned to their first choice, which they could obtain if $k > 3$, thus making Player 4 bossy in DA.

Table 3 summarizes the Nash equilibrium assignments by mechanism. In the strategy-proof DA and TTC, players 2 and 3 obtain either their best or second-best schools, and players 1 and 4 obtain either their third-best or fourth-best schools. In the manipulable IA, players 2 and 3 obtain their second-best schools, and players 1 and 4 obtain either their third-best or fourth-best schools. Since each player role is asked to submit a strict preference ranking report over the four schools and therefore has 24 different strategies to choose from, i.e. $4! = (4)(3)(2)(1) = 24$, I aim to succinctly describe the Nash equilibria that result in the different allocations across the three mechanisms:

- In DA,

[4]Reporting the third choice ahead of the fourth is Player 4's best-response to players 2 and 3 *Skipping-the-Top*. Importantly, if Player 4 reports her third choice as the first, this creates incentives for players 2 and 3 to report truthfully which allows them to obtain their first choice. But this, in turn, creates incentives for Player 4 to *Skip-the-Top*, hence she reports her second choice as the first in equilibrium.

[5]The truthful report is in the set of equilibrium strategies for Player 1.

- Allocations μ' and λ': players 2 and 3 report their first two choices truthfully and obtain their best school.[6]

  Allocations μ and λ: players 2 and 3 report either i) their second choice first, or ii) their first two choices truthfully.[7] They both obtain their second-best school.

- Allocations μ and μ': players 1 and 4 report their third choice ahead of their fourth and obtain their third-best school. Player 4 further reports her third choice ahead of her second choice in allocation μ', and may or may not report her third choice ahead of her second in allocation μ.

  Allocations λ and λ': players 1 and 4 report their fourth choice ahead of their third and obtain their fourth-best school. Player 4 further reports her fourth choice ahead of her second choice in allocation λ', and may or may not report her fourth choice ahead of her second in allocation λ.

• In IA,

- Allocations μ and λ: players 2 and 3 report their second choice first and obtain their second-best school.

- Allocation μ: Player 1 reports her third choice ahead of her fourth choice, and Player 4 reports her second choice first with a further imposition that she also reports her third choice ahead of her fourth. Both players obtain their third-best school.

  Allocation λ: Player 1 reports her fourth choice ahead of her third choice, and Player 4 reports her second choice first with a further imposition that she also reports her fourth choice ahead of her third. Both players obtain their fourth-best school.

• In TTC,

- Allocations μ' and λ': players 2 and 3 report their first choice truthfully and obtain their best school.

  Allocations μ and λ: players 2 and 3 report their second choice first and obtain their second-best school.

- Allocations μ and μ': players 1 and 4 report their third choice ahead of their fourth and obtain their third-best school.

[6] In allocation μ', players 2 and 3 could also report their first choice truthfully, school C second, and their second choice third.

[7] In allocation μ, players 2 and 3 could also report their first choice truthfully, school C second, and their second choice third.

Allocations λ and λ': players 1 and 4 report their fourth choice ahead of their third and obtain their fourth-best school.

Table 3: Nash Equilibrium Assignments by Mechanism

Matching Allocation	Assignment (Player-School)	Payoffs	Nash Equilibrium Outcome		
			DA	IA	TTC
μ	1-C, 2-B, 3-A, 4-D	$(7, 14, 14, 7)$	✓	✓	✓
μ'	1-C, 2-A, 3-B, 4-D	$(7, 20, 20, 7)$	✓	✗	✓
λ	1-D, 2-B, 3-A, 4-C	$(0, 14, 14, 0)$	✓	✓	✓
λ'	1-D, 2-A, 3-B, 4-C	$(0, 20, 20, 0)$	✓	✗	✓

Allocations μ and λ eliminate justified-envy.

2.5 Experimental Design and Procedures

The experiment implemented the game described in Section 2.4 in a 3×2 between-subject design. Subjects experienced the three aforementioned mechanisms {DA, IA, TTC} under FULL feedback where they learned the assignments of all other players after the game concluded, or PARTIAL feedback, where they only learned their own assignment. In the FULL feedback condition, subjects also receive a message with their relative rank at a more desirable option if they are not assigned to their most preferred option. In the PARTIAL feedback condition, subjects are informed of their assignment only, with no knowledge of others' assignments. Mechanism assignment was randomly assigned at the session level and feedback was randomly assigned at the individual level.

Before the experiment began, subjects underwent an eye-tracking calibration routine. In this paper, I assess subjects' visual attention in the manipulable IA mechanism during the reporting stage of ranked-order preferences.

At the start of each session, the instructions were read aloud and any questions were answered privately. Given the relatively complex nature of matching mechanisms, subjects were allowed to read instructions again at their own pace if they wished to do so. After subjects finished reading instructions, a quiz was administered to ensure comprehension. Questions were intended to check that subjects understood (i) option capacities, (ii) how to read payoff and priority ranking tables, and (iii) how to solve a simple allocation problem given others' reports. Subjects were required to pass the quiz and correct any incorrect responses before proceeding. Instructions and the comprehension quiz are available in the Appendix.

Subjects were randomly assigned to groups of four and each subject was randomly assigned to one of four preference types (1, 2, 3 or 4). Subjects played four unpaid "practice" rounds of

similar school choice games so they could become familiar with the decision environment and the nature of the matching mechanisms. In each practice round, subjects were randomly matched, and faced a new set of preference profiles and priorities; all differed from those shown in Tables 1 and 2. The overall structure of preferences and priorities were constant across experimental sessions and treatments. Before starting the incentivized one-shot game, subjects were informed that their earnings depend on the outcome of the following round. This round featured the game described in Section 2.4 and was the sole basis for (differential) payoffs for subjects.

After the school choice game, subjects answered an open-ended question on how they played the game and other questions on their perceptions of the manipulability of a mechanism. Finally, they completed a shortened version of the Raven's Progressive Matrices task (Raven, 2000).[8]

A total of 39 sessions which contained 72 groups for 288 participants took place at the Human Behavior Lab at Texas A&M University between April 2021 and July 2022. Of these groups, 9 participated in the DA sessions, 26 participated in the IA sessions, and 37 in the TTC sessions; the TTC was oversampled compared to DA in the interest of obtaining observations that experience justified-envy (Vitaku et al., 2026). The sessions lasted approximately one hour and subjects earned \$24.03 (sd=6.343) on average including a \$10 participation payment.

3 Predictions

Section 2.4 provides equilibrium predictions under dominant strategy (truthful) play in the experiment for both the TTC and DA mechanisms. In these focal equilibria, the TTC leads to an outcome that is efficient but creates justified-envy; conversely, assignments under the DA eliminate justified-envy but they are not efficient. These same assignments that eliminate justified-envy but that are not efficient occur in the focal equilibria of IA. While it is unlikely that every subject group will resemble focal equilibrium predictions exactly, I predict that comparative statics will hold.

Prediction 1. *Comparative statics of focal equilibrium predictions will hold. That is,*

[8]The Raven test is a leading non-verbal measure of analytic intelligence (Carpenter et al., 1990; Gray & Thompson, 2004). The test scores are associated with the degree of sophistication in the beauty contest (Gill & Prowse, 2016), with cooperation rates in both lab and field settings (Proto et al., 2019; Han et al., 2024), with performance in Bayesian updating (Charness et al., 2018) and with more accurate beliefs (Burks et al., 2009). Each question of the test asks to identify a missing element that completes a visual pattern from a list of candidates. The Standard version of the Raven test consists of 60 questions split into 5 blocks of increasing difficulty, labeled A–E, with 12 questions in each. I used blocks C, D and E for a total of 36 questions as in Basteck & Mantovani (2018). Subjects were given 5 minutes for each of blocks C and D, and 8 minutes to complete block E. Each block was shown on a separate page and subjects could change their answers as many times as they wished. Participants were awarded \$0.10 for each correct answer.

1. *The TTC mechanism will produce more efficient assignments than the DA and IA. DA and IA will produce a similar number of efficient assignments.*

2. *The DA and IA mechanisms will produce fewer assignments with justified-envy than the TTC. DA and IA will produce a similar number of assignments without justified-envy.*

3.1 Heterogeneity Among Cognitive Types

In IA, equilibrium strategies of players 2 and 3 can be summarized as *Skip-the-Top* where they each report their second choice first with no further impositions on ranked-order reports. Player 4 should similarly *Skip-the-Top* by reporting her second choice first, and also report her third choice ahead of the fourth in the focal outcome. For Player 1, on the other hand, a truthful report is in the set of this equilibrium outcome. Based on the characterization of reasoning levels in section 2.4 (Zhang, 2021), it suffices that Player 1 exhibits reasoning L0, Player 4 exhibits reasoning L1, Player 2 exhibits reasoning L2, and Player 3 exhibits reasoning L3. Assuming that the population distribution is decreasing in reasoning levels as is typically reported in previous studies (C.-T. Chen et al., 2018; Camerer et al., 2004), I predict that the probability of focal equilibrium play will decrease in level-k reasoning.

Prediction 2. *In IA, probability of focal equilibrium play based on the randomly assigned player roles and level-k reasoning will follow:*
Player 1 (L0)>Player 4 (L1)>Player 2 (L2)>Player 3 (L3).

Basteck & Mantovani (2018) document systemic differences in strategizing in the DA and IA mechanisms based on median ability classification on a shortened version of Raven's Progressive Matrices (RPM) task. They show that higher ability participants strategize better under the manipulable IA and receive higher payoffs. In the case of the strategy-proof DA and TTC mechanisms, focal equilibria correspond to truth-telling. Nonetheless, that study finds that the DA leads to no or a reduced difference in payoffs between subjects with high and low scores on the RPM. I do not expect this to be the case with the TTC. While equilibrium outcomes in the DA depend on Player 4, who is bossy and decides whether players 2 and 3 obtain their best or second-best schools, the focal equilibrium outcome in TTC requires multiple players to report truthfully.[9] Hence, efficient multi-way cycles in the TTC hinge on everyone's ability to recognize the mechanism's strategy proofness.

[9]This outcome can be attained through some non-truthful reports too as mentioned in section 2.4.

Prediction 3. *High-scoring subjects on the RPM task will be more likely to report focal equilibrium strategies than low-scoring subjects in all three mechanisms. Earnings will be similar for both types of subjects under the DA, but high scoring subjects will earn more under the TTC.*

4 Results

Result 1. *Theoretically predicted comparative statics hold in comparing DA and TTC, but not in comparing IA and DA, nor IA and TTC. That is,*

1. *The DA mechanism achieves fewer efficient assignments than TTC, and DA achieves more assignments without justified-envy than TTC.*

2. *The DA mechanism achieves fewer efficient assignments than IA, and DA achieves more assignments without justified-envy than IA.*

3. *The IA mechanism achieves a comparable number of efficient assignments to TTC, and IA achieves fewer assignments without justified-envy than TTC.*

Table 4 examines group-level outcomes of whether the three mechanisms achieved focal equilibrium assignments, efficiency, and eliminated justified-envy. The TTC achieves efficiency but does not eliminate justified-envy in its focal equilibrium.[10] The DA, in its focal equilibrium, eliminates justified-envy but does not achieve efficiency. IA attains this same allocation that eliminates justified-envy but does not achieve efficiency in its focal equilibrium. The comparative statics of theory as laid out in Prediction 1 do not quite hold with the exception of the comparison between the DA and TTC. The elimination of justified-envy is achieved in all but 1 DA group (88.9%) and about half of the TTC groups (43.2%) (Wilcoxon rank-sum test, $p = 0.032$; two-sided t-test, $p = 0.013$). In IA, the elimination of justified-envy is achieved in only a few groups (15.4%) (IA vs. DA: Wilcoxon rank-sum test, $p < 0.001$; two-sided t-test, $p < 0.001$. IA vs. TTC: Wilcoxon rank-sum test, $p = 0.036$; two-sided t-test, $p = 0.019$). In contrast, only 1 (11.1%) DA group achieved an efficient assignment compared to nearly half (45.9%) the TTC groups (Wilcoxon rank-sum test, $p = 0.114$; two-sided t-test, $p = 0.057$). In IA, nearly half (53.8%) the groups achieve an efficient assignment (IA vs. DA: Wilcoxon rank-sum test, $p = 0.058$; two-sided t-test, $p = 0.025$. IA vs.

[10] In this equilibrium, two efficient two-way cycles form between the pair of players 2 and 3 for their first choice, and between players 1 and 4 for their third choice. Inefficient equilibria also exist for both player pairs as noted in section 2.4. For strategy profiles satisfying weak payoff monotonicity, Velez & Brown (2019) show no sub-optimal equilibrium of the TTC is an empirical equilibrium.

TTC: Wilcoxon rank-sum test, $p = 0.712$; two-sided t-test, $p = 0.545$). Mean player payoffs are \$10.06, \$11.09 and \$11.64 in DA, IA and TTC, respectively. Of the three pairwise comparisons, only the difference between the DA and TTC groups is meaningful (Wilcoxon rank-sum test, $p = 0.087$; two-sided t-test, $p = 0.032$).

Table 4: Group-Level Outcomes of Deferred Acceptance (DA), Immediate Acceptance (IA) and Top Trading Cycles (TTC) Mechanisms

	Groups	Focal Equilibrium Assignments	Efficiency	Elimination of Justified-Envy
DA	9	6 (66.7%)*	1 (11.1%)	8 (88.9%)
IA	26	4 (15.4%)*	14 (53.8%)	4 (15.4%)
TTC	37	17 (45.9%)†	17 (45.9%)	16 (43.2%)
Total	72	27 (37.5%)	32 (44.4%)	28 (38.9%)

* Allocation μ (1-C, 2-B, 3-A, 4-D).
† Allocation μ' (1-C, 2-A, 3-B, 4-D).

I examine the robustness of Result 1 in a linear probability model. This specification controls for possible session-level correlations between groups from play in practice rounds as well as the number of subjects in the FULL treatment who received additional feedback at random.[11] I report regression results in Table 5. DA is not more likely to achieve equilibrium assignments as those attained through truthful revelation than TTC ($p = 0.234$) and IA is 31 probability points less likely to achieve its focal equilibrium outcome than TTC's own; DA is 51 probability points more likely to achieve its focal equilibrium outcome than IA is to achieve the same. Consistent with theory, DA is 35 probability points less likely to achieve an efficient outcome than TTC. In contrast with theory, IA achieves a similar efficiency level as TTC (p=0.479) and IA is 43 probability points more likely to achieve an efficient outcome than DA. DA is 46 and 73 probability points more likely to achieve an outcome that eliminates justified-envy than TTC and IA, respectively. IA is 28 probability points less likely to achieve an outcome that eliminates justified-envy than TTC.

Given the theoretically predicted comparative statics of the experiment do not quite hold, I turn to examining systemic differences in strategizing as causes behind these failures.

[11] Subjects assigned to the FULL treatment received additional feedback over the four practice rounds. While this assignment was done randomly and exogenous to other treatments, it is possible that subjects assigned to treatment FULL may act differently.

Table 5: Linear probability model of theoretical properties on mechanism and number of FULL treated subjects in group

	(1) Focal Equilibrium Assignments	(2) Efficiency	(3) Elimination of Justified-Envy
DA	0.207	-0.348**	0.456***
mechanism	(0.171)	(0.139)	(0.145)
IA	-0.306***	0.079	-0.279**
mechanism	(0.096)	(0.111)	(0.105)
# of FULL	-0.048	-0.143*	0.048
treated subjects	(0.085)	(0.077)	(0.069)
constant	0.555***	0.745***	0.337**
	(0.195)	(0.182)	(0.167)
Observations	72	72	72
Sessions	39	39	39

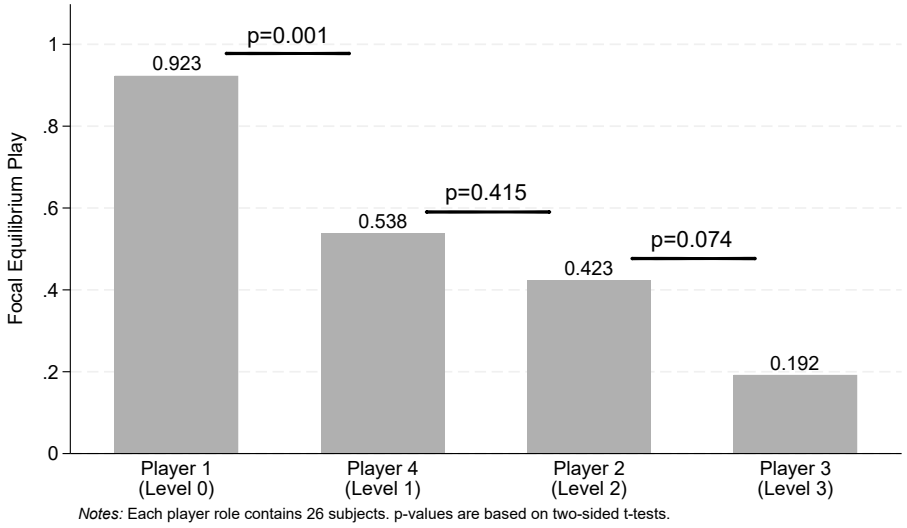
Notes: All three regression models report cluster-robust standard errors at the session level in parentheses. TTC is omitted.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$

Result 2. *Probability of focal equilibrium play is decreasing in level-k reasoning in the manipulable IA mechanism.*

As suggested in Result 1, theoretically predicted comparative statics especially do not hold for comparisons involving the IA mechanism. Hence, I first examine systemic failures in reporting focal equilibrium strategies in this mechanism. Since each player role is asked to submit a strict ranked-order report over the four options, each player has 24 different strategies to choose from, i.e. $4! = (4)(3)(2)(1) = 24$. Of these, only a subset are contained in the set of focal equilibria for a given player role as described in section 2.4. These strategies were clearly described and characterized in accordance with level-k reasoning (Zhang, 2021). Figure 1 shows the proportion of subjects reporting a focal equilibrium strategy by player role and associated equilibrium reasoning level.[12] Consistent with Prediction 2, the probability of focal equilibrium play is decreasing in level-k reasoning. Regressing probability of focal equilibrium play in a linear or probit model on equilibrium reasoning level (ranging between 0 and 3) yields a negative and statistically significant coefficient ($p < 0.001$) with the inclusion/exclusion of controls for session-level correlations between groups, randomly assigned feedback from practice rounds and performance on the RPM task.

[12]While level-k reasoning makes signed predictions, I report two-sided tests to be conservative.

Figure 1: Probability of Reporting a Focal Equilibrium Strategy in IA by Player Role



Notes: Each player role contains 26 subjects. p-values are based on two-sided t-tests.

To further examine failures in reporting equilibrium strategies in IA, I turn to the visual attention of Player 2 and 3 subjects during the reporting stage of ranked-order preferences.[13] I focus on these roles since equilibrium strategies require non-truthful preference reports that can be summarized by the first choice and subjects in these roles are least likely to report a focal equilibrium strategy of the four preference types.[14] Figure 2 provides heatmaps of fixation durations from the preference reporting stage averaged across subjects assigned to respective player roles. In both exhibits, subjects seem to allocate more attention toward the induced preferences (left table) than the priority orderings (right table). Subjects in both roles appear to similarly reference the row corresponding to their own induced payoffs most frequently. While subjects assigned to the Player 2 and 3 roles seem to allocate similar attention toward the priorities at Option B, subjects assigned to the Player 2 role seem to allocate more attention toward the priority of Player 4 at Option A than those assigned to the Player 3 role. Indeed, the average fixation count on Player 4's priority at Option A of subjects assigned to the role of Player 2 is 7.83 and of those assigned to the role of Player 3 is 4.29 (Wilcoxon rank-sum test, $p = 0.151$; two-sided t-test, $p = 0.148$).[15] Recalling reasoning levels, Player 2 responds to Player 4 by submitting Option B as the first choice at Level-2, while Player 3 responds to Player 2 (who responded to Player 4 in the previous level) by submitting

[13] 8 out of the 52 subjects assigned to these roles could not pass the eye-tracking calibration routine at the start of the sessions; hence these data include observations from 44 subjects.

[14] The truthful strategy is in the set of best-responses for players 1 and 4 assuming players 2 and 3 report equilibrium strategies by *Skipping-the-Top*.

[15] I examine fixations that are longer than 100 milliseconds since this duration has been shown to be an accurate threshold to discriminate between meaningful visual attention and passing moments (Manor & Gordon, 2003).

Figure 2: Heatmaps from the Preference Reporting Stage in IA

(a) Player 2



(b) Player 3



Option A as the first choice at Level-3. Additionally, level-k reasoning would predict that the gaze of a Player 3 subject needs to transition between the induced preferences table and the priority orderings at options A and B more frequently than a Player 2's in order to report an equilibrium

strategy. The difference in the likelihood of reporting an equilibrium strategy between Player 2 and 3 roles, however, coincides with the difference in the number of eye-movements between the two tables as Player 2 subjects averaged 27.3 transitions while Player 3 subjects averaged 18.9 transitions (Wilcoxon rank-sum test, $p = 0.135$; two-sided t-test, $p = 0.204$). Taken together, these patterns corroborate the level-k model not only as a theory of final choices, but also as a procedural theory of strategic decision-making (C.-T. Chen et al., 2018).

Lastly, a pattern emerges from these heatmaps, suggesting that subjects assigned to the Player 2 and 3 roles refer to the row corresponding to their own induced payoffs most frequently in a manipulable mechanism where they have incentives to not report preferences truthfully in equilibrium. Figure 3 shows the proportion of gaze time allocated toward different Areas of Interest (AOIs) averaged among participants assigned to respective player roles. I evaluate possible statistical differences in the mean proportion of time participants spent on their own and their counterparts' payoffs. Results indicate that subjects spent a significantly greater proportion of time gazing at their own payoffs (mean=0.078) compared to the payoffs of others (mean=0.041) (Wilcoxon paired test, $p < 0.001$). This pattern has been similarly observed in previous studies that have used mouse and eye-tracking techniques (Costa-Gomes et al., 2001; Wang et al., 2010; Polonio et al., 2015; Devetag et al., 2016).

Figure 3: The bold rectangles represent AOIs (not visible to the subjects) and the numbers in bold correspond to the proportion of gaze time allocated in each AOI averaged among participants assigned to respective player roles

(a) Player 2

Earnings by Assignment					
	Option A	Option B	Option C	Option D	
Player 1	$20	$14	$7	$0	**0.049**
Player 2	$20	$14	$0	$7	**0.086**
Player 3	$14	$20	$7	$0	**0.048**
Player 4	$14	$20	$0	$7	**0.023**

Priority Ranking				
	Option A	**Option B**	**Option C**	**Option D**
First	Player 3	Player 2	Player 4	Player 1
Second	Player 4 **0.019**	Player 3	Player 1	Player 2
Third	Player 2	Player 1	Player 3	Player 4
Fourth	Player 1	Player 4	Player 2	Player 3

(b) Player 3

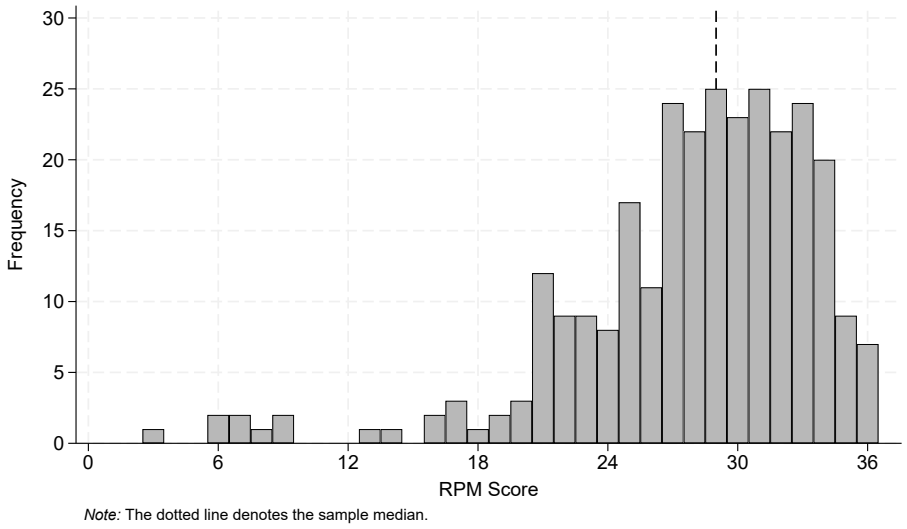
Earnings by Assignment					
	Option A	Option B	Option C	Option D	
Player 1	$20	$14	$7	$0	**0.041**
Player 2	$20	$14	$0	$7	**0.054**
Player 3	$14	$20	$7	$0	**0.070**
Player 4	$14	$20	$0	$7	**0.029**

Priority Ranking				
	Option A	**Option B**	**Option C**	**Option D**
First	Player 3	Player 2	Player 4	Player 1
Second	Player 4 **0.013**	Player 3	Player 1	Player 2
Third	Player 2	Player 1	Player 3	Player 4
Fourth	Player 1	Player 4	Player 2	Player 3

Result 3. *Consistent with previous literature, subjects with above-median scores on the Raven's Progressive Matrices task are more (less) likely to report truthfully in strategy-proof (manipulable) mechanisms. While these subjects do not receive higher payoffs under the DA, they do receive higher payoffs under the TTC.*

Previous literature finds subjects that perform better on a shortened version of Raven's Progressive Matrices (RPM) task are more likely to report strategies in line with the theoretical properties of the DA and IA mechanisms (Basteck & Mantovani, 2018). I examine this result in the same set of mechanisms as well as in the TTC. Figure 4 shows the distribution of the RPM scores for subjects in the experiment. The distribution is bounded at 36 and shows a negative skew and has mean of 28 and median of 29.

Figure 4: Distribution of RPM Scores



I first divide the subjects into above median and below median groups based on their RPM score.[16] Table 6 specification (1) provides regression results of truthful play of subjects based on the above (below) median classification of their RPM score. While reporting preferences truthfully is a (weakly) dominant strategy in the two strategy-proof DA and TTC mechanisms, it is in the set of focal equilibria only for Player 1 in IA. In DA, subjects who score above median on the RPM are 24.1 percentage points more likely to report ranked preferences truthfully than below median

[16]Subjects with a median score were separated by the time used to complete the task where subjects that took less time to completion are categorized as above median. 25 subjects had an RPM score of 29. The median subject in time used to complete the task was randomly categorized as below median. None of the results are affected if this subject is categorized as above median instead.

subjects ($0.079 + 0.162 = 0.241$, $p = 0.024$). Similarly under the TTC, above median subjects are more likely to report preferences truthfully than their below median counterparts (0.079, $p = 0.034$). Conversely, in the manipulable IA, above median subjects are 16.6 percentage points less likely to report preferences truthfully than their below median counterparts ($0.079 - 0.246 = -0.166$, $p = 0.053$). Taken together, these results align well with the findings in Basteck & Mantovani (2018) on the role of cognitive ability in reporting (non-)truthful preferences in strategy-proof (manipulable) mechanisms. Specification (2) examines focal equilibrium play. We observe similar patterns hold in both the DA and TTC mechanisms where above median subjects are 27.9 percentage points ($0.117 + 0.162 = 0.279$, $p = 0.048$) and 11.7 percentage points ($p = 0.037$) more likely to report a focal equilibrium strategy, respectively. In IA, above median subjects on the RPM are not more likely to report focal equilibrium strategies than their below median counterparts ($0.117 - 0.037 = 0.080$, $p = 0.440$).[17]

Table 6: Linear probability model of truthful reporting, focal equilibrium reporting and received rank by median ability classification on the RPM (High)

	(1) reports truthfully	(2) reports focal equilibrium strategy	(3) received rank (1=best, 4=worst)
High	0.079**	0.117**	-0.171**
	(0.036)	(0.054)	(0.065)
DA mechanism	-0.183	-0.064	0.229*
	(0.115)	(0.117)	(0.116)
DA mechanism ×	0.162	0.162	0.049
High	(0.109)	(0.148)	(0.148)
IA mechanism	0.078	-0.284***	-0.092
	(0.067)	(0.088)	(0.109)
IA mechanism ×	-0.246**	-0.037	0.364**
High	(0.092)	(0.118)	(0.168)
constant	0.535***	1.020***	3.031***
	(0.091)	(0.067)	(0.124)
Observations	288	288	288
Sessions	39	39	39

Notes: All regression models report cluster-robust standard errors at the session level in parentheses. TTC is omitted. Each model includes controls for randomly assigned player roles and feedback treatment.
***$p < 0.01$, **$p < 0.05$, *$p < 0.10$

Specification (3) turns to examining payoff differences across mechanisms based on median

[17]For subjects assigned to Player 2 and 3 roles, whose equilibrium strategy can be summarized by the first choice in the ranked report and is characterized as *Skip-the-Top*, above median subjects on the RPM are roughly twice more likely to report such a strategy than their below median counterparts which is in line with the findings in Basteck & Mantovani (2018).

ability classification on the RPM task. The dependent variable takes on integer values between 1 and 4 to capture received rank assignment based on one's own induced preferences and therefore earnings in the school choice game. Above median subjects on the RPM receive similarly ranked assignments compared to their below median counterparts in both the DA ($-0.171+0.049 = -0.122$, $p = 0.359$) and IA ($-0.171 + 0.364 = 0.193$, $p = 0.230$).[18] In the TTC, however, above median subjects receive higher ranked assignments (-0.171, $p = 0.013$). Having established that above median subjects are significantly more likely to report truthful (and focal equilibrium) strategies in the TTC, this result is entirely expected. Recall, in the focal equilibrium of TTC, two two-way cycles form between the pair of players 2 and 3 for their first choice, and between players 1 and 4 for their third choice.[19] For these efficient cycles to form, it is necessary that both players in the pair (2 and 3, or 1 and 4) report focal equilibrium strategies. Indeed, examining the group composition of pairs based on median ability classification on the RPM, above median-above median pairs achieve the top payoff for player type (first or third choice) most frequently (84.2%, 16 out of 19 pairs), followed by below median-above median pairs (70.3%, 26 out of 37 pairs), and both below median pairs (55.6%, 10 out of 18 pairs).

5 Concluding Discussion

In this paper, I examine systemic deviations from focal equilibrium play in school choice games resulting from differences in strategic sophistication and cognitive ability. I first investigate theoretically predicted comparative statics of three mechanisms, Deferred Acceptance (DA), Immediate Acceptance (IA) and Top Trading Cycles (TTC), and find predictions especially do not hold for comparisons involving the IA mechanism. The results highlight systemic failures in reporting focal equilibrium strategies in IA consistent with level-k reasoning (Zhang, 2021). I further confirm previous findings of Basteck & Mantovani (2018) that above median subjects on the Raven's Progressive Matrices (RPM) task are more (less) likely to report truthfully in the strategy-proof (manipulable) DA (IA) mechanism and extend their results by showing a similar pattern for the strategy-proof TTC. I then show that unlike in the DA where above and below median subjects on the RPM

[18] Basteck & Mantovani (2018) find above median subjects on the RPM receive higher payoffs in IA while payoff differences are reduced or eliminated under DA. In their experimental setting, there is almost full consensus on the rank-order preference of schools while in the present paper consensus exists only on the top two and the bottom two schools. They find that payoff differences between ability types in IA are primarily driven by above median subjects on the RPM reporting the third choice as second more frequently.

[19] In all TTC group outcomes, Player 2 and 3 subjects received either their first or second choice, and Player 1 and 4 subjects received either their third or fourth choice.

earn similar payoffs, above median subjects receive higher payoffs in the TTC due to the strategic complements of the algorithm.

In addition to the payoff differences between ability types, Basteck & Mantovani (2018) further show that an ability segregation emerges in IA where below median subjects on the RPM are overrepresented at the worst schools. Such segregation is not observed in the DA, however, further supporting the implementation of strategy-proof mechanisms for creating a level playing field. In the experiment, I show that above median subjects on the RPM receive higher payoffs in the TTC since they are more likely to report truthful (and focal equilibrium) strategies. Although this result may create concerns that the TTC does not create a level playing field, theoretically it can be shown that distributional concerns on below median types being overrepresented at the worst schools do not arise under TTC provided that ability types are uniformly distributed across provisional assignments.[20] Intuitively, consider the following three cases:

i) if two above median students on the RPM form an efficient two-way cycle with their provisional assignments, these students end up exchanging seats at their respective schools with school compositions effectively remaining the same;

ii) if two below median students on the RPM fail to form an efficient two-way cycle, school compositions similarly remain unaffected;

iii) if an above median-below median pair fails to form an efficient two-way cycle because the below median type does not report a focal equilibrium strategy, each school naturally has more students of one ability type. This segregation, however, is counterbalanced if another such pair exists with opposite provisional assignments.

A similar argument to the above can be extended to three- or four-way cycles, hence distributional concerns that the TTC leads to ability segregation across schools are put to rest provided that ability types are uniformly distributed across provisional assignments. Table 7 shows the distribution of below (and above) median subjects on the RPM across schools based on provisional and received assignments. We observe that below and above median subjects on the RPM have roughly equal representations at each school based on their provisional assignments, as subjects were randomly assigned to player roles. Since ability types are not perfectly balanced in provisional assignments, instead of directly comparing received assignments of below and above median subjects on the RPM, I examine if distributions of received and provisional assignments significantly

[20] I refer to a school at which one has automatic priority (for example, based on sibling attendance laws) as a provisional assignment. A one-way cycle is formed with a school at which one has automatic priority by reporting it as the first.

differ for a given ability type. We observe that below (and above) median subjects on the RPM have equal representations based on their provisional and received assignments at schools C and D. At schools A and B, there are small deviations in received assignments from representations in provisional assignments with below median subjects being slightly less (more) represented at school A (B). We cannot reject the hypothesis that the distribution of below median subjects across schools is comparable based on their received and provisional assignments (chi-square test, $p = 0.973$), which is in line with the intuition that segregation by ability does not arise in TTC.

Table 7: Distribution of Below (Above) Median Subjects on the RPM task across Schools based on Provisional and Received Assignments in the TTC

School	Provisional Assignment	Received Assignment
A	19 (18)	17 (20)
B	16 (21)	18 (19)
C	20 (17)	20 (17)
D	18 (19)	18 (19)
Total	73 (75)	73 (75)

School choice continues to be a divisive topic in education reform. In recent years, although school boards have increasingly adopted strategy-proof mechanisms, i.e. variants of DA and TTC, trade-offs remain in implementing equitable and efficient mechanisms. School boards may further have distributional concerns so as to reduce gaps in educational prospects; for example, teachers may be incentivized based on the performance of their students on standardized exams hence the importance of creating a level playing field in appropriately motivating educators. Additionally, students tend to gain from the presence of high ability peers, independent of their own ability (Henderson et al., 1978; Lavy et al., 2012). I showed segregation by ability does not arise in the TTC provided that ability types are uniformly distributed across provisional assignments. In the experiment, moving from the DA to the TTC mechanism under dominant strategy (truthful) play presents a Pareto improvement as two students are assigned to the same schools and two students are assigned to strictly better schools. I suspect a Player 4 subject who experiences justified-envy in the focal equilibrium of TTC would be indifferent about her/his experience had she/he known she/he would receive the same assignment under the DA; hence the consideration for implementing a strategy-proof mechanism from a set of such mechanisms and comparing allocative outcomes ex-post. Together with the findings from this paper, Vitaku et al. (2026) offer insights to school boards on implementing equitable and efficient mechanisms.

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Appendix

Instructions (DA)

Introduction

This is an experiment in economic decision making. If you pay attention to these instructions, you can earn a significant amount of money. If you have any questions, raise your hand and we will come to assist you. Your earnings will depend on the decisions you make and the decisions made by other participants during the experiment. These earnings will be paid in addition to your $10 show-up payment.

Instructions

This experiment consists of 1 round, and your earnings depend on the decisions you make and the decisions made by other players in that round. First, there will be 4 practice rounds for you to familiarize yourself with the decision environment. These practice rounds will not affect your earnings. At the beginning of each round, you will be randomly assigned to groups of 4. Each round has 4 options: Option A, Option B, Option C and Option D. Each option will be exclusively assigned to one of the players in the group. For every round, each player submits a preference ranking for every option from the most preferred to the least preferred. The ranking reports submitted by the four players determine the options that they will receive. Your earnings are based on the option you receive.

At the beginning of each round, the computer will assign each option a priority ranking for all players. A priority ranking is a list of all players in order from highest priority to lowest priority. Each option may be assigned a different priority ranking, so you may have a different level of priority for each of the four options. After all players submit their ranking reports, the computer uses the following method to decide which player is assigned to which option:

Step 1: Players are considered for the option they ranked first. If only 1 player is considered for that option, the player is provisionally assigned to it. If more than 1 player is considered for the same option, the option is provisionally assigned to the player with the highest priority rank at that option. Players that are not provisionally assigned to an option are permanently excluded from that option.

Step 2: Players that have been provisionally assigned in Step 1 are considered again for the respective option. Players that were rejected in Step 1 are considered for the next option in their ranking report. If only 1 player is considered for an option, the player is provisionally assigned to

it. If more than 1 player is considered for the same option, the option is provisionally assigned to the player with the highest priority rank. Players that are not provisionally assigned to an option are permanently excluded from that option.

Step 3: Players that have been provisionally assigned in Step 2 are considered again for the respective option. Players that were rejected in Step 2 are considered for the next option in their ranking report. If only 1 player is considered for an option, the player is provisionally assigned to it. If more than 1 player is considered for the same option, the option is provisionally assigned to the player with the highest priority rank. Players that are not provisionally assigned to an option are permanently excluded from that option.

- - -

The computer continues to follow this process until all players are provisionally assigned to an option. At this step, all provisional assignments become permanent assignments.

After all players in your group submit their ranking reports, you will find out the option you were assigned to and the corresponding earnings.

Instructions (IA)

Introduction

This is an experiment in economic decision making. If you pay attention to these instructions, you can earn a significant amount of money. If you have any questions, raise your hand and we will come to assist you. Your earnings will depend on the decisions you make and the decisions made by other participants during the experiment. These earnings will be paid in addition to your $10 show-up payment.

Instructions

This experiment consists of 1 round, and your earnings depend on the decisions you make and the decisions made by other players in that round. First, there will be 4 practice rounds for you to familiarize yourself with the decision environment. These practice rounds will not affect your earnings. At the beginning of each round, you will be randomly assigned to groups of 4. Each round has 4 options: Option A, Option B, Option C and Option D. Each option will be exclusively assigned to one of the players in the group. For every round, each player submits a preference ranking for every option from the most preferred to the least preferred. The ranking reports submitted by the four players determine the options that they will receive. Your earnings are based on the option you receive.

At the beginning of each round, the computer will assign each option a priority ranking for all players. A priority ranking is a list of all players in order from highest priority to lowest priority. Each option may be assigned a different priority ranking, so you may have a different level of priority for each of the four options. After all players submit their ranking reports, the computer uses the following method to decide which player is assigned to which option:

Step 1: Players are considered for the option they ranked first. If only 1 player is considered for that option, the player is assigned to it. If more than 1 player is considered for the same option, the option is assigned to the player with the highest priority rank.

Step 2: Players that are not assigned to an option after Step 1 are considered for the option they ranked second. If only 1 player is considered for that option and that option is not yet assigned, the player is assigned to it. If more than 1 player is considered for the same option and that option is not yet assigned, the option is assigned to the player with the highest priority rank.

Step 3: Players that are not assigned to an option after Step 2 are considered for the option they ranked third. If only 1 player is considered for that option and that option is not yet assigned, the player is assigned to it. If more than 1 player is considered for the same option and that option is

not yet assigned, the option is assigned to the player with the highest priority rank.

Step 4: If a player has not been assigned to an option after Step 3, he/she is assigned to the option ranked fourth in his/her ranking report.

After all players in your group submit their ranking reports, you will find out the option you were assigned to and the corresponding earnings.

Instructions (TTC)

Introduction

This is an experiment in economic decision making. If you pay attention to these instructions, you can earn a significant amount of money. If you have any questions, raise your hand and we will come to assist you. Your earnings will depend on the decisions you make and the decisions made by other participants during the experiment. These earnings will be paid in addition to your $10 show-up payment.

Instructions

This experiment consists of 1 round, and your earnings depend on the decisions you make and the decisions made by other players in that round. First, there will be 4 practice rounds for you to familiarize yourself with the decision environment. These practice rounds will not affect your earnings. At the beginning of each round, you will be randomly assigned to groups of 4. Each round has 4 options: Option A, Option B, Option C and Option D. Each option will be exclusively assigned to one of the players in the group. For every round, each player submits a preference ranking for every option from the most preferred to the least preferred. The ranking reports submitted by the four players determine the options that they will receive. Your earnings are based on the option you receive.

At the beginning of each round, the computer will assign each option a priority ranking for all players. A priority ranking is a list of all players in order from highest priority to lowest priority. Each option may be assigned a different priority ranking, so you may have a different level of priority for each of the four options. After all players submit their ranking reports, the computer uses the following method to decide which player is assigned to which option:

Step 1: Each player is provisionally assigned to the option at which he/she has the highest priority. If a player ranks his/her provisionally assigned option first, a 1-way cycle is formed and he/she is permanently assigned to that option (see Figure 1a). Assignments may also be resolved by 2-way, 3-way or 4-way cycles.

For example, if Player 1 ranks Player 3's provisionally assigned option first, and Player 3 ranks Player 1's provisionally assigned option first, this is a 2-way cycle (see Figure 1b). Both players are permanently assigned to their first-ranked option. (This example is for illustrative purposes; other similar combinations of players and options also form 2-way cycles.) A 3-way cycle is formed, for example, if Player 1 ranks Player 2's provisionally assigned option first, Player 2 ranks Player 3's provisionally assigned option first and Player 3 ranks Player 1's provisionally assigned option

first (see Figure 1c). All three players are permanently assigned to their first-ranked option. (This example is for illustrative purposes; other similar combinations of players and options also form 3-way cycles.)

A 4-way cycle is formed in a similar fashion.

Options that are permanently assigned are removed from the list of available options.

Step 2: If a player is not permanently assigned and his/her first-ranked option is not permanently assigned to another player after Step 1, assignments may be resolved by 2-way or 3-way cycles with the first-ranked option in his/her ranking report and the available options. Step 2 is repeated until either (a) a player is permanently assigned to his/her first ranked option or (b) until his/her first-ranked option is permanently assigned to another player.

Options that are permanently assigned are removed from the list of available options.

Step 3: If a player is not permanently assigned and his/her first-ranked option is permanently assigned to another player after Step 2, assignments may be resolved by 1-way, 2-way or 3-way cycles with the second-ranked option in his/her ranking report and the available options. Step 3 is repeated until either (a) a player is permanently assigned to his/her second-ranked option or (b) until his/her second-ranked option is permanently assigned to another player.

Options that are permanently assigned are removed from the list of available options.

Step 4: If a player is not permanently assigned and his/her second-ranked option is permanently assigned to another player after Step 3, assignments may be resolved by 1-way or 2-way cycles with the third-ranked option in his/her ranking report and the available options. Step 4 is repeated until either (a) a player is permanently assigned to his/her third-ranked option or (b) until his/her third-ranked option is permanently assigned to another player.

Options that are permanently assigned are removed from the list of available options.

Step 5: If a player is not permanently assigned after Step 4, a 1-way cycle is formed with the fourth-ranked option in his/her ranking report, and he/she is permanently assigned to his/her provisional assignment.

After all players in your group submit their ranking reports, you will find out the option you were assigned to and the corresponding earnings.

Figure 1a: 1-way cycle



Figure 1b: 2-way cycle

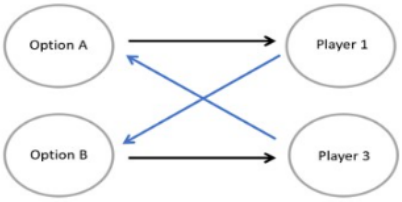
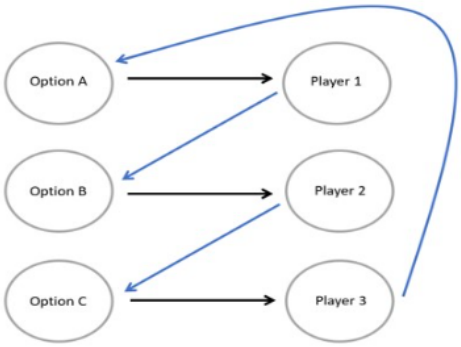


Figure 1c: 3-way cycle



Comprehension Quiz - Each question was displayed on a different page

1. An option can be assigned to more than 1 player in a group.
   - ○ True
   - ○ False
2. In the figure below, the player who is viewing the screen is:
   - ○ Player 1
   - ○ Player 2
   - ○ Player 3
   - ○ Player 4

Practice Round 1: In this round, you are Player 3

Earnings by Assignment				
	Option A	Option B	Option C	Option D
Player 1	$20	$7	$14	$0
Player 2	$14	$0	$20	$7
Player 3	$7	$20	$0	$14
Player 4	$14	$7	$0	$20

Priority Ranking				
	Option A	**Option B**	**Option C**	**Option D**
First	Player 1	Player 3	Player 2	Player 4
Second	Player 4	Player 2	Player 3	Player 1
Third	Player 3	Player 4	Player 1	Player 2
Fourth	Player 2	Player 1	Player 4	Player 3

Please mark your ranking below:

First Choice: --------- Second Choice: --------- Third Choice: --------- Fourth Choice: ---------

3. According to the figure below, if I'm assigned to option A, my payoff would be:
   - ○ $0
   - ○ $7
   - ○ $14
   - ○ $20

Practice Round 1: In this round, you are Player 3

Earnings by Assignment				
	Option A	Option B	Option C	Option D
Player 1	$20	$7	$14	$0
Player 2	$14	$0	$20	$7
Player 3	$7	$20	$0	$14
Player 4	$14	$7	$0	$20

Priority Ranking				
	Option A	**Option B**	**Option C**	**Option D**
First	Player 1	Player 3	Player 2	Player 4
Second	Player 4	Player 2	Player 3	Player 1
Third	Player 3	Player 4	Player 1	Player 2
Fourth	Player 2	Player 1	Player 4	Player 3

Please mark your ranking below:

First Choice: --------- Second Choice: --------- Third Choice: --------- Fourth Choice: ---------

4. According to the figure below, I have a higher priority than Player 1 at Option C.
   - ○ True
   - ○ False

Practice Round 1: In this round, you are Player 3

Earnings by Assignment				
	Option A	Option B	Option C	Option D
Player 1	$20	$7	$14	$0
Player 2	$14	$0	$20	$7
Player 3	$7	$20	$0	$14
Player 4	$14	$7	$0	$20

Priority Ranking				
	Option A	**Option B**	**Option C**	**Option D**
First	Player 1	Player 3	Player 2	Player 4
Second	Player 4	Player 2	Player 3	Player 1
Third	Player 3	Player 4	Player 1	Player 2
Fourth	Player 2	Player 1	Player 4	Player 3

Please mark your ranking below:

First Choice: --------- Second Choice: --------- Third Choice: --------- Fourth Choice: ---------

5. Based on the figure below, if I submit Option B as my first choice, and players 2, 3 and 4 submit Options A, D and C as their first choice, respectively, I would be assigned to:

- ○ Option A
- ○ Option B
- ○ Option C
- ○ Option D

Practice Round 4: In this round, you are Player 1

Earnings by Assignment				
	Option A	Option B	Option C	Option D
Player 1	$14	$20	$0	$7
Player 2	$20	$7	$0	$14
Player 3	$14	$7	$0	$20
Player 4	$7	$14	$20	$0

Priority Ranking				
	Option A	**Option B**	**Option C**	**Option D**
First	Player 4	Player 3	Player 1	Player 2
Second	Player 2	Player 1	Player 3	Player 4
Third	Player 3	Player 2	Player 4	Player 1
Fourth	Player 1	Player 4	Player 2	Player 3

Please mark your ranking below:

First Choice: ---------

Second Choice: ---------

Third Choice: ---------

Fourth Choice: ---------

Screenshot of a Puzzle from the Raven's Progressive Matrices (RPM) Task

